

Implementation of global traceability standards: incentives and opportunities

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Abstract

Purpose – Implementing global traceability standards (GTSs) facilitates interoperability in food supply chains (FSCs). The purpose of this paper is to present incentives, opportunities and requirements for implementing GTSs in a fresh FSC.

Design/methodology/approach – The research was developed in two stages: a literature review was conducted to establish a theoretical framework; and then an in-depth case study of a Swedish fresh fish supply chain was conducted. The Kano methodology was used to evaluate opportunities based on implementation requirements in each enterprise.

Findings – FSC enterprises implement a GTS to meet legal food traceability requirements. This incentive is stronger among enterprises upstream in the FSC than among downstream enterprises. Downstream enterprises emphasize communication with the end consumer as an incentive to implement a GTS. Implementing a GTS increases the opportunity to preserve end consumer confidence, efficiency in information sharing, reduces time in inventory management and the risk of theft.

Research limitations/implications – The paper contributes to the field of food traceability by providing knowledge regarding incentives, opportunities and requirements for implementing standards to meet food traceability requirements at FSC enterprises.

Practical implications – Regulatory requirements on traceability preservation of food safety, quality and sustainability stipulate the implementation of a GTS. The research presented can support managers in understanding incentives and opportunities for implementing a GTS.

Originality/value – This paper combines in-depth academic research with the involvement of Swedish fresh food enterprises. The study is of benefit to fresh food enterprises, authorities and organizations in the further implementation and development of GTSs.

Keywords Tracking, Small-to-medium-sized enterprises, Standardization, Standards

Paper type Research paper

1. Introduction

Management of food traceability based on standardized approaches has gained considerable industrial interest during the last decade (Lowe and Taylor, 2013; Thakur and Hurburgh, 2009; Manzini and Accorsi, 2013). Development in the globalized food trade of raw materials (Trienekens *et al.*, 2012) and products has extended the transport distances between primary producers and consumers (Aung and Chang, 2014). Ensuring food traceability within the enterprise as well as in relationships with business partners has become crucial for food enterprises. Moreover, consumers have become more aware cooperative social responsibility in production, distribution and in purchase of specific food products (Manning, 2013). Food enterprises all over the world have to consider economic impacts from foodborne diseases (e.g. bovine spongiform encephalopathy, *Salmonella*, *Escherichia coli* strain O157:M) and food fraud, but also changes in consumer interest in safe, high quality and sustainable food products to maintain or improve market share and customer confidence.



In the European Union, legal requirements for food traceability and the establishment of traceability systems are specified in the European General Food Law (Folinas *et al.*, 2006; Asioli *et al.*, 2011). In the USA, mandatory rules on food traceability are provided in the Bioterrorism Act, which was written as a reaction to bioterrorism threats (Thakur and Hurburgh, 2009; United States, 2002), and in the Food and Safety Modernization Act (FSMA). The FSMA includes industrial guidelines and a system for preventive control, inspection and regulatory compliance of food safety regulations and for the recall of products in domestic and imported food supply chains (FSCs, United States, 2011). Thus, food traceability has become an important global economic and legal issue.

Food traceability in global FSCs can only be fully accomplished if food businesses apply standardized approaches that enable interoperability (Aung and Chang, 2014). Food traceability involves linking internal logistics systems (e.g. transportation, production) and recordkeeping systems used for business, safety and quality control. In addition, these systems must be connected to other logistics and recordkeeping systems used by business partners or regulatory bodies. Guidelines for following technical standards in the food industry are presented in the Directive (EC) 98/34. This directive states that the technical standards should be applied to a “product”, defined as “any industrially manufactured product and any agricultural product, including fish products” (Directive (EC) 98/34, Article 1). Previous studies have identified benefits in implementing standards to achieve food traceability (Ringsberg and Mirzabeiki, 2013; Aung and Chang, 2014; Thakur *et al.*, 2011) or to improve food safety and quality of food (Spadoni *et al.*, 2013; Henson and Reardon, 2005), but also barriers against implementation of standards (Lowe and Taylor, 2013) and the lack of standardization in information sharing among FSC enterprises (Storøy *et al.*, 2013). Thus, further research is needed to address opportunities in using global standards to achieve food traceability (Maruchek *et al.*, 2011). This paper aims to fill this gap by presenting incentives, opportunities and requirements of implementing global traceability standards (GTSs) in fresh FSCs. The case study approach was applied to meet the objective of the paper. The next section presents the applied methodology along with a description of the case study. This section is followed by a review of published literature (Section 3). Thereafter, the results and discussion are presented (Section 4), followed by conclusions (Section 5).

2. Methodology

2.1 Research design

The paper is based on a longitudinal (Eisenhardt, 1989) and an in-depth case study (Yin, 2009) conducted between 2011 and 2013 with the objective of identifying opportunities, incentives and requirements for implementing a GTS in fresh FSCs. To fulfil this objective, a questionnaire including both structured and semi-structured interview questions was prepared (Bryman and Bell, 2007). The questionnaire was sent out to 15 enterprise owners and logistics managers employed by enterprises, with a total response rate of 80 per cent. Structured interview questions were used to identify whether implementing a GTS generates business opportunities for an FSC enterprise. The questions also inquired the level and source of knowledge each FSC enterprise had about GTSs. To ensure reliability in the answers, each structured question was formulated as a pair of statements: one functional (positive statement) statement to score the level of satisfaction if a requirement is fulfilled followed by a dysfunctional (negative) statement to show the emotional reaction if a requirement is disregarded (Bergman and

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Klefsjö, 2007; Kano, 2001; Kano *et al.*, 1984). The answer to each question was classified according to the following alternatives: I like it that way; it must be that way; I am neutral; I can live with it that way; and I dislike it (Kano, 2001; Kano *et al.*, 1984) (Table I).

The following categories were used to evaluate the satisfaction indicated in the answer to each question:

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- must-be requirements (M): a lack of must-be requirement causes dissatisfaction;
- one-dimensional requirements (O): requires attention since meeting these requirements increases satisfaction;
- attractive requirements (A): increases satisfaction;
- indifferent requirements (I): does not provide either satisfaction or dissatisfaction;
- reverse requirements (R): causes dissatisfaction; and
- questionable (Q): includes questionable results because of an incorrect or misunderstood question (MacDonald *et al.*, 2006).

Semi-structured questions requested information about the incentives of implementing and possessing knowledge about GTSs, and about the size of each FSC enterprise in terms of annual turnover and number of employees. The complete analysis of each answer to the semi-structured questions was reviewed and confirmed by the interviewee according to Yin (2009). Incentives and requirements of implementing a GTS were evaluated according to economic, time and communication aspects identified in the literature (Table II).

Table I.
Example of
the structured
questions used

Survey question statement	Classification
If an implementation of a GTS <i>would have</i> an impact on the operational time required for information sharing with business partners, how would your company experience it?	I like it that way
	It must be that way
	I am neutral
	I can live with it that way
	I dislike it that way
If an implementation of a GTS <i>would not</i> have an impact on the operational time required for information sharing with business partners, how would your company experience it?	I like it that way
	It must be that way
	I am neutral
	I can live with it that way
	I dislike it that way

Table II.
The unit of analysis
and evaluation
aspects of
implementing a GTS

Unit of analysis	Evaluation aspects	
	Incentives	Requirements
Economic	Costs of implementing standards	Sales revenue
	Cost information management	Cost of information sharing
Time	Information sharing to meet legal traceability requirements	Cost of product identification
		Information sharing
	Information sharing to improve business	Inventory management
Communication	Preservation of consumer confidence in products	Registering of products
		Risk of theft
		Risk of fraud

To meet food traceability requirements, FSC enterprises in a supply chain (SC) have to cope with similar requirements for food safety, quality and sustainability in their relationships with business partners. Lambert *et al.* (1998) also stressed that the number of enterprises within a tier and the number of tiers across an SC are crucial in the description, analysis and management of SCs. Based on the annual turnover and the number of employees, cluster analysis (Humphries *et al.*, 2007) was applied in the description of the fresh FSC.

2.2 Case study

Requirements on traceability in fish supply chains include prevention of overfishing; reduction of the environmental impact of fish farms and wild-capture fisheries; and reduction of illegal fisheries (United Nations Global Compact Office, 2014). In the European Union each enterprise in the fishing industry must fulfil traceability requirements on codfish products no later than 1 January 2013 (Regulation (EC) No. 404/2011, Article 67). Increased time and costs in the logistics management of codfish products to meet regulatory requirements on fishery control and food traceability have been reported in previous studies (Ringsberg and Mirzabeiki, 2013).

Based on the legal requirements for fishery control and traceability, a sample of micro- (i.e. employs less than ten persons), small- (i.e. employs 10-50 persons) and medium-sized enterprises (employs 50-250 persons) (European Commission, 2003) in a FSC of fresh codfish from the Baltic Sea was selected for the case study (Figure 1).

The sample is illustrated in Table III and included fishing vessels, wholesalers and retailers with business ranging from a one-employer hook fishing vessel with an annual turnover of approx. €9,600-€15,000 to a process industry with 20 employees and an annual turnover of €1,000,000-€1,500,000. The Tier 3 suppliers supply the Tier 2 suppliers with fresh fish, based on business agreements. Tier 1 retailers receive fresh fish from Tier 1 suppliers. Tier 3 suppliers and Tier 1 companies are micro-sized family-owned companies with limited financial resources, while Tier 2 suppliers and the Tier 1 suppliers are small- and medium-sized companies owned by several shareholders and hence have greater financial resources. It ought also to be noted that the Tier 1 supplier fish auction is partly owned by Tier 3 suppliers. Thus, the sample represents the diversity of enterprises in the Swedish fishing industry between 2011 and 2013.

All enterprises in the fresh codfish SC are knowledgeable about global food safety and quality standards, such as the Food safety and Certification (FSSC22000) standard and the Marine Stewardship Council (MSC) standard, through their daily business. They are also knowledgeable about the Electronic Product Code Information Services

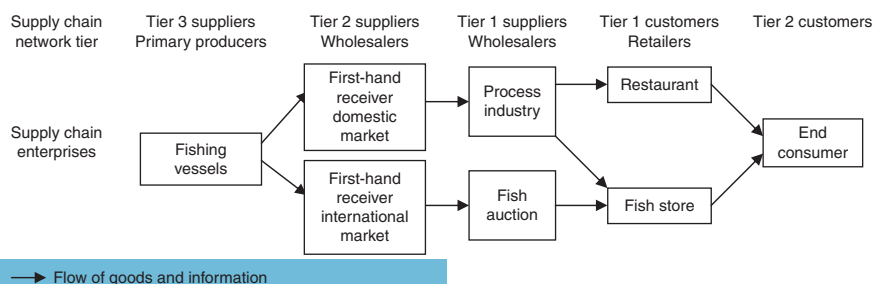


Figure 1.
The Swedish fresh codfish SC

→ Flow of goods and information

BFJ 117,7	SC cluster	SC enterprises	No. of enterprises included	Approx. annual turnover (€)	No. of employees	
1830	Tier 3 suppliers	Hook fishing vessel	1	8,000-15,000	1	
	Primary producers	Net fishing vessel	2	20,000-50,000	2-4	
		Trawl fishing vessel	2	100,000-150,000	3-4	
	Tier 2 suppliers	First-hand receiver, domestic market	1	1,000,000-1,500,000	4	
		Wholesalers	First-hand receiver, international market	2	1,500,000-2,000,000	20-25
	Tier 1 suppliers	Wholesalers	Fish auction	1	1,000,000-1,500,000	10
		Tier 1 customers	Process industry	1	1,000,000-1,500,000	70
	Retailers		Fish store	1	600,000-800,000	3
	Restaurants		Restaurant	1	150,000-200,000	5-10

Table III.
Sample enterprises
involved in
the case study

(EPCIS) standard (EPCglobal, 2014) through their involvement in a previous published research project.

3. Literature review

3.1 Standardized information sharing in FSCs

Standardized information sharing approaches to meet food traceability requirements has been addressed in terms of improved data exchange and communication in FSCs. Food traceability requirements for food quality, safety and sustainability can only be completely achieved using interoperable systems for management and regulatory control within FSCs. According to Marakas and O'Brien (2013), interoperability is defined as "Being able to accomplish enduser applications using different types of computer systems, operating systems and application software, interconnected by different types of local and wide area networks" (Marakas and O'Brien, 2013, p. 692). Research has also been published that presents frameworks to enhance interoperability according to food traceability requirements (e.g. Storöy *et al.*, 2013; Salampasis *et al.*, 2012) but which also emphasizes interoperability in the development of global food traceability standards and regulations (Zhang and Bhatt, 2014).

To support Directive (EC) 98/34, the European Interoperability Framework (EIF) has been developed. The EIF includes recommendations and guidelines about providing pan European electronic government services to ease public administration and interactions between enterprises and citizens across European borders (European Communities, 2004). It identifies four categories of interoperability (European commission, 2010; European Communities, 2004):

- (1) Technical interoperability refers to formalizing technical specifications (e.g. interface specifications, interconnection services, data integration services) based on a mutual request of information. Thus, technical interoperability is characterized by the use of standardized messaging technology and information exchange protocols (e.g. Simple Object Access Protocol (SOAP)) to integrate IT systems (Cimino and Marcelloni, 2011).
- (2) Semantic interoperability refers to the significance of information and technical aspects to achieve information sharing. Linked to the significance of

information, semantic interoperability employs principles about information structure; i.e. the structural design of shared information environments (Information Architecture Institute, 2007). Published research emphasizes that the information structure to achieve traceability should consist of separate information layers. The layers should be created based on management of information (Thakur and Donnelly, 2010) and requirements regarding acquisition of information from FSC enterprises (Folinas *et al.*, 2006; Aung and Chang, 2014).

- (3) Organizational interoperability refers to cooperation to achieve mutually established goals of integrating business and logistics processes based on information exchange.
- (4) Legal interoperability refers to maintaining the legal validity of information exchanged across borders and legislation to protect information.

3.2 GTSs

Due to the development of globalized FSCs, there is a need for standardized and harmonized requirements that provide opportunities for regulatory bodies to react efficiently with respect to food safety deficiencies but which also allow food enterprises to adapt to traceability requirements in their business operations (Zhang and Bhatt, 2014). One of the biggest challenges for FSC enterprises today is reliable information sharing in relations with business partners and regulatory bodies to meet traceability requirements. Application of GTSs is essential to enable efficient information sharing in FSCs (Trienekens and Zuurbier, 2008). Organizations such as the Codex Alimentarius Commission (CAC), the International Organization for Standardization (ISO), MSC and the Global Standardization Organization 1 (GS1) are important actors in developing GTSs and industrial guidelines on food traceability. Certification bodies and business associations also play a role in the development of GTSs because voluntary methods, product labelling certified by private enterprises, or private voluntary certification are applied in the European Union to meet legal food traceability requirements (Souza-Monteiro and Caswell, 2010).

3.2.1 CAC standard. The CAC standard was developed to protect the public health and to serve as an industrial guideline to balance trade relationships in FSCs. The standard includes principles regarding analysis and sampling methods and the management of food hygiene, pesticide residues, contaminants, and labelling. The CAC standard further recommends the use of the Hazard Analysis of Critical Control Protocol (HACCP) for quality assurance and to maintain safety in the food supply (Trienekens and Zuurbier, 2008).

3.2.2 Standards provided by ISO. ISO has published a number of standards concerning food traceability based on the ISO 9000 series for Quality Management Systems (QMS). For example, ISO 9001: 2000 (International Organization for Standardization (ISO), 2012) includes a standard model for food quality management and assurance, but excludes issues regarding food safety. ISO 9001: 2008 (International Organization for Standardization (ISO), 2008) highlights the importance of unique identification to enable food traceability. Food traceability according to food safety requirements is further addressed in ISO 22000: 2005, which emphasizes management system requirements, establishment of QMS based on ISO 9000, and analysis of food hazards based on HACCP (International Organization for Standardization (ISO), 2005).

ISO 22000: 2007 includes principles and basic requirements for designing and implementing food traceability systems and formalizes the use of a traceable resource unit in its definition of "lot". The standard also introduces the requirement that each FSC enterprise must define attributes to be acquired, collected and shared at each stage so that they can be communicated to customers. Thus, each FSC enterprise must know their immediate business partners according to the "one up" and "one down" principle (International Organization for Standardization (ISO), 2007).

ISO standards structures information into layers based on the use of the terms shall (i.e. on mandatory information), should (i.e. on recommended information) and may (i.e. on optional information). The structure is especially used in sector-specific standards on the traceability of fish and fishery products, such as ISO 12877:2011 and ISO 12875:2011. However, ISO standards and guidelines do not specify any method to meet legal food traceability requirements. The methods are not specified because ISO standards primarily are oriented to "business to business" transactions in FSCs.

3.2.3 GTs provided by certification and business associations. Private food safety and quality standards developed by certification bodies or business associations focus on commercial interests in information sharing and identifying products to meet food traceability requirements. To ensure convergence between food safety and quality standards, and to maintain benchmarking of private food safety management schemes, the Global Food Safety Initiative (GFSI) was formed (Powell *et al.*, 2013; Mensah and Julien, 2011). The GFSI includes the following five internationally accepted food safety management schemes: British Retail Consortium (BRC); International Food Standard (IFS); Dutch HACCP; Safe Quality Food Code (SQF Code); and FSSC 22000. The BRC standard include recommendations and best practice guidelines to enable traceability in food production processes based on principles of HACCP, a documented quality management system, manufacturing environment and facilities, product and process control and personnel (British Retail Consortium, 2009). The IFS standard, is a standard for auditing retailer, wholesalers and suppliers/producers of branded food products, to ensure safety in activities for processing, handling of loose food products and primary packing (IFS, 2014). The SQF Code standard was developed to enable food traceability in the processes of primary production, transport and distribution of food based on principles about food safety and quality management, HACCP. Thus, the SQF standard is convergent with guidelines from CAC. In addition, the SQF includes guidelines about the unique identification of animals and products and the withdrawal and recall of unsafe food products (Safe Quality Food Institute, 2012). The FSSC 22000 standard is developed to support implementation of ISO 22000 guidelines in production of food and drinks to ensure consumer trust. The standard include the certification scheme and the audit protocol to meet food safety requirements of ISO 22000 standard (FSSC22000, 2014).

In addition, MSC has developed standards for wild capture fisheries, including the MSC Chain of Custody Standard for Seafood Traceability. The standard requires traceability by batch from initial production until sales to end consumers as well as the segregation of certified products from non-certified products at all steps in the SC. To ensure traceability, the standard uses the MSC Ecolabel which originated from a certified fishery. In compliance with the MSC Chain of Custody Standard for Seafood Traceability, the ASC has developed standards for farmed seafood (MSC, 2014; United Nations Global Compact Office, 2014)

Literature on GTs shows that most developed standards lack guidelines about standardized identification of products. However, GTs based on the use of GS1

identification keys have also been published, such as the GS1 GTS, the EPCIS standard and the Global Good Agricultural Practices (GLOBALG.A.P.) standard.

3.2.4 GTSs provided by GS1. The GTS is a voluntary business process standard developed by the GS1 and is based on principles about data acquisition from traceable units (e.g. products, logistical units, trade units) and locations through the use of GS1 identification keys (GS1, 2014). The standard meets basic legal and business requirements on food traceability. Likewise, the EPCIS standard is a voluntary standard that enables food traceability through the use of unique EPC identity keys provided by GS1 (Manzanares-Lopez *et al.*, 2011; EPCglobal, 2014). EPCIS provides an event-based architecture (i.e. the EPC architecture) that consists of four types of events for structured storage and communication of information linked to the distribution of products (Bottani and Rizzi, 2008). The EPC architecture observes risks with information visibility in the sharing and structuring of information to ease interoperability in SCs (EPCglobal, 2014). Published studies also confirm that the EPCIS standard meets basic food traceability requirements (e.g. Thakur *et al.*, 2011).

To ensure good agricultural practices in primary food production and to preserve consumer confidence based on compliance with consumer safety and sustainable requirements, the GLOBALG.A.P. standard was developed. GLOBALG.A.P. pays special attention to assuring food safety, animal welfare, environmental protection and worker health and safety. It includes HACCP principles and makes a distinction between guidelines for growers and farmers (i.e. prefarm gate) and guidelines for food packing and processing enterprises (i.e. postfarm gate). To ensure the traceability of batches, the GLOBALG.A.P. The standard uses unique GLOBALG.A.P. numbers (GGNs) that are linked to harvest data about each produced batch. The GGN identity key is based on the GS1 identification key system to ease communication among FSC enterprises (Globalgap, 2014).

4. Results and discussion

4.1 Incentives to implement GTS

In the studied Swedish fresh codfish SC, the main incentive to implement a GTS addressed by FSC enterprises was to meet legal traceability requirements on fishery control. The results show that this incentive is stronger among enterprises upstream in the FSC (i.e. Tier 3 suppliers) than among downstream enterprises (i.e. Tier 1 suppliers) which emphasize the improvement of business. According to regulatory requirements on fishery control in the European Union, primary producers (i.e. fishing vessels) must share information with governmental authorities within 24 hours to avoid costs of legal actions. Micro-sized FSC enterprises with limited financial resources have greater difficulties meeting the costs of legal actions than small- or medium-sized enterprises in the FSC.

Moreover, the costs of implementing a GTS in the business of a micro-sized enterprise are lower than those of a small- or medium-sized enterprise. This is because the license cost of a GTS is determined based on the annual turnover of the enterprise (i.e. the license cost is lower for a micro-sized enterprise since the annual turnover is lower). The initial costs of structuring information according to the recommendations of a selected GTS increases with the volume of information about goods that need to be managed. Therefore, the initial costs of structuring information according to a selected GTS are lower for a micro-sized enterprise (e.g. fishing vessel, a restaurant or a fish store) than for a small- or medium-sized enterprise. However, the results revealed

a difference in incentives among Tier 3 suppliers. The net fishing vessels emphasized improvement of communication with the end consumer in preserving confidence, while the trawl fishing vessels and first-hand receivers active in the international market identified improved information sharing with international trade organizations.

The main incentive in implementing a GTS, emphasized by the two Tier 1 suppliers, was to improve information sharing with customers. To illustrate this incentive, the following quotation from the transcribed semi-structured interviews is provided:

[...] standards provide a simplified approach to communicate and exchange information. We use XML in communication with governmental authorities today and will implement standards in sales procedures if our customers request it [...] (fish auction manager).

The above quotation illustrates the incentive to implement a GTS associated with the simplification of communication of information with customers. This is also emphasized by the two Tier 1 customers (i.e. fish store and restaurant), illustrated by the following quotation:

[...] sometimes we get a lot of questions regarding the safety and origin of our products from our customers. We have the required information since we have to meet regulatory requirements on food safety, quality and fishery control, but we don't know what information must be communicated to meet their requirements. A standard can help us to identify this information [...] (fish store owner).

The last quotation also shows an incentive to improve the communication of safety and quality information to end consumers and confirms previous published studies on forgery and the mislabelling of goods in FSCs (Warner *et al.*, 2013; Cawthorn *et al.*, 2013).

4.2 Opportunities and requirements for GTS implementation

The implementation of a GTS facilitates interoperability in FSCs, and opportunities are created for enterprises based on the efficiency to meet food traceability requirements. Table IV presents the opportunities identified during the analysis of the semi-structured interviews according to economic, time and communication aspects.

The results presented in Table IV above show opportunities to preserve the end consumer's confidence during sales based on the facilitated presentation of information by implementing a GTS. Several studies in the field of food traceability confirm the importance of efficient communication of information on food safety and quality in preserving consumer confidence in food products (Kher *et al.*, 2010; Hobbs *et al.*, 2005). Regarding economic and time aspects in implementing a GTS to meet legal food traceability requirements, opportunities to reduce the costs and time of information sharing, identification and registering of products and inventory management have been identified. These opportunities are all linked to the business benefits of facilitated information management based on the implementation of standards (Brunsson and Jacobsson, 2002).

The analysis revealed improved communication based on opportunities to reduce the risk of fraudulent mislabelling of products due to the implementation of GTSs. This is because a GTS includes guidelines for the presentation of information on transport units and consumer packages. For example, published research shows that approx. 33 per cent of all fishery products in the European Union and the USA and 68 per cent of all meat products in South Africa are fraudulently mislabelled (Cawthorn *et al.*, 2013; Warner *et al.*, 2013). In addition, many GTSs are based on the use of unique

Table IV.
Opportunities of
implementing GTSs
in a Swedish fresh
codfish SC

Unit of analysis	Evaluation aspects	Opportunities of implementing GTSs
Economic	Sales revenue	Preserve end consumer confidence; a GTS facilitates communication of information during sales
	Cost of information sharing	Reduce costs of labour and additional software required to convert data to share information
	Cost of product identification	Reduce costs of product identification
Time	Information sharing	Reduce time required for manual information sharing; a GTS eases automatic electronic information sharing without human intervention
	Inventory management	Reduce time required in identification of products during inventory operations; a GTS eases identification due to the standardized structure
	Registering of products	Reduce time required for registration of products; the standardized structure provided by a GTS eases identification within registers
Communication	Risk of theft	Reduce risk of theft due to increased monitoring of products; the use of standardized unique identification keys
	Risk of fraud	Reduce risk of fraud due to increased verification of goods labelling; guidelines about presentation of information attributes on labels

identification keys in the labelling of products (e.g. GS1 identification keys). Communication of unique identification keys associated with the physical product flow reduces the risk of theft based on improved monitoring opportunities. Hence, implementation of a GTS might be beneficial in meeting legal (e.g. European General Food Law; Regulation (EC) 1224/2009) and consumer food traceability requirements. Meeting legal food traceability requirements on fishery control is of special importance to FSC enterprises because a violation not only implies increased legal costs but also poses the risk of losing a business or fishing license.

The identified opportunities of implementing a GTS were subjected to requirements analysis based on the Kano methodology (Table V).

The results presented (Table V) show that most enterprises (except the two first-hand receivers active in the international market) emphasize opportunities (i.e. must-be or attractive requirements) to preserve consumer confidence and increase efficiency (i.e. reduce costs and time) in information sharing by implementing a GTS. An interesting result concerning communication with end consumers is that the fishing vessels see opportunities to improve communication by implementing a GTS. This may be explained by the fact that micro- and small-sized enterprises emphasize the quality of the product to a higher degree than do medium- and large-sized enterprises. The result shows that opportunities to improve communication with end customers based on the implementation of a GTS are mainly emphasized by micro-sized enterprises upstream (i.e. fishing vessels) that have to comply with legal requirements on fishery control, and by micro or small enterprises downstream in the FSC that need to consider consumer requirements (fish auction, process industry, restaurant and fish store). The results presented (Table V) also indicate that enterprises with limited financial resources may experience benefits in the preservation of consumer confidence and comply with legal traceability requirements based on the implementation of a GTS.

Table V.
Opportunities and requirements of implementing GTSS in the fresh codfish SC

Opportunities	Requirements												
Preserve consumer confidence	M	M	M	M	A	I	I	M	M	M	M	M	M
Reduce the cost of information sharing	M	M	M	M	A	I	I	M	M	M	M	M	A
Reduce the cost of product identification	M	M	M	M	M	M	M	M	M	M	M	M	A
Reduce the time required for information sharing	M	M	M	M	A	A	I	M	M	M	M	M	I
Reduce the time required for inventory management	M	M	M	M	A	M	M	M	M	M	M	O	M
Reduce the time required for registering of products	M	M	M	M	M	M	M	M	M	M	M	O	I
Reduce the risk of theft	M	M	M	M	M	M	M	M	M	M	M	M	A
Reduce the risk of fraud	M	M	M	M	M	M	M	M	M	M	M	M	O
Trawl fishing vessel	Trawl fishing vessel	Trawl fishing vessel	Hook fishing vessel	Net fishing vessel	Net fishing vessel	Net fishing vessel	Domestic first hand receiver	International first hand receiver	International first hand receiver	International first hand receiver	Process industry	Fish auction store	Fish Restaurant

Notes: M, must-be requirements; O, one-dimensional requirements; A, attractive requirements; I, indifferent requirements; R, reverse requirements; Q, questionable results

Furthermore, the results presented indicate an opportunity for all enterprises to reduce costs of product identification as a requirement of implementing a GTS. However, this may be linked to decreased costs of utilizing standardized identification keys (such as GS1 identification keys).

The opportunity to reduce time in inventory management by implementing a GTS is stressed as a requirement by most enterprises (i.e. must-be, indifferent and attractive requirements). This is of special interest for the fish auction, since the results show that implementation of a GTS will reduce time for inventory (one-dimensional requirement). At the fish auction, goods are labelled with a variety of information attributes, which adversely affects the time needed for identification of goods during inventory. Implementation of a GTS at the fish auction will decrease the time used for identification of goods during inventory, based on a more standardized/unified labelling. Similarly, implementation of a GTS will reduce the amount of time used in registering products for the hook fishing vessel and net fishing vessel enterprises and for the process industry, based on a reduction of the information attributes that must be registered. The satisfaction of implementing a GTS to reduce time in registering products will increase at the fish store (i.e. attractive requirement) due to the reduction of information attributes.

Regarding the opportunity to reduce the risk of theft, most enterprises emphasized this as a requirement of implementing a GTS. Surprisingly, this was indicated by the fishing vessels, since the risk of theft is associated with the management of goods within fishing activities or landing operations but is also associated with the sensitivity of fresh codfish products. Because of this, the result may be explained by the fact that the risk of theft also includes the costs of theft of fish boxes leased by the fishing vessels. Similarly, the results presented (Table V) show an opportunity to reduce the risk of fraud by implementing a GTS. Based on the opportunity to reduce the risk of fraud, the results show an increased satisfaction at the restaurant (one-dimensional requirement). This is because the restaurant sees the implementation of a GTS as an approach to ensure the origin of products and to prevent the mislabelling of products. The interviews revealed challenges in implementing GTSs related to cost and development.

Cost-related challenges referred to sharing of initial costs to achieve semantic interoperability, such as costs of structuring or restructuring data according to the information structure of a selected GTS (e.g. development costs of transcription modules and labour), and the costs of uniquely identifying products (e.g. costs of GS1 identification keys). The costs are affected by the volume of information about products that need to be registered and communicated in the FSC.

Development-related challenges referred to the further development and implementation of GTS in a FSC. These include improvement of GTSs linked to information visibility and the need to preserve an enterprise's integrity. Food traceability is positively related to the information visibility aspect of transparency. However, transparency increases the difficulties of protecting an FSC enterprise's integrity due to similarities in competitive interests (Trienekens *et al.*, 2012). In addition, the literature indicates the further development of GTSs regarding legal interoperability, guidelines on unique product identification and interconnectivity (except standards provided by GS1 and the GLOBALG.A.P. standard).

5. Conclusions and further research

The implementation of GTSs plays a significant role in ensuring the quality and safety of food in the FSC. The presented research shows that enterprises in fresh FSCs

have different incentives and benefit opportunities associated with the implementation of a GTS.

The analysis of the incentives to implement a GTS in a fresh codfish SC shows that the main incentive of enterprises is to meet legal food traceability requirements, which confirms previously published studies (e.g. Escanciano and Santos-Vijande, 2014; Ringsberg and Mirzabeiki, 2013). The results from conducted interviews reveal that the incentive is emphasized more by micro-sized enterprises upstream in the FSC than by downstream enterprises. This is because micro-sized enterprises have greater difficulties in meeting costs resulting from legal actions and have lower implementation costs (license costs and costs of structuring information) than small- or medium-sized enterprises farther up in the FSC.

One of the most significant results is the opportunity to respond efficiently to legal and end consumer food traceability requirements through the implementation of a GTS. The results reported an increased incentive to improve communication with customers based on improved information sharing and labelling of goods associated with the implementation of a GTS. Since communication with customers could be facilitated by the implementation of a GTS, improvement opportunities are mainly emphasized by micro- and small-sized enterprises downstream in the FSC (i.e. fish auction, process industry, restaurant and fish store) that must consider consumer requirements and the recall of products. However, the presented research shows that fishing vessels also perceive opportunities to improve communication with end consumers based on the implementation of a GTS. This is because micro- and small-sized enterprises may emphasize the quality of the product to a higher degree than do medium- and large-sized enterprises. Thus, micro and small enterprises with limited financial resources experience benefits from preserving consumer confidence and complying with legal traceability requirements based on the implementation of a GTS.

In addition, the results indicated opportunities to reduce time in inventory management based on implementation of a GTS in labelling of goods. These opportunities contribute to the efficiency due to unique identification and reduction of information attributes during registration of goods within management of internal traceability. One interesting result regarding the reduction of the risk of theft through the implementation of a GTS is that fishing vessels emphasized this as an opportunity. This indicates that further studies are needed that identify theft of products or transport units and that quantify the costs to reduce the risk of theft in fresh FSCs. The results also indicated opportunities to prevent fraudulent mislabelling of fish products based on the implementation of a GTS within retail. Due to this, another subject for further research is the quantification of the costs of fraudulently mislabelled food products and the implementation of a GTS to prevent the mislabelling of food products. Furthermore, enterprises active in the international market indicate the improvement of information sharing with trade organizations as an incentive to implement a GTS. To ensure traceability across European national borders, further research will now be undertaken to determine the business impacts of implementing a GTS in export enterprises.

Challenges in implementing GTSs in fresh FSCs are related to either cost or development. Cost-related challenges include sharing the initial costs of structuring or restructuring information and of uniquely identifying products. Development-related challenges include preserving an enterprise's integrity according to the risk of information visibility, observing legal interoperability and including guidelines about unique product identification in the further development of GTSs.

Knowledge concerning incentives, opportunities and challenges can also support managers at FSC enterprises and governmental authorities in their decisions about implementing GTSs to meet legal and end consumer food traceability requirements. In order to achieve this, additional research will be carried out which focuses on the development of a GTS based on cooperation between a standardization organization, FSC enterprises and a governmental authority. Further research is needed on quantifying the costs and time required to implement a GTS. These are important factors regarding interoperability in global FSCs to meet food traceability requirements.

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Further reading

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