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Multiplex Uses of Food-Product Standards

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Abstract

Food-product traceability systems have been developed to achieve seamless electronic connectivity to assure food safety through the use of information technology. This is determined by legislation. While achieving customer value through quality, food supply is the core logistical purpose. Food-product traceability as such is seldom regarded as a core purpose. Food-product standards are a key resource in developing connectivity between information systems operated by different firms in a supply network using numerical product codes. This study couples the technical characteristics of a food-product standard with the organizational characteristics of a supply network. The common purpose is to achieve customer value in the supply network. Alderson's (1965) marketing-channels (transvection) model of product supply is applied to analyze potential multiple uses of the TraceFish product standard in its supply network. The case study of North Sea herring supply involves following raw material from in Norway to finished product in the Netherlands. Analysis of this empirical data exposed variation in TraceFish standard use, including coupling it with GTIN product codes. This facilitated seamless electronic information exchange between firms for a range of supply-network purposes, including tracing food. This perspective is possible when multiple functions and professions that are equally involved in operating and managing business processes are allowed to handle not only operation, but also develop information systems.

Keywords: seafood product standards, transvection, product traceability, multiplex resource use, food product value, supply networks.

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Background and Introduction

Food-product traceability is a global issue, as seen by the growing number of legislative measures in different countries. Product traceability requires that businesses have the expertise to retrieve product history in a complex, often long, food-product flow from raw material to consumption. Product traceability is an organizational competence. One major technical and economic challenge is developing information systems that support traceability. These are often called traceability systems. Swaroop et al. (2010) showed how experts view traceability as a vital component in improving safety and consumer confidence in food products. On the other hand, food-product traceability remains theoretically and practically underdeveloped (ibid. 2010). Canavari et al. (2010) examined traceability in relation to competiveness. Traceability may also be an organizational resource, since it solves a range of a company's societal and business needs. This evokes many useful facets regarding competence. This variation in traceability usage represents the foundation of this study. The research focuses on a specific technological component, which is a system of food-product standards called TraceFish.

Efforts toward developing food-product traceability primarily come from a technical angle aimed at automating and tracing information processes that register transformations from raw material to finished product. Information technology (IT) professionals have dominated many research and developmental projects involved in food-product traceability. This IT dominance in developing food-product traceability should be weighed against food supply as a collective responsibility of business actors that are networked to ensure food safety and quality (Engelseth 2009, Engelseth et al. 2009). The result of this unbalanced involvement of IT professionals is that companies with tacit knowledge of supply processes and a good perception of customer value are rendered passive partners in traceability-system development. This is partially due to IT project control and that IT is outside the companies' realm of proficiency.

Implementation of TraceFish has also proven challenging due to high investment costs, coupled with organizational inexperience in securing electronic traceability and a general lack of inter-organizational thinking. As a result, implementing electronic traceability has been slow (Engelseth and Nordli 2006). This resulted in research switching focus from implementing food-product traceability systems to developing trust as a foundation for cooperation in the supply network (Fritz 2008; Canavari et al. 2009; Hofstede et al. 2010). However, Canavari et al. (2010) noted that tracing products is one of many informational processes supporting an overall aim of a safe and quality food supply. This brings up the concept that tracing processes are interlinked with other processes involved in food supply. This also indicates that resources for tracing foods may have other uses in the supply network. The term multiplex is used to describe a form of complexity involving interaction between the TraceFish product-standard and other information resources in a relatively wide food-supply network organizational context. For analytical purposes, embedding TraceFish in an organizational context shows how this it can be interlinked with various purposes in a supply network normally characterized as a conglomerate of heterogeneous actors and processes.

Alternatively, information system (IS) development may provide technical efficiencies by widening the perspective of traceability development and implementation, thereby avoiding IS myopia. Investments in electronic traceability systems can also not be limited to just product traceability. When different IS system components are difficult to integrate, information processes may be duplicated. This is a form of waste that operates in parallel to satisfy the technical requirements of incompatible IS. This line of thought is in accordance with Engelseth and Nordli (2006). They proposed TraceFish as an economizing resource not solely as a means to facilitate a higher degree of automated product traceability, but to also include other potential societal and business uses in a supply network environment.

From a total cost perspective investment costs include other factors than a contracted price. A total cost of a purchase encompasses lifecycle costs as well as a range of "hidden" costs. This involves a mix of adapting the invested resource to business processes and adapting business processes to the resource. Finding the right balance between these adaptations in IT investment is never straightforward. Some help is found in that the aim of such adaptation should be functional; aligned with, if existent, an explicitly formulated business objective of securing customer value. The basic idea set forth in this paper is that food producers and distributors through investing in and implementing a potentially costly seafood product standard like TraceFish may increase the return on this IT investment by invoking uses in addition to those for which the standard was originally designed. Often understanding diverse use opportunities emerge over time among practitioners in organizations including both labor and management. Through this study we illustrate, however, in a proactive manner the multiplex use potential of the TraceFish seafood product standard. The concept of "multiplex" is used is this paper as an eye-opener; to evoke and underpin the potential of more than one use of the studied TraceFish seafood product standard. This approach to IT investment in food chains, searching for uses other than what the IT resource was originally designed for, is applicable to a range of business cases concerning IT investment in different types of food industry and in different stages of the chain, from raw-material production (agriculture/aquaculture/wild catch), through processing, distribution, and ultimately reaching businesses serving the end-user (retail/restaurant/catering). A focused study is provided here for illustrative purposes providing experiences of TraceFish implementation and use in a specific seafood supply network. The cases study illustrates a food chain including product traceability issues from a starting point of fishing herring off the coast of Norway, through production and Norway and then export to The Netherlands for further processing and retail purposes. This provides an inter-organizational, and therefore realistic setting for considering food product traceability issues. The supply network is a complex conglomerate of interconnected actors. Given that product supply is a collective responsibility and that traceability involves all actors who are stakeholders in product transformation and use, an end-to-end (or complete) supply-network analytical framework was used. In Alderson's (1965) analytical approach, a end-to-end, systems-oriented, marketing-channels model (transvection) is discussed and applied to analyze the potential for multiplex benefits of using the TraceFish standard in an IS.

The TraceFish Standard

The unit of analysis in this study is the supply network. The TraceFish standard is an artifact in relation to its multiplex, technical potential in a predominately managerial organizational context. In exploring this use potential, it is vital to picture various features of this informational resource. The EU concerted action QLK1-2000-00164, "Traceability of fish products" (finalized in 2003), represents the foundation for developing the TraceFish CEN (European Committee for Standardization: www.cenorm.be) standard. This standard enables precise classification of fish products through a complete supply network.

Studies regarding product traceability have cited a range of issues, including: litigation and economic risk, supply-chain integration, information connectivity, consumer perceptions of product quality, safety and traceability, inter-organizational information system compatibility, the relationship with tracking goods, and product and industry features (Florence and Queree 1993;Töyrylä 1999; Kees 2002; Van der Vorst at al. 2002; Bourlakis and Allison 2003; Senneset et al. 2006; Folinas et al. 2006; Van Rijswijk and Frewer 2008). These studies share a mainly technical focus on resources such as food characteristics and IS.

A product standard is one of a conglomerate of resources in an information flow in a supply network. The product standard is at the microlevel. Information flow is a logistical term, indicating purposeful information transformation in relation to time, place, and form to support goods transformations and product utility, measured from an end-user perspective (Heskett et al. 1973; Engelseth 2012b). More specifically, a product standard is a classification of product types. The level of detail is determined by the people developing the standard. The standard is usually administered by an organization that sets rules for standardization practice. TraceFish is administered by CEN, which classifies fish species, weight groups, fat content, and other potential indicators (depending on the product). This differentiates a seafood product at a generic (non-branded) level. This classification is mainly verbal and facilitates numerical coding. The purpose of any product standard is to secure quality in product registration, identification, and communication. It efficiently links a material product artifact to its representation within an information system.

TraceFish was adapted to facilitate numerical product classification through the Global Trade Item Number (GTIN) in the GS1 (www.gs1.org) system. The GTIN is an open (nonproprietary) classification system that uses bar codes. TraceFish is also adapted through the TraceCore extensible mark-up language (XML) standard to support communication of document information types between IS, using the internet. XML is a an electronic data interchange (EDI) type that provides a cost-efficient way to communicate documents, since it considerably reduces information system investment costs, compared to proprietary EDI solutions. The TraceFish standard provides a common numerical language that electronically links heterogeneous firms' information system. TraceFish contains three, voluntary, consensus-based standards for recording and exchanging traceability information in the seafood chains:

- The farmed fish standard for full-chain traceability determines which data should be recorded in the captured fish chain, as well as how and where the data is recorded. This is distributed through CEN (CWA 14659:2003, Traceability of fishery products - Specification of the information to be recorded in farmed-fish distribution chains).
- The captured fish standard for full-chain traceability determines which data should be recorded in the captured fish chain, as well as how and where the data is recorded.. This is distributed through CEN (CWA 14660:2003, Traceability of fishery products - Specification on the information to be recorded in captured-fish distribution chains).
- A technical standard regarding how the data should be coded, transmitted, or made available in electronic form, including which existing electronic standard will disseminate data.

Several research projects in Norway are seeking to implement TraceFish to secure efficiency in traceability routines by integrating IS on fishing vessels, the pelagic seafood auctions administered by Norges Sildesalgslag (the Norwegian Fishermen's Sales Organization for Pelagic Fish), and industrial producers of pelagic fish products. Another project was concerned with developing an IS using TraceFish (as a GTIN code) to create bar-coded labels/markings on distribution packages. Developing the TraceFish standard is a continuous task, as new product classification needs and uses emerge (www.tracefish.org). This case study was part of one such research project.

Information system development involves a single firm investing in a mixture of information resources, including IT hardware/software and people operating these systems. Traceability systems are generally no different from other types of information systems. However, securing traceability is almost always an inter-organizational challenge. It involves developing information flows across company borders. Investments encompass traceability-system development and integration in several supply networks. IT is usually an outsourced, external competence. A traceability system is often an individually developed information system component. After implementation, the system is coupled with other information system components (such as human resources, supply-chain management, and accounting). This view of information system as a combination of components is embodied in enterprise resource planning (ERP) systems marketed by information system suppliers. An ERP system is a development of materials-requirement planning systems that is widened to encompass a range of business enterprise information systems. However, it may prove technically and organizationally challenging to secure a fit between various functional information system components developed at different stages of time and in different organizational contexts. Current ERP systems usually encompass traceability functionality and are in widespread use within larger food-production and distribution enterprises.

A Transvection Approach to Product Standards and Traceability

The preceding sections examined how TraceFish is implemented and used in a complex seafood-supply network. This part presents an approach to examine the multiplex potential for TraceFish use, based on a marketing-channels model. Transvection, although largely unknown today, should be regarded as a classical management model (Alderson 1965), given its conceptual interlinking of customer value and value creation. This model was used to create a framework to study and analyze end-to-end food-value networks (Engelseth 2007; Engelseth 2009; Engelseth and Felzensztein 2012; Engelseth 2012a; Engelseth 2012b). Alderson (1965) proposed that the concept of transactions be complemented by transvection to fully understand and develop customer-oriented product supply. While transactions are concerned with sales and purchasing activities, transvection is predominately a logistical concept found in publications usually classified as marketing literature. This provides a cross-functional approach, from a time in management literature when logistics and supply-chain management were emerging as academic disciplines with unclear borders with marketing theory. Early marketing-channel models (e.g., Alderson 1965) provided the basis for cross-functional analysis by interconnecting a marketing and logistics perspective of supply efficiencies. An interesting aspect is that this logistical model enhances what is now known as customer value, which is; an increasingly prevalent concept in business research and practice. In business practice the transvection model may be applied as a powerful tool in drawing an end-to-end picture, a mental model, of the inherently complex food supply network. This perspective is especially important in regards to food product traceability since occurrence of food product discrepancies through flows of food transformations must be accountable from “sea or farm” to “plate and fork”. The transvection is accordingly a functional food chain development tool that helps to cure managerial myopia through providing a complete picture of how goods and information are transformed the supply network. This end-to-end chain knowledge empowers managers through increasing understanding of how value is created in the supply network when seeking to develop product traceability systems in an obscure sea of IT potential.

Marketing-channels literature highlights the number and roles of intermediaries involved in product supply to an end-user (Rosenbloom 1995). These supply roles depend on characteristics of these individual firms and their organizational role or position in a supply chain. Alderson (1965) explained that product supply involves a complete, multi-tiered channel, consisting of a heterogeneous set of actors. He also included technical logistics of supply. The transvection model provides an end-to-end view of product supply and encompasses both a marketing focus on transactions, as well as a logistics focus on value creation by transforming goods. Product-transforming activities are carried out in accordance with the step-by-step transvection model, creating a cumulative whole that can be measured in relation to customer value upon receiving the product. Figure 1 shows the transvection model.

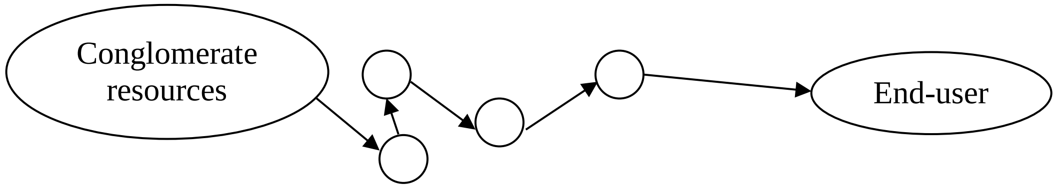

Figure 1. The transvection model (circles indicate sorts, and arrows indicate transformations).

Technical product transformation can be measured in terms of time, place, and form. This shows sequential product dependencies. Thompson (1967) labeled this form of product supply as "long-linked technologies," which represents an industrial classification. Because this term may not be very clear to the reader, we will attempt to show a picture of prolonged time and distance in physical distribution and sequentially dependent food transformation.

In Thompson's (1967) view, these different technologies are sequentially dependent. In the food industry, value creation depends on transformation. This is not the case in service and handicraft value networks, where the fundamental forms of dependency are reciprocal (Stabell and Fjeldstad 1998).

In addition, sequential dependencies may vary between different physical distribution forms. For example, manufacturing does not involve prolonged farming, which is a heavily culturally embedded industry in very small firms. This shows the potential for more precise classification of sequential dependencies found in physical distribution. Evoking the core importance of sequential dependencies in food supply also provides a foundation for analyzing creation and use of information resources, including product standards. As products are transformed, information about them also changes. A product standard helps visualize and communicate information about transformation.

The TraceFish standard simplifies comparison between identical products or combines transformed components in relation to time, place and form in the flow of goods. TraceFish provides information about seafood, which is a biological artifact. They may efficiently provide information about raw material for processing or link the final seafood product with where it was slaughtered and packed.

Conceptions of customer value are interlinked with product transformations. The transvection model depicts piecemeal transformation of goods through a series of complementary activities that provide time, place, and utility of products. Utility can be interpreted as customer value, while the provision of utility can be called value creation. This long linking of value generation and value realization encompasses customer responsiveness. This can be modeled as technical linkage between the end-user, intermediaries, supporting actors, and initial suppliers. From a multistage, food-supply viewpoint, matching value generation with realization occurs in sequences of events involving different supply-network actors. One important feature of TraceFish's utility is how it realizes customer value. This is true for value creation from a supply side, as well as perceptions of supply quality from the customer side.

Transvection (Alderson 1965) provides a way to model the piecemeal, sequential nature of seafood-product transformation, which generates customer value by a series of intermittent decision-making events that Alderson termed sorts. The TraceFish standard facilitates this process by contributing to information-flow efficiency, as well as in interactions with the flows of goods. These two efficiency aspects affect goods transformation. TraceFish has an indirect impact on efficiencies in the flow of goods. Since value is created through product transformation, product information is an important boundary-spanning resource that links various local and event-specific customer perceptions of product features as they are identified in product flow. Because supply-network actors sequentially transform the product, the end-user registers these transformations and perceives responsibility in securing safe, quality food. Accordingly, the information flow is sequential when focusing on how product information reflects the product itself. This product flow, embedded in the supply network or chain, is the organizational context for providing utility through transformations of product "time, place and form features" (Alderson 1965).

Decision-makers in the supply network are influenced by the degree of integration between firms in multiple tiers. However, product information is more intricate than the product itself. Products have past, present, and future states that may be seen through orders, forecasts, tracking, and tracing (Engelseth 2007). The same information about a specific product can be duplicated and transmitted to different recipients. Therefore, the IS is more complex than the logistical product-flow system.

Product flow is the key value driver in the supply chain. People (labor), competence, information, IS, the focal product, other products, packaging, facilities, and equipment are used to make decisions regarding product flow. In accordance with Alderson's (1965) transvection model, a sort represents a local and event-specific arena for supply-chain actors to combine people, knowledge, products, facilities, and information into a dynamic resource. By focusing on customer value as the prime indicator of supply purpose, it is natural to term TraceFish's organizational context as a value network, rather than a supply network. This paper applies the transvection model to approach the "value network" (Engelseth 2012a). It retains the original logistical focus on the flow of goods to evoke the multiplex use of the TraceFish product standard. We generated the research question: "What benefits may product standards, specifically the TraceFish standard, provide from a transvection-model approach?" The case narrative provides a basis for analyzing how the TraceFish standard may support value creation in an industrial network.

Method

The empirical data was collected for a research project called TraceFish Use, financed by the Norwegian Research Council. The project leader was an IT company that specialized in package-labeling systems. The research consortium also comprised a Norwegian pelagic (herring and mackerel) seafood-processing firm and its main logistics supplier for shipping goods to the Netherlands. This project aimed at implementing the TraceFish standard at one of three seafood-processing factories and linking it with the existing ERP system. Operationally, the project involved implementing a package-labeling system using the TraceFish standard as a central information component with other information systems to support fully inter-organizational, electronic traceability. The data in this study was presented with a preliminary analysis as a conference paper (Engelseth and Nordli 2006).

The data is further analyzed in this study with the transvection model discussed in the previous section. This case study was driven by the project's need to embed the package-labeling system in a wider, inter-organizational context. It focused on the TraceFish product standard as the unit of analysis. However, this standard is hard to follow in an empirical setting. It was more practical to use Alderson's (1965) transvection model as a research guideline to trace the product (particularly product information) back from finished state to raw material. This was in accordance with the transvection model of studying it in an upstream pattern.

For practical reasons, the initial interviews were conducted with the seafood producer's marketing organization to gain an initial overview of end-to-end product transformation. Interviews were then conducted to describe the flow from raw materials to finished product. In the initial interview, we got a relatively clear concept of the final product state to which we wished to relate the raw material. Subsequent interviews provided detailed descriptions of information and product transformations, as well as different perceptions of supply propose in the network. Interviews did not strictly follow an upstream pattern, especially since informants were geographically dispersed. Some interviews were conducted with informants in Norway, while other interviews were conducted in the Netherlands.

This is a case study that explores the complex, embedded nature of product information. Ellram (1996) stated that case studies provide "depth and richness, allowing the researcher to really probe the how and why questions." In accordance with this statement, the case-study research strategy was chosen to capture the details and complexities of using GTIN TraceFish in the diverse settings of a supply network. While the unit of analysis in this study is the supply network, the unit of analysis, while conducting the case study was product information. Product information involves different rules that may be explicit, including using standards. TraceFish was not yet implemented throughout the supply network. This meant that the study aimed at accounting different forms of product standards and their interlinking use in goods identification. Data was collected on goods identification and descriptions of actual product-tracing incidents.

Since this was an exploratory investigation, the case study encompassed an iterative inductive method. Iterative methodology is inspired by dialectic epistemology. Each interview involving analysis directed the next stage of inquiry to find new understanding and conceptualization. This is a common feature of case studies, according to Eisenhardt (1989). Research follows an emergent design, including continuous iterations between theory and empirical findings that involved adductive reasoning through trial and error (Kováks and Spens 2005). Findings are progressively noted in a research protocol and new empirical findings with theory are explored. Theoretical understanding gradually develops.

Since this study was rooted in a relatively postmodern ontological stance, validity and reliability were considered with alternative terms (Lincoln and Guba 1985). Taped and transcribed interviews, together with additional observation notes, were provided to ensure an audit trail, which is a vital component in establishing credibility and trustworthiness (Erlandsson et al.

1993). Informants were also allowed to inspect interview transcripts to ensure accuracy and provide additional comments.

From a vague initial understanding of the research problem concerning the TraceFish standard, more specific research issues became evident. This may be compared to hypothesis formulation based on empirical data that further steers the research process (Eisenhardt 1989). Because this is a single case study, there may be limitations on the degree to which findings may be applied in other industrial settings. Theoretic generalizability (Merideth 1998) and transferability (Lincoln and Guba 1985; Erlandson et Al. 1993) are terms used in a non-positivist, qualitative research tradition to address the question of generalizing empirical findings. This study aimed for analysis of empirical findings to generate theory that may be used in different settings. This transfer must be done with caution, adhering to a range of empirical particularities. Since this material is published, analysis is also subject for debate also contributing to theoretical development.

Informants all had key roles in their firms and were chosen to provide different perspectives of TraceFish use in the supply network. They were briefed that this was a case study aiming to describe information and product transformations, with an overall goal of better understanding how to improve product traceability though electronic interlinking of information flows between firms. Informants provided described the logistics processes, as well as marketing-channel roles, in the supply network. We avoided conflicts of interest because this case study represented research, rather than process development.

The 15 semi-structured interviews involved open-ended questions provided as a guide. Each interview guide was created specifically for each informant. Guides were influenced by preceding interviews, along with preliminary analysis noted in the research protocol. The research design was flexible. Ad-hoc questions were often formulated when fruitful issues arose during interviews. Each interview created a foundation for a following interview. This was part of the research's emergent and iterative nature to develop new understanding regarding TraceFish use. Interviews were sequentially dependent on each other in developing the research protocol and theoretical understandings regarding TraceFish use.

Case Narrative

The Product Flow

The product flow follows a specific path chosen for research purposes. This path is one flow of goods in the complete supply network. This structure of the case narrative was chosen to reduce the complexity of this text. Figure 2 shows the flow of North Sea herring from Norway, to a specific producer of finished goods, and then to retailers.

Fish bound for the Dutch market mainly consists of small herring filets caught during a short season in the spring. Fish quality and size categories for herring are: over 300 g; 200 to 300 g; and 150 to 200 g. Large fishing vessels use nets mounted on the side of the ship to catch fish. Catches vary from day to day. Fish are hauled into ships' refrigerated holding rooms, where they are kept up to 48 hours before delivery to the land-based processing facility. The fish-processing plant receives the goods at port through a device that sucks the fish through a funnel from the fishing vessel. Semi-automatic production lines fillet the fish before they are packed.

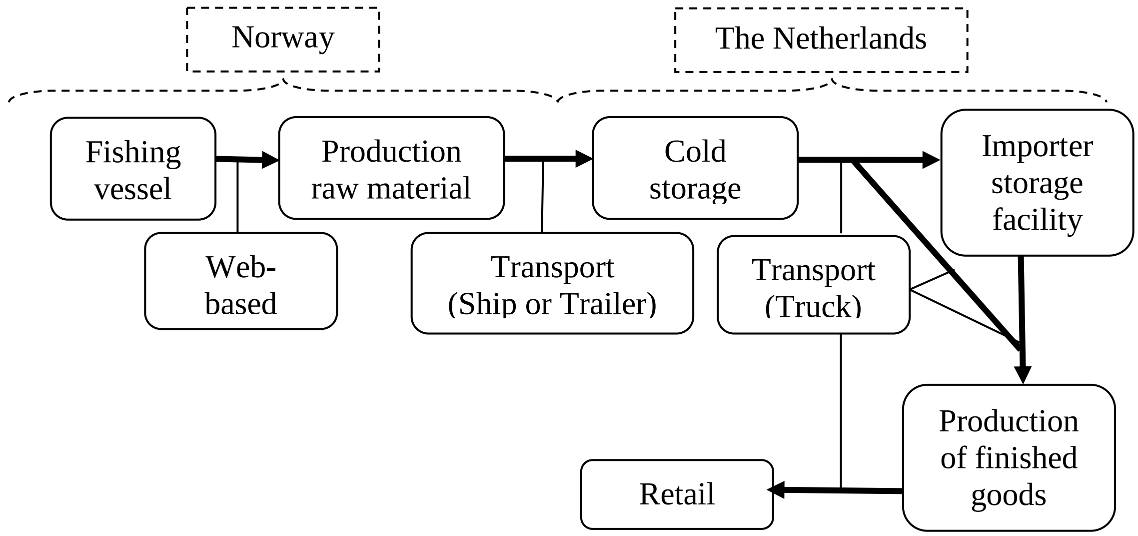

Figure 2. Flow of North Sea herring through different principal (marketing-channel actors) and supporting facilities from Norway to the Netherlands.

The Norwegian producer distributes most of the fish products sent to the Netherlands. The package is an innovative foil pouch that vacuum-seals the goods, thereby increasing durability. Approximately 20 kilo of goods are contained in one automatically labeled package. Pallets of packages undergo a 10- to 12-hour freezing process to -25 C°. A forklift then moves the pallets of goods to the storage facility in the production plant. The product may be stored for up to a year, depending on market features.

Reefer (cold-storage) ships or containers placed on ships transport goods. The frozen goods are sturdy, reducing damage. Most goods are loaded directly onto a truck for a short trip to the importer's storage facility on the other side of the harbor. Goods can also be transported directly to the finished-goods producer. A forklift unloads goods off the truck into the customer's cold-storage facility. The goods remain there until they are sold, primarily to other Northern European customers.

The Flow of Information

Personnel on the fishing vessel register in the ship's log the size and quality of the catch. The vessels vary greatly in size. In parts of the season, as many as 50 vessels will be in the same location. Norges Sildesalgslag receives this information by radio or mobile phone. A blind auction sets the price of the fish. There are four to five Web-based electronic daily auctions. Each purchaser (the raw-material producer in Norway) bids on the catch of a chosen fishing vessel located near their processing plant. After each auction, the purchaser can get an idea of who won the bid and use this information on subsequent bids. Purchasers are informed about the size of the catch, measurements of the fish's fat content and the general appearance of the goods.

When the purchasing contract has been agreed upon through the auction, the boat communicates the anticipated time of arrival at the production facility. Upon delivery, the processing facility carries out quality control and certifies the supplied batch. A batch comprises the catch of one boat from a single day. Catches from two different days are kept in separate tanks on the vessel and registered as separate batches. The producer classifies the batch in accordance with three size categories. Fish size is used as basis to classify different product types. The producer's IS then registers size group and fat content.

Goods are packed into distribution-level packages, most often containing 20 kg of fish. The producer then labels the distribution packages with a GS1 standard transport label containing information about the batch, production date, best-before date, and information classification, in accordance with the TraceFish standard. The TraceFish classification is also printed in numerical and bar-code form on the transport label. The producer scans packed goods and registers the volume placed in cold storage. When orders are received from customers, the volume is scanned when goods leave the storage facility. Goods are tallied by scanning as they are loaded on the truck or ship. This tally is used in the bill of lading sent to the customer and the transport company. The producer's sales representative uses this updated inventory information registered in their ERP system as a basis to promote its products.

The Dutch producer informs the transport vessel, customer, and cold-storage/transit facility of the vessel's expected docking time at its destination in the Netherlands. The sales office informs the operator of the transport ship and registers this agreement in the ERP system. Invoice documents are sent as email attachments to the Dutch importer, and a packing list is sent to the transport company by fax or email. The transport company verifies the goods' arrival to the cold-storage/transit facility by faxing a transport document to that facility. The different actors in the supply chain log product temperature during transport and storage. Customers demand this information when they detect product discrepancies. Providing "cold trail" information is a highly manual process. When goods arrive in the Netherlands, the cold-storage/transit facility and the vessel operator do a tally control by manually counting pallets. Tally discrepancies are the responsibility of the transport operator and are financed by transport insurance. The cold-storage/transit facility operates an IS that is well-adapted to GS1 standards. On the other hand, the Dutch importer uses a small IS with a three-digit proprietary code to register and monitor inventory. The Dutch producer uses the ERP system to support automated ordering systems with its retail customers.

Roles of the TraceFish Standard in the Supply Network

Overall, pelagic fish is a high-volume, low-value product. The Norwegian producers are squeezed between profitable catches and profitable retail. Although frozen fish can be stored for many months, producers are forced to sell as quickly as possible on the market. This economic situation also affects investments in the supply network, including developing IS, supply-network connectivity, and seamless electronic traceability. The few reported incidents of product tracing involved a simple form of manual tracing. The foreign customer phoned the Norwegian producer, who then checked production records on their intra-firm IS. There was no automated information connectivity between the different supply-network companies. On one occasion, the source of the discrepancy was already detected through control routines carried out by the producer. On another occasion, the grounds for tracing the product may have been to negotiate a lower price. TraceFish is thereby an element in a system to secure product traceability. The producer is the sole user of TraceFish to label goods.

Analysis

According to the transvection model, the crucial location of product-value is found in relation to end-use. This was also starting point of analysis. Customer value, based on the transvection model, is result of a set of sequentially dependent decision-making events (sorts). The transvection shows how sequential dependencies in the product flow also affect information flow. Product history embodies past sequentially dependent product transformations in a supply network.

From Alderson's (1965) perspective, the studied supply network has an important technical aspect that involves sets of sequentially ordered decision-making events. This is in line with Thompson (1967), who highlighted how different industries have different resource-dependency patterns. Since transvection predominately illustrates sequential dependencies, it is well-adapted to analyzing various forms of food distribution.

Supply-network integration involves more than developing trust and actor relationships. It is also a technical imperative. Business relationships constitute decision-making events combined with knowledge of product value objectives. These objectives are affected by how to attain value through technical product and information transformations. In other words, value creation meets value realization. Supply network integration provides guidance on how to integrate customer value into the value creating processes that transform food products.
Decision-making events (sorts) represent a meeting place between the technical and organizational realms. Product-supply information is predominately technical and chronologically measured. Time may be either relational or chronological (Hedaa and Törnroos 2002). The transvection sort involves combining two levels of time: the past, present and future states of products along with the preceding and following operational sorts carried out at a specific time at the organizational level. The technical level involves creating value, while organization involves decision-making to support operations. Figure 3 models TraceFish as an integrator between a product standard and product transformation.

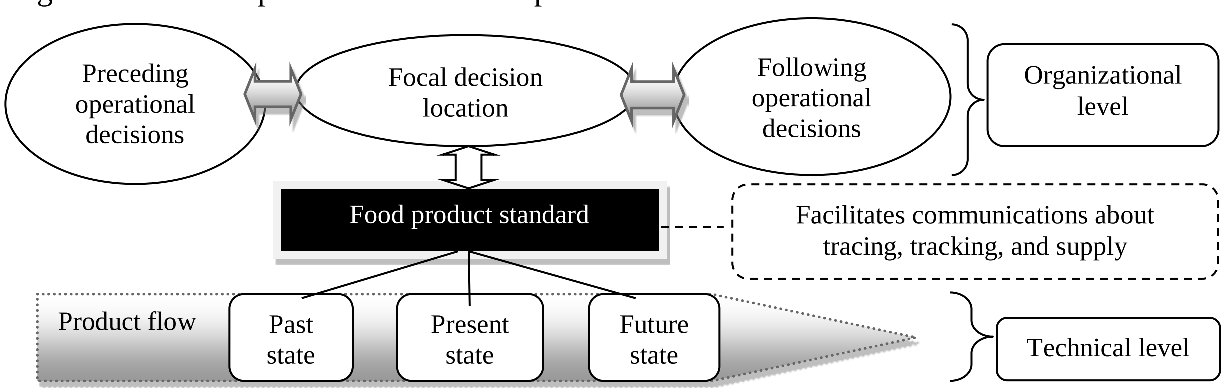

Figure 3. The product standard as integrator between organizational and technical activities.

Figure 3 shows the core of a product standard integrating organizational decision-making (sorts) and technical components. The model shows how product information is intertwined with time. The time factor is also associated with activities. Combining time aspects of product supply evokes how timing involves relative time (“before”-“now”-after”) and chronological time (numerical variable) (Hedaa and Törnroos2002). These aspects of time and timing are associated with different activities. Timing is also associated with supply purpose.

The TraceFish standard interlinks supply purpose with the product flow. There is no demand that product standards be used, especially not from a complete food chain perspective. The demand in most countries is related to product traceability leaving it to practitioners to find our how to meet this product information demand. The TraceFish seafood product standard simplifies designing and organizing the information flow thereby supporting information flow quality. TraceFish is an information resource that increases information quality when supply network actors jointly invest in its implementation and use. The multiplex use of this standard involves potentially a higher investment cost and later economizing this use in relation to multiple informational functions classified in Figure 3 as tracking, tracing, and logistical product supply.

Food-product standards improve connectivity since they also facilitate standardized terminology regarding product features. The open TraceFish standard is a low-investment, modular (interacting with other heterogeneous resources) resource that supports connectivity and transparency in the information flow by interlinking the past, present and future states of products in relation to different actors. Information distortion is reduced by using a product standard that automates goods identification and seamless communication between operational decision-making events.

Furthermore the product standard facilitates viewing information as a set of components where features of product time may easily be seen and compared with each other. Given the centrality of products in generating value, the standard is a simple central resource that potentially drives supply-network integration efforts. This involves a wider range of uses than the traceability function for which the standard initially was developed. Accordingly, TraceFish may facilitate value-network integration.

Based on an assumption of economizing by uncovering potentials for multiplex use of the TraceFish standard, different actors may develop information flows to explicitly seek to uncover its complexity. This modular approach in which information-flow resource components are designed to function together for different purposes simplifies developing information exchange in a complex food supply network setting. This regards designing new information systems, implementing them as well as use and later further development. In an initial development phase, TraceFish laid the foundation for automating informational processes for connectivity between information systems. However, information system strategy should not stop at initial usage (such as product standards explicitly designed to support traceability), but instead seek a wider range of uses not necessarily explicitly found in the core resource's development process. TraceFish is a generic information resource that can support daily supply activities by enhancing goods identification and communication. Improved goods identification and communication may better support activities such as production, logistics, purchasing, and sales.

The TraceFish standard may also support process automation when used with GTIN numerical standards so that a product document can be seamlessly communicated from seller to customer and numerous logistics providers. This will reduce administrative costs and potential errors associated with manual document handling. Most important, using a product standard to facilitate seamless information exchange is a tool to secure customer value.

Supply-network integration may be classified in relation to different measurable variables, including access to inter-organizational information systems (Frohlich and Westbrook 2001). Since many food-supply networks remain a conglomerate of loosely integrated actors managing their internal processes, weak supply-network integration is accountable as manual operations in the information flow. Litigation associated with traceability requirements thus influenced supply-chain integration efforts and increased motivation to develop end-to-end information transparency.

In practice, manual solutions are preferred, since this reduces investment risk. Although trust is fundamental in integrating supply networks, the case narrative did not find lack of trust to be a fundamental obstacle to integration, other than limiting investment in traceability systems. The total cost issue related to information system investment is vital. Although smarter, hi-tech solutions encouraging supply-network integration are available at a relatively high investment cost, simple and safe solutions are preferred when the product information flow spans inter-organizational boundaries. Manual product tracing is also understandable since tracing is seldom required and plays a relatively peripheral role in relation to daily value generation through product transformation. Information transparency is achieved with minimal investment.

The case narrative shows that business actors usually navigate the supply network by interacting with their first-tier partners. An alternative view of supply integration is achieved through evoking the complete supply network by highlighting the transvection model. This view involves interdependencies between multiple tiers of actors, including both vertical (organizing complementary activities) and horizontal (organizing similar or alternative activities) aspects of integration. From a business perspective, traceability implementation demands applying a complete, multi-tiered, end-to-end scope to analyze product supply. It should also include internal integration. Information systems cross the functional borders found in firms. Different functions should therefore take part in information system development. In addition, IT enabled process development should utilize labor as well as management. Labor, being close to operations, sees problems to which management may be blind. Without coaching, labor may not be motivated to see nor report potential for information system development.

Concluding Remarks

The linkage between the information system and IT capabilities should also be considered when IT suppliers promote and sell their traceability solutions. There is no limit to how wide this perspective may be, from an internal-firm and a supply-network perspective. Within the firm, product traceability may be linked with existing information systems for a range of uses. There is a need for product traceability from an inter-organizational perspective, since tracing products inherently concerns following goods identifications and registrations through the product history in its flow toward the end-user. However, developing information connectivity between firms is more challenging than within firms, due to trust, power, and conflict issues in the supply chains.

TraceFish is an informational resource with a range of divergent potential uses to explore a wider range of economies related to information system investment. The standard is a fixed resource to which other information system components must relate. In this manner, the standard is the glue in supply-network integration efforts. To support this development, actors need to move toward a common supply-network mindset when business managers seek to develop product traceability. Information system development involves people and decision-making. The product information standard is merely a standardized facilitator. For business practitioners this evokes an understanding regarding how a technical artifact, a food product standard, is a tool that supports integration necessary for achieving successful information system development.

Information systems are explored through the literature review and the case narrative as conglomerates of information-resource components. Managers should seek microlevel solutions, without forgetting the broad picture of what information systems can do as a unified mix of heterogeneous components. TraceFish can be used to develop seamless product traceability through the use of GTIN-based numerical product standards.

However, a greater potential for investing in traceability systems should be considered. Traceability is designed into the overall inter-organizational food-distribution system. The transvection model shows a piecemeal picture of product supply. This should also stimulate a more piecemeal perception of information flows and how interactions between companies involve boundary-spanning that need not require expensive, proprietary-system investments. Rather, the use of standard open systems should enable boundary-spanning in a simpler and less costly manner.

While the TraceFish standard was developed to make seafood traceability more efficient, its main usefulness is found in supporting decision-making to direct product flow. This study reveals a simple truth that may be forgotten when different professions, functions, and companies inter-mingle. This mingling may hide obvious facts, such as that a resource has several potential uses, which may not always coincide with the original design. This indicates opportunities for economizing value-creating operations.

This has clear implications when evaluating risk in regards to investments. This is illustrated by the case regarding IS development to support product traceability. Tracing products is not a core business activity and is seldom carried out. Food-product traceability is required by law. Not having full information about a product's history creates concern among the public. The seeming hassle of investing in traceability systems may be rendered null when considering multiple uses. This study focused on how a product standard facilitates supply-network integration of different IS components to achieve product-supply objectives.

Since customer value is the driving force in achieving information connectivity, further research may look at detecting new aspects of product-value perceptions and their measurement in relation to operational decision-making, and how these perceptions may support supply-network integration. Research may also examine the development of actor perceptions regarding product value, based on efficient product-transformation measurement at different "sort" stages and communication of these measurements. Product and information transformations represent a meeting of two complex systems of combined and transforming resources to create customer value. This is a prime motivator toward designing improved overall food product supply.

For business practice, developing this understanding of multiplex use will enhance information system development with potential for securing customer value objectives. This, is revealed as a continuous (possibly Kaizen type) process involving understandings of product supply; something that not easily achieved. Also markets, technologies and environments change. The path to understanding how to develop information systems is inherently continuous in nature. It is not necessarily simple to grasp how product standards at an operational level function as informational resources with multiplex use and how multiplex may aid the development of efficient customer value-oriented information systems. Furthermore, each food chain must create adapted information systems that support the flow of foods through facilitating tracking, tracing and logistics activities. The good news is that knowledge that takes time to develop, so-called "sticky information" (Von Hippel 1994), is also difficult to copy by competitors.

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