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TRACEABILITY IN FOOD SUPPLY CHAINS: TOWARDS THE SYNCHRONISED SUPPLY CHAIN

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Abstract

Today, food products are distributed all over the world. This has led to advantages in terms of availability but disadvantages in terms of more complex food supply chains. Global food competition is intense and therefore actors have started to adapt their mindsets toward a more holistic view and a supply chain perspective. In addition, food scares during recent years have turned focus towards food safety and traceability in a "farm-to-fork" perspective.

The aim of this study is to explore and elaborate on challenges raised by supply chain traceability and on how traceability in food supply chains can add value to the actors. The theoretical findings are combined with empirical input from a case study within a food supply chain. To achieve a value-added approach to traceability this study shows the need to go beyond regulatory demands.

The literature study indicates and the case study confirms that gaining supply chain traceability raises challenges for supply chain actors. The study also shows that supply chain traceability can be value-adding for supply chain actors. The added values gained through supply chain traceability can enable synchronisation of the supply chain.

Key words: Food traceability, food supply chain, supply chain traceability, synchronisation.

Introduction

The food sector has radically changed during recent decades (Stadig et al., 2002). 60 or 70 years ago food was sold by local dairies, butchers, bakers and farmers, and very few food products were ever packed and transported between different actors in a supply chain (Thorén & Vinberg, 2000). Today, we expect to be able to buy food from all over the world and food products are distributed more quickly and over greater distances than before. This means advantages in terms of availability but also disadvantages in terms of more complex supply chains (Stadig et al., 2002).

Since a defect-free product, or safe foodstuff, delivered on time is no longer considered a competitive advantage for a company but a basic requirement, collaboration and co-ordination of the supply chain are needed (Mentzer et al., 2001). Bowersox et al. (2002) state that the importance of collaboration has increased and the supply chain has thus become the primary unit of competition. Lambert and Cooper (2000) agree and claim that companies no longer only compete as independent entities, but rather as supply chain vs. supply chain. Management of supply chains has become increasingly important as the structure of the supply chains gets more complex. This is for example shown when companies assume that when optimising their own interests they also maximise the supply chain's interests. *"A supply chain works well if its companies' incentives are aligned - that is, if the risks, costs, and rewards of doing business are distributed fairly across the network."* (Narayanan & Raman, 2004). According to Narayanan and Raman (2004), a distribution of risks, costs and rewards can be accomplished with new or redesigned contracts, sharing previously hidden information and/or using personal relationships to develop trust between supply chain actors.

Successful implementation of supply chain traceability calls for co-operation among all the actors of the chain (Kelepouris et al., 2007; Viaene & Verbeke, 1998). Co-operation, co-ordination and collaboration are usually found in supply chain-related literature, however, no commonly accepted definitions are found, nor are views shared on how the concepts are interrelated. Interaction between companies is described by Peterson (1991) with a three level scale. The first level starts with co-operation, where independent actors for instance share information which supports each other's activities. On the next level comes co-ordination, where independent actors align activities which beneficially support their individual goals. On the last level is collaboration, where actors give up some degree of independence in their efforts to realise a shared goal. No commonly shared definition of the concept supply chain synchronisation was found in literature. However, Kim (2006) describes supply chain synchronisation as constituted by the following: alignment of strategies, alignment of assets and capacity, and integration of processes, infrastructure and information. The theoretical supply chain

perspective leads actors, from being effective companies, to being parts of effective food supply chains. However, there are practical implications which raise challenges. The implementation of supply chain traceability raises additional challenges for actors but according to, for instance, Kelepouris et al. (2007), and Wang and Li (2006), it also provide actors with beneficial outcomes.

The aim of this study is to explore and elaborate on challenges raised by supply chain traceability and on how traceability in food supply chains can add value to the actors. The theoretical findings in the area of supply chain traceability are combined with empirical input from a case study carried out within a Swedish supply chain for frozen food.

Method

This paper is based on literature review and a single case study, comprising interviews, observations, and internal document studies in a frozen food supply chain in Sweden. A literature review was conducted with search words like traceability, synchronis*, synchroniz*, collaborat*, coordination and supply chain in the Elin (**E**lectronic **L**ibrary **I**nformation **N**avigator) database which integrates data from several publishers, databases and e-print open archives. Different search combinations were used. The articles found were all scanned / skimmed and articles based on relevant research were selected for more thorough examination. Additional articles were found through references in literature.

The case study is chosen as a strategy in line with Eisenhardt (1989): *"building theory from case study research is most appropriate in the early stages of research on a topic"*. This study is based on a single case. The study is conducted within the food industry and the rationale for selecting the food industry is the increased focus on supply chain traceability due to recent food scares, ever tougher legislation in Europe and demands for food safety. The data were collected through interviews, observations and review of internal documents. This is in line with Yin (2003) who argues that the data in a case study can come from many different sources of evidence and especially mentions, *"documentation, archival records, interviews, direct observation, participant-observation and physical artifacts"*. Data collection was complemented with information gathered at workshops with the companies involved in the case study. The focal company was chosen as it is a special case with many interesting characteristics. It is a very small company, with no production of its own, but with very high standards of food safety and traceability issues are high on the company agenda. Focus is placed on two supply chain actors: the focal company, and the company who runs the production. Their inbound and outbound contact with other actors in the supply chain are also included. Both companies are categorised within the small and medium-sized enterprises (SME¹) category, which also characterises the vast majority of food production companies in Sweden.

Traceability in the food industry

In the literature search including the words *traceability* and *supply chain* 70 per cent of the literature found is related to the food industry. The research field of traceability in the food industry is relatively young and most authors of the literature found agree that food-related scandals and incidents during recent years have increasingly driven authorities, consumers and other stakeholders' interest towards food safety. Full traceability or traceability throughout the entire supply chain is seen by many of the authors, e.g. Kelepouris et al. (2007), Morrison (2003), Van Dorp (2003) Viaene & Verbeke (1998) as essential for ensuring food safety and quality, and thus a way to regain or maintain consumer confidence. Although traceability itself cannot improve food safety or quality it can provide necessary information and keep track of products (Wang & Li, 2006). Consumers' increased concerns have, according to authors such as Beulens et al. (2005), Lareke (2007), and Wang and Li (2006), led to an increased demand for information about food safety and other properties of the food they consume.

Different perspectives of traceability

Several different definitions of traceability are found in the literature studied. In a review of definitions Van Dorp (2002) confirms that there is no uniform understanding of the concept. In this paper the one posed in the regulation which concerns food safety in the European Union will be used: *"traceability means the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution"* (REGULATION (EC) No 178/2002 Article 3 §15). Two kinds of traceability are referred to in literature; local and chain (or internal and external). Chain traceability refers to the ability to trace a product/batch and its history throughout an entire supply chain. Local traceability refers to the ability to

¹ Companies which employ fewer than 250 people with an annual turnover not exceeding EURO 50 million are included in the SME category. (RECOMMENDATION 2003/361/EC)

trace ingredients and raw material within one of the actors in a supply chain (Alklint & Göransson, 2004; Moe, 1998; Stadig et al., 2002). Van Dorp (2002) proposes four perspectives on traceability:

- **The enterprise perspective:** Traceability viewed from within a manufacturing company.
- **The multi-site perspective:** Views traceability issues related to the additional aspects emerging in companies with several manufacturing plants.
- **The supply chain perspective:** Includes the entire supply chain with an integrative approach encompassing planning and control of material flow, and efficient and effective information management throughout the supply chain.
- **The external environment perspective:** Refers to external requirements which affect traceability, from authorities, branch organisations and external stakeholders.

The supply chain and the external environment perspectives presented by Van Dorp (2002) will be in focus in this paper. The traceability definition selected indirectly demands a supply chain perspective since it requires all the actors in the food supply chains to be able to trace ingredients and products one step up and one step down in the supply chain. The supply chain perspective presented by Van Dorp (2002) is wider than the demands in the EC regulation since it also encompasses information management aspects, as previous studies confirm (Eken & Karlsson, 2006).

The challenges of supply chain traceability

Full traceability, end-to-end traceability, chain traceability and supply chain traceability are frequently used by authors in the field. However few authors define what they include in these concepts. In this paper all the expressions will be regarded as traceability throughout an entire supply chain. However, Kelepouris et al., (2007) state that: *“achieving end-to-end traceability across the supply chain is currently quite a challenge from a technical, a co-ordination and a cost perspective.”* Co-operation throughout the supply chain is stated as being a main success factor for achieving supply chain traceability by Viaene and Verbeke, (1998). Wang and Li (2006) concur that collaboration is needed between supply chain actors. Kelepouris et al. (2007) state that participation of all actors in the supply chain is needed.

To reach supply chain traceability Viaene and Verbeke (1998) state that managing product- and information flows effectively throughout the chain is a challenge. Lo Bello et al. (2005) state that: *“For complete product traceability it is necessary to record not only all incoming and outgoing movements of the production lots, but also all the procedures and processing operations applied to them”*. Companies need to exchange traceability data with other actors in the supply chain (Lo Bello et al., 2005). Wang and Li (2006) highlight sharing of information along the supply chain and good communication between the different actors as important aspects for successfully achieving supply chain traceability. Kelepouris et al. (2007) agree that information on the total product's lifecycle is needed in order to achieve supply chain traceability.

Wang and Li (2006) state that a properly designed traceability system is crucial to assure that data collection is managed effectively and that the right data are collected. They also state that integration of traceability systems with other enterprise systems is crucial in order to gain the most beneficial outputs from supply chain traceability. Lo Bello et al. (2005) feel that security and authentication in the communication between the actors through the systems is a problem to be tackled while Moe (1998) points out that limitations or particular aims of one actor in the supply chain set the demands or limits the traceability for the entire supply chain.

Different approaches and systems designed to achieve supply chain traceability appear in literature: they range from paper-based records to sophisticated computer-based information technology including biological technologies (Folinas et al., 2006; Wang & Li, 2006). Despite the different computer-based traceability systems proposed by researchers, most companies have adopted paper-based traceability systems (Lo Bello et al., 2005). Sioen et al. (2007) state that studies within seafood industry show a gradual change from paper-based traceability systems to computer based technology, however Roth et al. (2008) state that adoption is slow. Although technological solutions seem available there is a major challenge in economical feasibility for SMEs according to Sioen et al.(2007). Kelepouris et al. (2007) agree that costs are especially critical for SME's but state that labour cost for the required work effort to collect the information to support the traceability system is the critical cost, while, RFID technology and proper information infrastructure are affordable solutions for SMEs. Independent of how challenging the task is most authors agree that traceability must high on the agenda for companies within the food industry. In the process towards supply chain traceability there are also important actual and expected benefits (Kelepouris et al., 2007; Wang & Li, 2006).

Added value through supply chain traceability

In order to achieve more beneficial outputs and added value an integration of traceability systems with the supply chain management processes is suggested by Wang and Li (2006). "If the objective is only to meet regulatory requirements, these costs can be a significant burden with little perceived payback. In fact, traceability can provide substantial benefits beyond the traditional understanding of its value." However not all beneficial outputs add value: improved core value of a product or service rate as value adding. It can be regarded as exceeding of customer expectations (Näslund et al., 2006). In this paper added value will be viewed in a supply chain perspective.

Efficient consumer response in Europe confirms that the best way to ensure food safety and supply chain traceability is through close collaboration between actors in the supply chain. It is through this collaboration that supply chain actors can find ways to *"improve the efficiency of business processes and procedures, reduce waste and to do things in new ways in the supply chain"* so that benefits can be shared (ECR 2004). Wang and Li (2006) agree that waste can be reduced through traceability and state that it can be done by an optimised use of raw material. They further state that supply chain traceability enables high inventory visibility and optimised production planning which in turn can facilitate decreased inventory levels. Moe (1998) and Morrison (2003) state that supply chain traceability can be used to improve process control. All of these add value in terms of increased efficiency.

Roth et al (2008) state that there are economic incentives for companies to invest in traceability and that it can *"improve supply management, increase safety and quality control"*. Providing safe food to customers and consumers is hardly considered a competitive advantage, rather a basic requirement according to Mentzer et al. (2001), however, the ability to accurately target the product lots in case of a recall can generate added value to the actors in the supply chain through cost savings. These are regarding lost sales, product disposal and damage to the company's marketing profile (Kelepouris et al., 2007). Roth et al (2008) also state that supply chain traceability can *"reduce the likelihood of expensive and embarrassing recalls"*. Wang and Li (2006) agree that accurate traceability effectively reduces risk exposure by enabling supply chain actors to identify, isolate and correct the problem quickly and efficiently through the facilitation of follow-ups after disruptions.

Van Dorp (2003) state that it is expected that all supply chain actors will benefit from the information transparency. A shared and holistic overview of the supply chain can be created through the efforts towards supply chain traceability (Lindh et al., 2008). According to Kelepouris et al. (2007), and Viaene and Verbeke (1998) advertised traceability can raise customer confidence in, and loyalty to a company and is thus a competitive advantage. Traceability beyond the legal requirements can generate benefits in meeting new and higher consumer expectations regarding quality and safety and increased value to the consumer while increasing efficiency and effectiveness in the supply chain (ECR 2004). Traceability also enables selling high margin products through product differentiation by providing special raw material or product properties (Moe, 1998; Roth et al., 2008; Wang & Li, 2006).

Empirical insights vs. literature

Supply chain management researchers like Bowersox et al. (2002), Lambert and Cooper (2000), and Mentzer et al. (2001) state that the competition of tomorrow is between supply chains, the companies studied are willing to share information but are careful about what information they share and how they do it. Production planning and prognoses, seen as trade secrets, are not areas companies want to share. According to relevant literature, supply chain traceability is dependent on the participation of all the actors in the chain and other issues related to interaction among the actors. The level of interaction is indicated by literature as being influential on the added value gained by supply chain traceability. Challenges, outputs and added value, related to gaining supply chain traceability, found in literature and in the case study are summarised in Figure 1.

A challenge noted by the case companies is that of gain understanding among the suppliers of the importance of traceability and related information so that suppliers assume responsibility for their part in maintaining traceability throughout the supply chain. Literature confirms the importance of the participation of all the actors. The studied companies, confirms the statements found in literature that economic feasibility is important for SME's. The beneficial outcomes perceived and expected by the companies studied mostly coincide with the ones found in literature. In literature it is found that supply chain traceability facilitates follow-ups after disruptions, however, the companies studied also pointed out the proactive use of traceability in terms of facilitated follow-ups after producing an especially good final product.

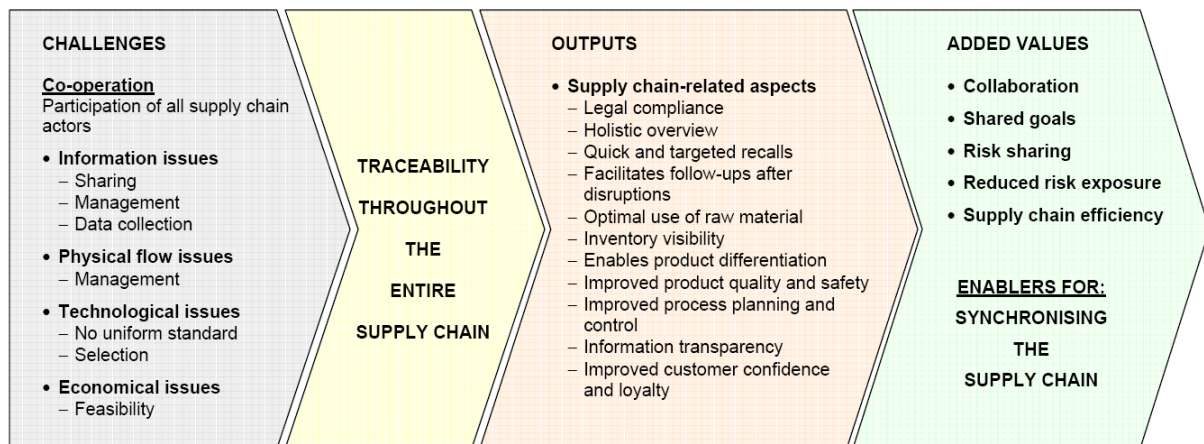


Figure 1: The challenges, possible outputs and added value of supply chain traceability

Risk sharing was discussed during a workshop with the actors involved in the case study. The companies studied had little faith in being able to share the risks with other supply chain actors due to their small company size compared to for instance their customers. Possible effects on the ability to share risks due to implementation of supply chain traceability are hard to find in literature.

The study showed a deeper level of interaction than before between the companies studied but not as deep as the level of collaboration. Overall, the empirical study indicates that the case companies do not express traceability-related issues with such a deep level of supply chain perspective as found in literature

Conclusions

This paper attempts to make a contribution to both researchers and practitioners within the logistics area in general, and in food supply chains in particular, by its exploration and presentation of challenges raised by supply chain traceability and of how supply chain traceability can add value to supply chain actors. The study indicates that the supply chain perspective and the supply chain collaboration needed which has been elaborated on in literature is not yet a reality for the companies studied.

The study also indicates that added value in terms of increased collaboration with shared goals, shared risks and benefits, reduced exposure to risks and increased supply chain efficiency can be gained through supply chain traceability. Information sharing, integration in terms of supply chain collaboration and incentive alignment in terms of shared goals, risks and benefits gained through supply chain traceability are also found in literature as requirements in a synchronised supply chain. Supply chain traceability can thus be regarded as an enabler for synchronising a supply chain.

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