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Catch to landing traceability and the effects of implementation – A case study from the Norwegian white fish sector

Kathryn A.-M. Donnelly*, Petter Olsen

Norwegian Institute of Food Fisheries and Aquaculture Research – Nofima, Muninbakken 9-13, Breivika, Postboks 6122, NO-9291 Tromsø, Norway

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ABSTRACT

White fish is an important part of the diet of European consumers. The sources of such white fish range from wild caught to aquaculture. In order to provide consumers with better product information about the fish they purchase, information must be recorded in a retrievable fashion along the supply chain. In this study, current traceability practice on board a freezer trawler was modelled, areas for improvement were identified and the attitudes of employees towards the traceability system on board the trawler were investigated. The trawler was shown to have traceability information registered at a haul level. All information was stored electronically, the majority of changes in state of the fish (transformations) were of the transfer type. Traceability implementation was a positive experience for the employees. The information registered by the trawler needs to be used further down the supply chain.

1. Introduction

White fish is fish with a pale flesh such as cod, plaice, haddock, tilapia and pangasius. White fish can be either wild caught or farmed in aquaculture. White fish is a popular and important part of the diet across the EU, with examples of its use ranging from fish and chips to sushi. Within the European Union much of the white fish comes from wild capture. The total worldwide annual catch of one species of white fish, Atlantic cod (*Gadus morhua*), is about 800 thousand tonnes Over 90% of the world supply of this species comes from the North-east Atlantic. Tilapia (*Oreochromis niloticus*) and pangasius (*Pangasius hypophthalmus*) from aquaculture in Asia and the Far East is a main competitor in the EU white fish market. Worldwide production of Pangasius (*Pangasius* spp) has increased from 88,061 tonnes in 1999 to 1,203,223 tonnes in 2009 (FishStat, 2011). Imports of farmed white fish are often cheaper providing a major advantage in terms of market share.

In order to differentiate and communicate the differences between wild caught and farmed fish the Norwegian fisheries industry needs to capture and effectively communicate information related to catch area data and catch method. Current research has shown that consumers may be poorly informed about the fish they eat, for example not knowing if it is wild or farmed (Altintzoglou, Vanhonacker, Verbeke, & Luten, 2010). Product and process information can be a tool for increasing market access and share. Some product information is already required by the European Common Food Law requirements 178/2002 (EU, 2002) which demands that companies record who they have received goods from and who they have delivered goods to. In order to create value from this information it must be easily retrievable.

1.1. What is traceability?

Containers of milk often show a picture of one of the contributing farmers, and frozen fillets of fish often show a fishing boat (Egeness, Heide, Nøstvold, & Østli, 2010). This visual information is intended to aid the customer in their choice of food. In the fisheries sector it provides the white fish with an 'identity'. Provision of this identity is an important issue for the long line fishing fleet in Norway (Kvalheim, 2011). Sales of products can be improved by identifying appropriate information and using suitable, accurate and efficient methods for capturing and communicating this information along the supply chain to the final product. This may be termed 'traceability'. Traceability is not the product and process information itself, but a tool that makes it possible to find this information again at a later date. The concept can be summarised as follows: each link in the supply chain records what it is doing, relates it to 'that which is under consideration' and provides a mechanism for getting access to these recordings at a future date. Definitions of traceability vary with regards to the depth and detail of the traceability system (Donnelly, 2010; Karlsen, Donnelly, & Olsen, 2011; Ringsberg, 2011; Thakur & Hurlburgh, 2009).

* Corresponding author. Tel.: +47 77 62 90 00; fax: +47 77 62 91 00.
E-mail address: kathryn.donnelly@nofima.no (K.A.-M. Donnelly).

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Traceability in food supply chains can be separated into 3 areas:

1. Within internal enterprise activities
2. Along a supply chain
3. Within a sector (Fritz & Schiefer, 2009).

Internal traceability relates to area 1, i.e. a company's own production and process. Such data is often already controlled in the company's information systems. This area is relatively easy to control within one company. Areas 2 & 3 relate to chain traceability, the matters of interest being what information to share and how to share it e.g. what ID's to use. The most common problems in chain traceability are data protection and privacy. Chain traceability is dependent upon internal traceability. This study will focus upon the internal enterprise activities because it is at this level that information can be captured which can be of future use to a company with regard to improving market share and improving profits. Without internal traceability, the chain has no information to share.

1.2. Seafood traceability

The high degree of globalization in the seafood trade and the lack of standards for information exchange have made tracking and tracing seafood challenging (Thompson, Sylvia, & Morrissey, 2005). These challenges with regards to fisheries management include, for example, documentation of origin when products are processed in different countries (Donnelly, 2011). Authorities need reliable information about catch statistics in order to appropriately plan and control fishing activities. The EU has environmental concerns about depletion of fish stocks which has led to new regulations for ensuring that imported fish are from a legal catch.

In many private initiatives, where supply chains are integrated, the benefits of bringing appropriate information to consumers through traceability has been shown, for example the 'red line initiative' of the Cooperative supermarkets in Norway (CoopNorge, 2012). Indeed the prevalence of the Marine Stewardship Council (MSC) label in English supermarkets (Guichoux, 2010) shows the perceived value of such information, customers have been shown to prefer fish which is marked in this way (Roheim, Asche, & Santos, 2011; Voldnes & Heide, 2011). But information such as the MSC label is merely 'the tip of the iceberg' with regards to what information it is possible to capture and communicate in such a system and the marketing possibilities that this presents to the individual actors and the industry as a whole (Sporleder & Moss, 2002).

1.3. Current levels of traceability in the seafood industry

Various studies have attempted to analyse the current levels of traceability in the seafood industry. Fig. 1. illustrates the results from three studies. Study one (1), carried out in Norway in 2006 (Karlsen & Senneset, 2006) on fish products, showed that over 60% of the products could be traced back to boats or fish farm of origin. Study two (2) carried out in the Nordic countries (Norway, Faroe Islands, Denmark, Finland and Iceland), in 2006–2007 (Randrup et al., 2008), showed that about 50% of the products could be traced back to the boat or farm of origin. The third study (3), a larger study carried out in 2009 (Donnelly, Karlsen, & Dreyer, in press) shows again that about 50% of the fisheries products could be traced back to their origin. In this study, the products were from across Europe and America.

Fig. 1 shows that many producers of seafood have the ability to trace products through their supply chains from supermarket to

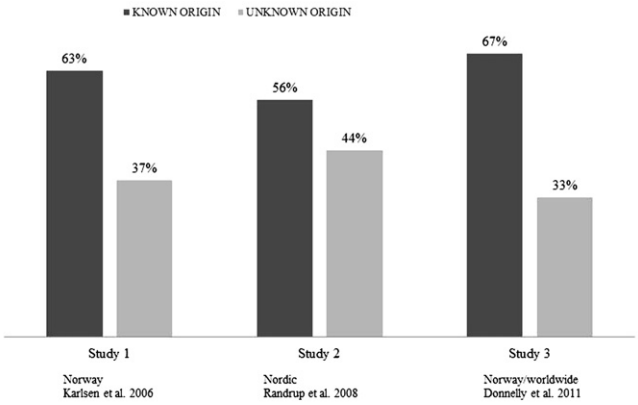

Fig. 1. Traceability of seafood product origin in three studies in Europe. Study 1 is the earliest and is followed in chronological order by study 2 then study 3.

origin. The studies categorised 'traceable' in different ways. In each of these studies the degree of traceability was more detailed than that required by the current European Union legislation (EU, 2002). In many cases the authors reported that they could trace back to the farm, boat or set of boats of origin, depending on the fishing method or landing procedures. Some boats, e.g. freezer trawlers, could deliver large amounts of product in one 'batch' while in other cases the catch from several much smaller boats would be mixed during the first stage of production. What the studies also show is that around 40% of companies have not yet implemented traceability at an advanced level.

1.4. Challenges associated with implementation

There are many reasons for the lack of implementation above, ranging from technical to motivational. Few studies identify the reasons for implementation success or failure with regards to people related factors. Mensah and Julien (2011) observed that the 'topmost challenge enterprises faced in their quest to implement integrated food safety management systems was people related'. It would be useful to study further the 'people related' effects in order to discern both the positive and negative factors.

2. Objectives

This study aims to describe current traceability practise, identify weaknesses and areas for improvement and the barriers and motivations. The barriers and motivations will be identified both in relation to technical and people related challenges.

3. Methods

The objectives were addressed by carrying out a case study of one freezer trawler CodTrawl Inc (CTI). The methods used were process mapping, interviews and structured questionnaires. For a full discussion of appropriateness of these techniques with regards to traceability in seafood supply chains see Ringsberg and Lumsden (2009).

Process mapping (Anjard, 1996) involves following a food stuff or product through the company and registering both changes which take place and the information registered at each change. The outcome of this mapping was a diagram highlighting material flow at CodTrawl for one product.

The information obtained by process mapping, including data about physical movements of the fish on board, and data regarding external information exchange was then further analysed with

regards to the type of transformations as seen at the critical traceability points for this individual product. These were recorded and compared to theory and previous findings (Donnelly, Karlsen, & Olsen, 2009; Dupuy, Botta-Genoulaz, & Guinet, 2005; Mai, Margeirsson, Stefansson, & Arason, 2010).

Finally during the interview phase of the mapping the interviewees were questioned with regards to their perceived reasons for both barriers and motivational factors associated with the system.

Examples of questions

How do you as an employee perceive the traceability system, does it cause extra work?

As a manager did you find the traceability system challenging to implement?

As a manager did you encounter many negative reactions from you staff about extra recordings?

These questions led naturally to a discussion about the traceability system, its advantages, disadvantages and perceptions of the employees.

4. Results

The company CTI chosen for this study owns one freezer trawler, CodTrawl, and is based in Norway. CodTrawl delivers frozen white fish to production facilities in China, Lithuania and Poland. The vessel fishes all year round and delivers approximately 5000 metric tonnes of white fish and shrimps per year. CodTrawl fishes the North Sea, the Norwegian Sea, the Barents Sea and the fishing grounds around Spitsbergen. CTI employs 36 people, including two crews of 17 people. CTI sell fish on contract (customer known) and on open sale (customer unknown). In this study it was fish sold on contract that was investigated.

4.1. Material flow at CodTrawl

Most of the material documented below came from a visit to the trawler when it was docked in Tromsø on the 14th of August 2009. In-depth interviews with the factory foreman, who is responsible for all practical operations on board, and the CEO who has overall responsibility for the company's operations also took place during the visit. Some details were clarified and added in the month following the interviews.

CodTrawl produces blocks of frozen white fish involving the following processes:

1. Trawls for fish
2. Harvests and bleeds the fish
3. Sorts the fish into species and size
4. Freezes the fish into blocks
5. Delivers the blocks of frozen fish to a terminal either in Tromsø or Ålesund.

The product flow is modelled in Figs. 2 and 3.

4.2. Traceability information flow

At the start of each trawl for a haul of fish, the position, time and type of trawl is registered. This generates a 'trip number' which is then linked to all the fish in that haul. On each fishing trip several hauls will be made. These proprietary 'trip' numbers contain the information above plus date and a unique sequential number and a 'haul' number. Each haul is then frozen in one of the seven possible freezers capable of containing 52 blocks or trade units of fish of approximately 25 kg with each of these blocks receiving a unique ID that also links back to the 'trip' number. This ID enables the identification of boat, date, time, type of trawl, and area of trawl i.e. complete traceability.

The first method Ringsberg (2009) describes is Ishikawa diagrams and the second is a process mapping technique described by Aronsson, Ekdahl, and Oskarsson (2003). Ringsberg describes that the different techniques are suited to different purposes, that of Ishikawa is better suited to mapping material flow and that of Aronsson et al. (2003) is better suited to mapping time aspects. The study presented here uses a similar type described by Olsen and Aschan (2010) designed to analyse material and information flow and identify critical traceability points in food supply chains. The validity of this method was discussed by Karlsen and Olsen (in press) however their study gave no clear conclusion as to the validity of the method and states only that one can 'assume' a generalization could be valid. The reader should therefore be aware that the method used here is only one of many which may give useful information and in future studies use of a combination of these methods may be more appropriate.

Software for documenting trip and on board production is WinCatch. CodTrawl has excellent electronic traceability systems on board the boat. This includes online integration with the GTNet

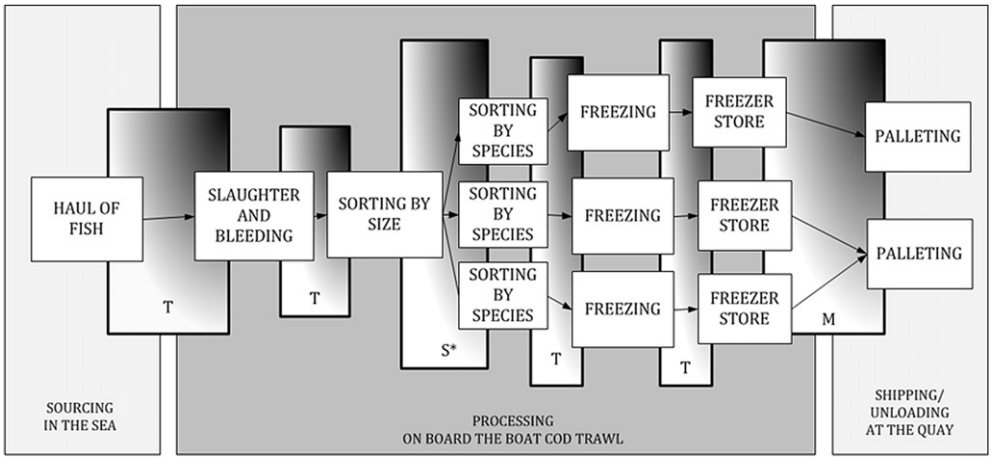

Fig. 2. Material flow and transformation analysis for frozen blocks of white fish, on board the freezer trawler CodTrawl. This study is focussed on the area, 'processing on board.' Arrows represent material flow, letters indicate transformations and type T = transformations, S* = splitting (in this case of individual fish from one haul) M = mixing (Donnelly et al., 2009).

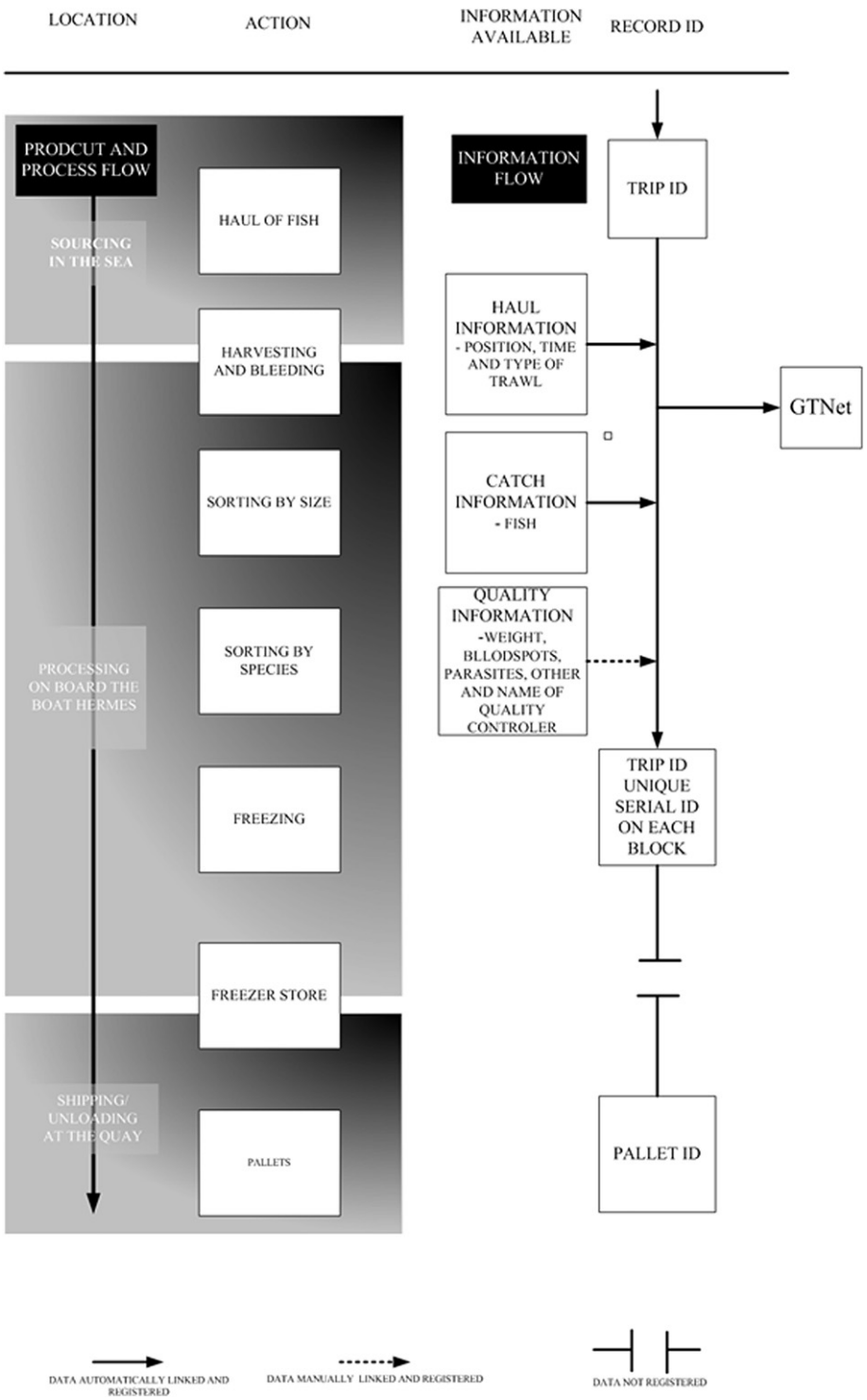

Fig. 3. Analysis of information flow on board CodTrawl.

system supplied by TraceTracker the ability to send XML in standard format and automatic upload of product information to the company internet pages.

4.3. Transformation analysis

The types of transformations on board CodTrawl were analysed (Donnelly et al., 2009) and the results show that the majority of transformations observed were transfers (see Fig. 4).

4.4. Potential improvements

The results show that while CodTrawl demonstrates what can be considered an advanced level of information registration (no loss of ID on a block or trade unit of frozen fish on board the trawler (see Fig. 4)). Folinas, Manikas, and Manos (2006) stated that traceability information management is important even where no processing of the resource takes place which is this case in this study. Further in Fig. 4 we can see that the type of transformation

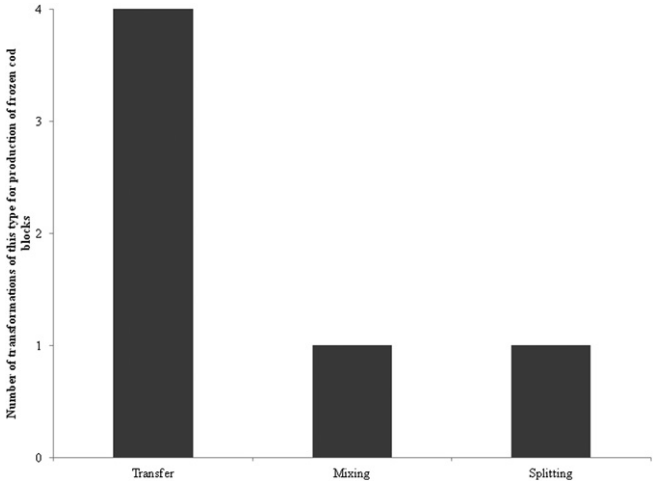

Fig. 4. Based on the observations made and the data presented in Fig. 3 and the analysis presented by Donnelly et al. (2009) and Mai et al. (2010).

which is most common is transfer, this is not the type of transformation which consumers are most concerned about (Gellynck and Verbeke, 2001) and nor are the transfer transformations the type which present the greatest challenges for traceability (Donnelly et al., 2009). There is one main area where improvements could still be made on board CodTrawl. This is the integration of the quality control system and the traceability system. Authors such as Mai et al. (2010) and Bollen, Riden, and Opara (2006) have highlighted the potential of traceability information and exploitation of the information accessible through them to improve the management of product quality. Currently, selected quality control parameters have to be re-punched into the traceability system. Speed and accuracy would improve, and duplication of effort would decrease if these recordings were automatically linked to the trip ID, the details of which are as described at the beginning of this section. The current granularity of the traceability system, is high – each haul and information from this haul is related to the ID's on each frozen block.

In addition there are two more minor findings which require further attention. These are the use of the information which is recorded and the other is the decrease of granularity when the frozen blocks of fish are unloaded off the trawler. Currently only one customer is making use of the information collected on board the trawler. In order to maximise the effectiveness of the information collected and money invested in new systems, it is of the greatest importance that companies make use of the information collected. Communicating such information and making it 'useful' has been identified as an important factor affecting many sectors (Bechini, Cimino, Marcelloni, and Tomasi, 2008) and attempts have been made to address such problems for example in work with the soya industry, (Thakur & Donnelly, 2010) the International organisation for standardisation standards ISO 12877 (ISO/IDS, 2010) and 12875 (ISO/DIS, 2010) which describe standards for the Traceability of finfish products and the information to be recorded in captured finfish distribution chains. Currently there are few customers making use of the data which CodTrawl is registering which would seem to indicate that few companies are making use of such standards and leads one to ask why?

No system exists outside the trawler to relate the CodTrawl product identifier to for example, consumer packets, meaning that the full value of the information is not being exploited. The other problem is that the CodTrawl product ID is necessary to access the product and process information and unfortunately this is not linked to the pallet identifier as 'palleting' happens onshore after landing, consequently there is no way that the identifier can be found by an eventual consumer. A linkage between the pallet ID and the CodTrawl ID would need to be made in order to exploit the information further. Palleting on board would have solved some of the traceability problems (direct link from trade unit ID (CodTrawl ID) to pallet ID), but this is not currently physically possible. The only viable way to give the customer access to the trade unit IDs (CodTrawl Id's) would be through RF-ID tags and scanning upon reception. It was reported that it is not seen as practical or economically viable for the customer to carry out bar-code scanning of 52, 25 kg trade units upon reception.

4.5. Motivational factors and implementation barriers

The main motivations for traceability investment in CodTrawl were: a) market access along with b) better price and c) better control. Such benefits have been seen in other areas such as with the implementation of the ISO 9000 (Buttle, 1997). CodTrawl has presented traceability as a success story, so workers were motivated. The employees workload had increased in some areas, especially related to quality control and document handling (as previously discussed further development of the system would reduce this workload), but the workload related to documentation had decreased in some areas, especially related to production monitoring and reporting, now done automatically and without paper involved. Overall workload related to documentation was therefore about the same as before. The production foreman was happy with the new system and indicated that the employees were also satisfied, especially with production to contract and slightly better price (Roheim et al., 2011).

No complaints from people working on the boat were noted after introducing the new system. Prior to implementation of the system the most common complaints had been about quality, especially relating to gutting, bleeding and gaping. Although the new system has no direct influence on these issues, it was the opinion of the interviewees that awareness of quality (Caswell & Mojduszka, 1996) in general had increased as a result of the focus on product documentation.

5. Discussion

The method used in this study is that of case study, such techniques have been described in detail by Eisenhardt (1989) and Yin (2003). Process mapping (Anjard, 1996) is a visual aid for picturing work processes which shows how inputs, outputs and tasks are linked and prompts new thinking about how work is done, this is the theory behind the diagram in Fig. 4. Ringsberg has used two process mapping techniques (in addition to other techniques commonly used in case studies) in order to assess traceability in fish supply chains and to study the appropriateness of these techniques.

This study presents a number of findings which are original and of great interest to the fisheries industry, regulators and researchers. The most important findings are the method of catch to block traceability, lack of actual use of this data in the supply chain and the positive reception related to traceability implementation. The findings are limited by the fact that this is one case study and therefore the data may not be easily transferable to other situation. Interestingly, despite the case study findings being based on traceability implementation in an advanced environment the study identified new areas for improvements. The most significant being the need to improve efficiency and accuracy by automatically registering quality data about a catch. This requires both a logistical and a technical solution. The study also sheds light on the motivational factors concerning traceability implementation such as

level of traceability and the human factors which are relevant (Donnelly, 2010) for example that the higher and more secure prices has a positive impact upon employees. The company when asked to estimated that if the information they recorded in this information and used if further down the supply chain in order to create consumer loyalty that it could increase the yearly earning by 3 million Norwegian kroner per year (which is equivalent to £337,000, $404,000).

The study also revealed that employees did not experience any negative 'big brother is watching you' reactions (Singels, Ruel, & Van der Water, 2001) as has been suggested may be the case and observed in other studies in the fisheries sector (Donnelly & Karlsen, 2010). In fact the employees experienced traceability as something positive which could secure their jobs and improve their income in uncertain times. It has however not led to an overall reduction in workload.

An interesting area of further study would be the development of analysis techniques based on multiple mapping tools as a suggested by Ringsberg and Lumsden (2009). A meta-analysis of current published process mapping methods and case studies would further inform the appropriateness of these methods and their applicability in real world settings. Another interesting area highlighted here is the need to investigate what and how information can be used outside the direct setting of the boat or supply chain in which it was collected. For example what are the best strategies for using this information to inform consumers about the differences between wild caught and farmed white fish and how much information would be interesting for customers. What affect would this information have on calculations related to sustainability considerations? Would improved traceability systems allow companies to carry out sustainability analysis in a more detailed fashion?

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References

Altintzoglou, T., Vanhonacker, F., Verbeke, W., & Luten, J. (2010). Association of health involvement and attitudes towards eating fish on farmed and wild fish consumption in Belgium, Norway and Spain. *Aquaculture International*, 1–14.

Anjard, R. P. (1996). Process mapping: one of three, new, special quality tools for management, quality and all other professionals. *Microelectronics and Reliability, 36*, 223–225.

Aronsson, H., Ekdahl, B., & Oskarsson, B. (2003). *Modern Logistik – for okad lonsamhet*. Malmo: Liber forlag.

Bechini, A., Cimino, M. G. C. A., Marcelloni, F., & Tomasi, A. (2008). Patterns and technologies for enabling supply chain traceability through collaborative e-business. *Information and Software Technology, 50*, 342–359.

Bollen, F. P., Riden, C. P., & Opara, L. U. (2006). Traceability in postharvest quality management. *International Journal of Postharvest Technology and Innovation, 1*, 93–105.

Buttle, F. (1997). ISO 9000: marketing motivations and benefits. *International Journal of Quality & Reliability Management, 14*, 936–947.

Caswell, J. A., & Mojduszka, E. M. (1996). Using informational labelling to influence the market for quality in food products. *American Journal of Agricultural Economics, 78*, 1248–1253.

CoopNorge. (2012). *coop Rød tråd*.

Donnelly, K. A.-M. (2010). Factors affecting implementation of the information exchange for traceability in food supply chains. In *Faculty of Biosciences, Fisheries and Economics; Department of Arctic and Marine Biology*. Tromsø: University of Tromsø.

Donnelly, K. A. M. (2011). *Traceability requirments for foreign producers wishing to use the 'Norway' logo, Nofima*. Tromsø: Nofima.

Donnelly, K. A., & Karlsen, K. M. (2010). Lessons from two case studies in implementing traceability in the dried salted fish industry. *Journal of Aquatic Food Product Technology, 19*, 38–47.

Donnelly, K. A.-M., Karlsen, K. M., & Dreyer, B. A simulated recall study in five major food sectors. *British Food Journal*, in press.

Donnelly, K. A.-M., Karlsen, K. M., & Olsen, P. (2009). The importance of transformations for traceability – a case study of lamb and lamb products. *Meat Science, 83*, 68–73.

Dupuy, C., Botta-Genoulaz, V., & Guinet, A. (2005). Batch dispersion model to optimise traceability in food industry. *Journal of Food Engineering, 70*, 333–339.

Egeness, F.-A., Heide, M., Nøstvold, B. H., & Østli, J. (2010). *Hvitfisk i det britiske markedet. Ferske vs. tinte filetprodukter av hvitfisk i britiske supermarkedkjeder*.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review, 14*, 532–550.

EU. (2002). *Regulation (EC) No 178/2002 OF the European parliament and of the council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety*. EU, ed. (EU).

FishStat. (2011). *FAO FishStat*. FAO.

Folinas, D., Manikas, I., & Manos, B. (2006). Traceability data management for food chains. *British Food Journal, 108*, 622–633.

Fritz, M., & Schiefer, G. (2009). Tracking, tracing, and business process interests in food commodities: a multi-level decision complexity. *International Journal of Production Economics, 117*, 317–329.

Gellynck, X., & Verbeke, W. (2001). Consumer perception of traceability in the meat chain. *Agrarwirtschaft, 50*.

Guichoux, N. (2010). *Certified sustainable seafood MSC*.

ISO/DIS. (2010). *12875 Traceability of finfish products – Specification on the information to be recorded in captured finfish distribution chains*. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=52084.

ISO/IDS. (2010). *12877 Traceability of finfish products – Specification on the information to be recorded in farmed finfish distribution chains*. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=52085.

Karlsen, K. M., Donnelly, K. A. M., & Olsen, P. (2011). Granularity and its importance for traceability in a farmed salmon supply chain. *Journal of Food Engineering, 102*, 1–8.

Karlsen, K. M., & Olsen, P. Validity of method for analysing critical traceability points. *Food Control*, in press.

Karlsen, K. M., & Senneset, G. (2006). Traceability: simulated recall of fish products. In J. Luten, J. Oehlenscghlager, C. Jacobsen, K. Bekaert, & A. Særbo (Eds.), *Seafood research from fish to dish, quality, safety and processing of wild and farmed fish* (pp. 251–262). the Netherlands: Wageningen Academic Publishers.

Kvalheim, J. (2011). Råstoff fra Lineflåten. In *Linekonferansen (Måløy)*.

Mai, N., Margeirsson, S., Stefansson, G., & Arason, S. (2010). Evaluation of a seafood firm traceability system based on process mapping information: more efficient use of recorded data. *Journal of Food Agriculture and Environment, 8*, 51–59.

Mensah, L. D., & Julien, D. (2011). Implementation of food safety management systems in the UK. *Food Control, 22*, 1216–1225.

Olsen, P., & Aschan, M. (2010). Reference method for analyzing material flow, information flow and information loss in food supply chains. *Trends in Food Science & Technology, 21*, 313–320.

Randrup, M., Storøy, J., Lievonen, S., Margeirsson, S., Árnason, S. V., Ólavsstovu, D.í., et al. (2008). Simulated recalls of fish products in five Nordic countries. *Food Control, 19*, 1064–1069.

Ringsberg, H. (2011). Traceability in food supply chain exploring governmental authority and industrial effects. In *Department of Design Sciences*. Lund: Lund University.

Ringsberg, H., & Lumsden, K. (2009). Traceability in the fish supply chain – evaluating two supply chain mapping techniques. *Proceedings of the Nordic Logistics Research Networked (NOFOMA)*, 695–710.

Roheim, C. A., Asche, F., & Santos, J. I. (2011). The elusive price premium for ecolabelled products: evidence from seafood in the UK market. *Journal of Agricultural Economics, 62*, 655–668.

Singels, J., Ruel, G., & Van der Water, H. (2001). ISO 9000 series – certification and performance. *International Journal of Quality & Reliability Management, 18*, 62–75.

Sporleder, T. L., & Moss, L. E. (2002). Knowledge management in the global food system: network embeddedness and social capital. *American Journal of Agricultural Economics, 84*, 1345–1352.

Thakur, M., & Donnelly, K. A. M. (2010). Modeling traceability information in soybean value chains. *Journal of Food Engineering, 99*, 98–105.

Thakur, M., & Hurlburgh, C. R. (2009). Framework for implementing traceability system in the bulk grain supply chain. *Journal of Food Engineering, 95*(4), 617–626.

Thompson, M., Sylvia, G., & Morrissey, M. T. (2005). Seafood traceability in the United States: current trends, system design, and potential applications. *Comprehensive Reviews in Food Science and Food Safety, 4*, 1–7.

Voldnes, G., & Heide, M. (2011). Felles kvalitetsmerking av norske pelagiske produkter- har det noe for seg? In Nofima. (Ed.), *Nofima reports* Nofima. http://www.nofima.no/publikasjon/1ACA8E85B57628C7C1257942004D6A00.

Yin, R. K. (2003). The role of theory in doing case studies. In R. K. Yin (Ed.), *Applications of case study research*. Thousand Oaks CA: Sage.