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Information Sharing Strategies in Whitefish Supply Chains in Norway vs. Iceland: Impact on Supply Chain Decision Making

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ABSTRACT

Information sharing is one of the main supply chain strategies for reducing uncertainty and is vital for supply chain efficiency. For decades, whitefish industries in Iceland and Norway have produced similar products and have exported to the same global markets. However, the differences in the supply chain integration in the two countries affects the information sharing between the fishing vessels and processors that in turn has an impact on supply chain decision making. In this paper, the information sharing practices in the whitefish supply chains in Norway and Iceland are compared. Vertical integration in the Icelandic industry enables information sharing between the fishing vessels and processors which is not the case in Norway. However, Iceland is still not taking full advantage of the available information. The use of the available information in supply chain planning, specifically production planning is discussed and suggestion for improved exchange and use of information is provided.

Keywords: information sharing; supply chain process mapping; whitefish supply chain; Norway; Iceland; production planning

1 Introduction

The whitefish industries in Iceland and Norway produce similar products and export to the same global markets but studies have shown that the Icelandic industry has more market success than the Norwegian industry over the same periods of time. A recent study revealed that Iceland was pursuing a differentiation strategy by exporting more high-priced, fresh whitefish fillets (REF). Several issues are believed to contribute to price difference in the marketplace where the Icelandic fish is sometimes fetching better prices than the Norwegian whitefish. Norwegians have been more unified in marketing fish but they are affected by the short fishing season where bulk of their catches are caught early spring while the Icelandic market strategies are often more fragmented and on company level. The organization of transactions, the flow of goods and information flow in the supply chain is of great significance for value creation and depends on many factors (Tverterås et al., 2014). Previous studies have argued that the superior harvesting and marketing strategies of the Icelandic industry may be rooted in factor conditions that are difficult to duplicate and in a rigid institutional framework in Norway. This framework is related to the freedom to organise the value chain i.e. by vertical integration (Bjorgvinsson et al., 2015).

This lack of vertical integration seems to limit information sharing between the fishing sector and the processing sector in Norway, which are usually done by separate companies. With limited data, there are limits for decision support at the processing stage and this also limits any data flow upstream in the value

chain. This gap between the industry on the other hand and consumers, retailers and foodservice sectors is of fundamental interest to many stakeholders and policy makers. A relevant research topic is to elaborate on how this gap can be closed or minimized. Some would argue for stricter labelling regulations, and others for some industry concession declaring that they are willing to increase value chain transparency with modern technology.

Information sharing is one of the main supply chain strategies for reducing uncertainty (Chaudhuri et al., 2014). Information sharing plays a central role in supply chain collaboration and is vital for supply chain efficiency (Van der Vorst and Beulens, 2002). Management of food supply chains are particularly complex due to an intrinsic focus on product quality (Luning and Marcelis, 2006). Various motivation factors for supply chain information sharing are mentioned in the literature and include legislative requirements, efficient product recalls, optimization of business processes and product differentiation (Trienekens et al., 2012; Zhang and Chen, 2013; Mishra et al., 2009).

In recent years, several studies have been conducted on the value of information sharing in supply chains and its impact on supply chain performance. Sahin and Robinson (2005) studied the impact of information sharing and physical flow coordination in a make-to-order supply chain and found that information sharing reduces costs and the main economic benefit comes from coordinated decision-making. Information systems in marketing are often well connected to the processing information systems or at least to the product inventory. However, when it comes to displaying marketing information from the other parts of the value chain, no such system is available in the seafood industry (Margeirsson and Sigurdardottir, 2010).

Information sharing and coordination between the buyer and vendor in the supply chain have been considered as useful strategies to remedy the so-called bullwhip effect and to improve supply chain performance. The debate is not about whether production information should be shared in the supply chain, but about how to share the right information at the right time in the right format by the right people under the right environment to maximize the mutual benefits of the whole supply chain as well as the individual business players (Huang et al., 2003).

The next section provides an overview of the whitefish supply chains in Norway and Iceland.

2 Whitefish supply chains in Norway and Iceland

Whitefish supply chains are complex in nature due to seasonal variations, high supply uncertainty and rapid quality deterioration due to handling and temperature variations. In Norway, catch volumes for whitefish including cod, saithe and haddock amounted to 721 525 tonnes in 2014. This included 473 478 tonnes of cod with a value of approximately 520 million Euros. Most wild cod is exported as lower-value products preserved in salted, dried, and frozen forms. In-season whitefish processors typically buy from coastal vessels that deliver fresh fish and in off-season buy from sea-going vessels that deliver frozen fish.

For the same year in Iceland, catch volumes for whitefish amounted to 322 124 tonnes in 2014. This included 239 951 tonnes of cod with a value of approximately 343 million Euros (average exchange ratio for 2014 was 154.9 IKR/€). Icelandic seafood companies exported almost 35 thousand tons of fresh fish, thereof the cod is the most important specie with 23 245 tonnes with a value of approximately 181 million Euros. Figure 1 shows a typical whitefish supply chain from the catch to the processor.

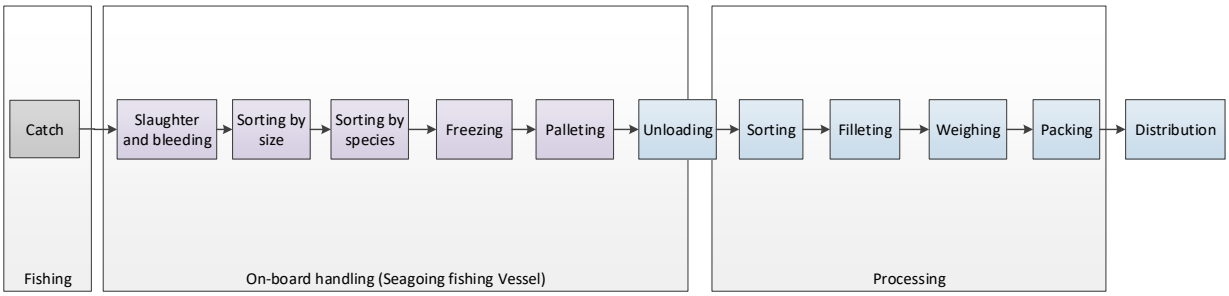

Figure 1. A typical whitefish chain from catch to processor.

Vertical integration in the fisheries industry in Iceland has a long history, which goes back to early 20th century. The largest fishery companies at that time were vertically integrated with a large number of trawlers, in-house processing (salt fish, herring processing and meal/oil reduction) and integrated distribution channels and export activities to the main markets in Europe. In-house distribution activities

ended in the 1930s and in 1940s when co-operative sales organisations with export monopoly took over (Union of Icelandic Fish Producers, Icelandic Freezing Plants and Samband of Iceland). But, the large fishery companies kept on as partially integrated with the harvesting part and the processing part in own hands. This type of organisation was kept unchanged up into the early 1990s when the quasi-monopoly of the sales co-operatives was discontinued. Consequently, more and more of the larger companies then took the distribution and export activities in their own hands.

In 1997, of the 50 largest fishery companies in Iceland there were 34 companies partially vertically integrated (harvesting and processing). Some of the largest companies had already taken steps towards downstream integration but largest part of the downstream activities were still mainly outsourced. In the last two decades, a fundamental change has taken place in organisation of the largest fishery companies. Firstly, in 2014/15 the number of vertically integrated companies were 18 and partially integrated companies were 16.

In this study, we analyse the data management and information exchange strategies in the fishing and processing sectors in these two countries and how they affect the supply chain decision making.

3 Objective

The objective of this study is twofold:

1) Compare the data management and information exchange practices in Norway and Iceland and to understand how these affect the supply chain decision making, including production planning, fleet management, control of catches, product differentiation and marketing strategies.
2) Provide a suggestion for improved information exchange between fishing vessels and processors to enhance supply chain decision making and provide a platform for product differentiation.

4 Methodology

In this study, the Event-driven Process Chains (EPC) technique is used to develop as AS-IS model of the whitefish processing chain depicting the current material and information flow practices between the fishing vessels and the processors. Case study methodology was used to analyse the whitefish chain including the fishing and processing operations in Norway and Iceland. Process mapping was conducted through visits to the companies to understand the flow of material and information. Information about the data management and supply chain planning practices was gathered during these visits through semi-structured interviews. The following companies were included in the study:

- A whitefish processor in Norway
- A fishing company using deep-sea trawlers in Norway
- An integrated fishing and processing company in Iceland

The companies selected in this study are major market players in the whitefish sector in Europe and provide a good representation of information sharing strategies that exist in this sector. The following questions were included in the semi-structured interviews:

1) What data is captured by the fishing vessels? Is it communicated to the processors?
2) What data management systems are used on-board the fishing vessels and by the processing plants? Are these systems integrated?
3) How is the information from fishing vessels used in production planning by the processors?
4) What information and how is it used downstream in the supply chain specially to communicate with the consumers, for product differentiation and marketing strategies?
5) How to improve the production planning practices, control of catches and market strategies based on the information that is already available in the supply chain?

EPC is a process modelling technique used for modelling, analysing and redesigning business processes. The language is used to describe processes at the level of their business logic and easy to understand and use by end users. In addition, the same EPC models can be used for the requirements definition of an information system.

An EPC consists of the following elements:

- Functions: the basic building blocks are functions. A function corresponds to an activity (task and process step), which needs to be executed.

- Events: events describe the situation before and/or after a function is executed. Functions are linked by events. An event may correspond to the post-condition of one function and act as a pre-condition of another function.
- Control flows: A control flow connects functions, process paths or logical connectors creating a sequence and interdependencies.
- Logical connectors: connectors can be used to connect activities and events. In this way, the control flow is specified and they can be used to split the control flow from to two or more flows or to combine two or more flows into one control flow. There are three types of connectors: Λ (and), XOR (exclusive or) and V (or).
- Organization unit: Organization unit is used to describe which organization is responsible for a specific function.
- Information: Information refers to information, material or resources connected to a function.
- Information flow: Information flows show the connection between functions and input or output data.

The various EPC elements are described in Figure 2.

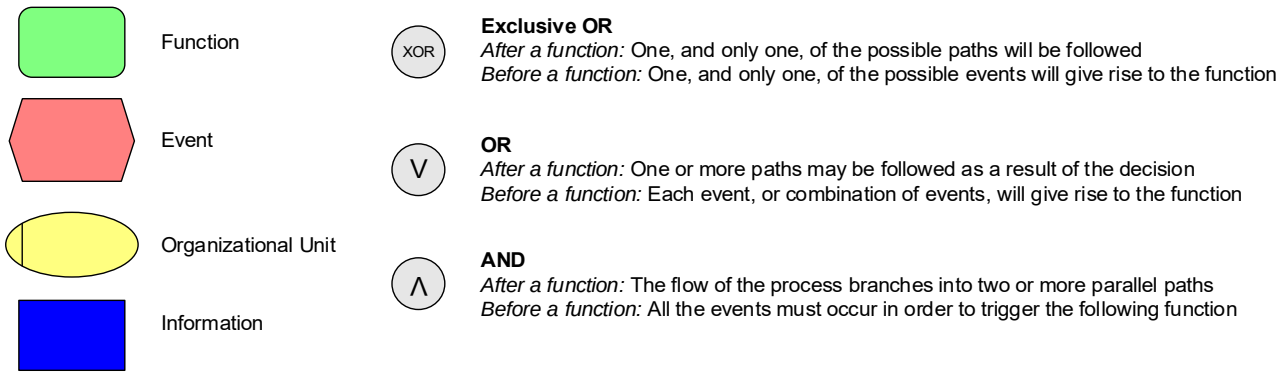

Figure 2. Elements of the Event-driven Process Chains.

Microsoft Visio 2013 software was used to develop the EPC models for the whitefish *processor and the fishing vessel.*

5 Results

The following section presents the EPC models developed for the fishing vessel (trawler) and processors both in Norway and Iceland. The Icelandic whitefish industry is usually vertically integrated where the processor owns its own fishing vessels whereas in Norway this is not the case. Figure 3 shows the flow of information and material at the Seagoing fishing vessel in Norway. The Seagoing vessels deliver frozen fish to land (processors/exporters). The vessel interviewed for this study uses the trawling method for catching whitefish. The company uses the eCatch (www.ecatch.no) system on-board the fishing vessel for recording catch information and communicating it to the Norwegian and EU authorities (for export products). The eCatch system is accessible by the Sales department and the office in Norway. The company has direct contacts with buyers or can sell through auctions. Daily production reports are used to manage the on-board operations. The company also sells direct to buyers in Poland and China and transportation to Poland takes 3-5 days while to China it takes 5-6 weeks (frozen).

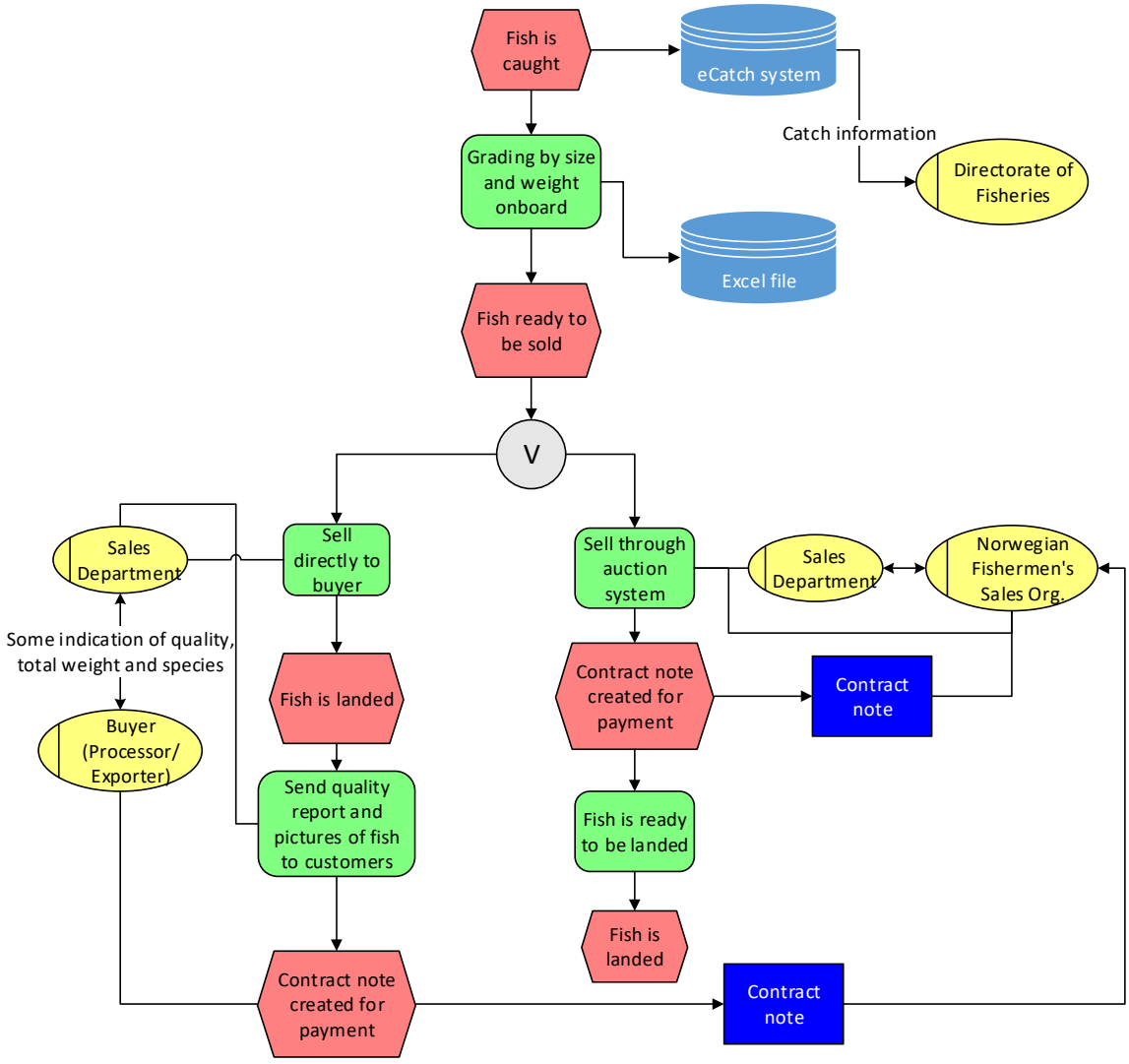

Figure 3. Information and material flow at the seagoing vessel (Norway).

Figure 4 shows the flow of information and material at *the processor in* Norway. The first step in the supply chain is the catching process which is described in Figure 3. In-season, the fish is mostly delivered by *Coastal Vessels* (fresh on the same day) while in off-season, the fish is delivered (mostly frozen) either by *Seagoing vessels* or transported from another processing plant of the same company. Fish is graded on-board by size and a contract note is created using the information from grading. This information is communicated to the Norwegian Fishermen's Sales Organization that communicates the catch information to Catch Certificate SA for issuing the catch certificate. Various data management systems are used by the *Processor* and their details are provided in Section 5.2.

Figure 5 shows the flow of information and material between the fishing vessel and the processor in Iceland. The figure depicts a vertically integrated whitefish supply chain where the processor owns its own fishing vessels. Unlike the push supply chain system followed by the Norwegian companies where they must process the fish that they receive, the Icelandic processors places orders to its fishing vessels based on the customer orders and quota status, thus following a pull supply chain system. The Icelandic processor sends orders to the vessels for how much fish of each main spices is wanted, where to catch and when (and sometimes where) to land so they have the desired size and quality of raw material needed for fulfilling customer orders.

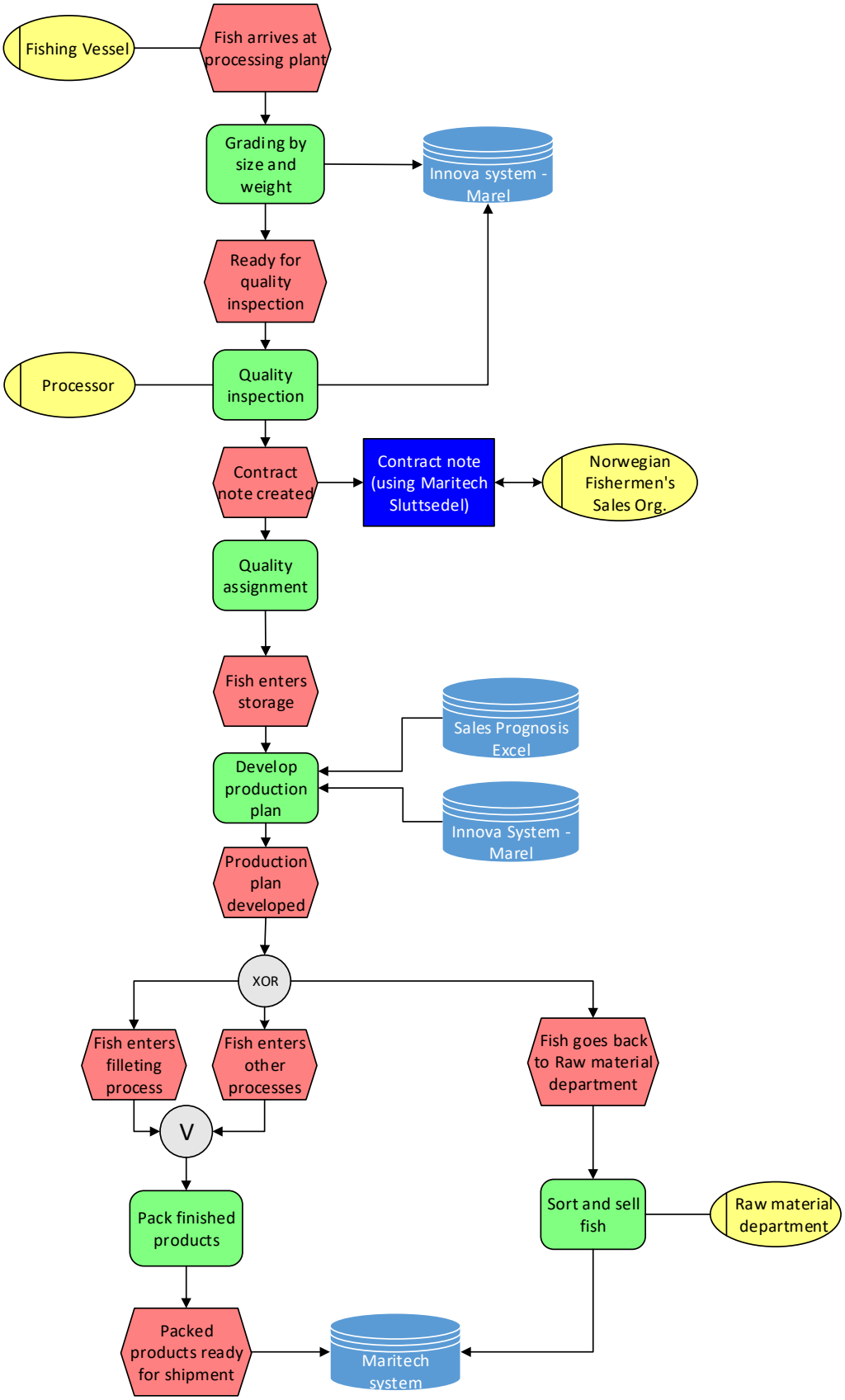

Figure 4. Information and material flow at the processor (Norway).

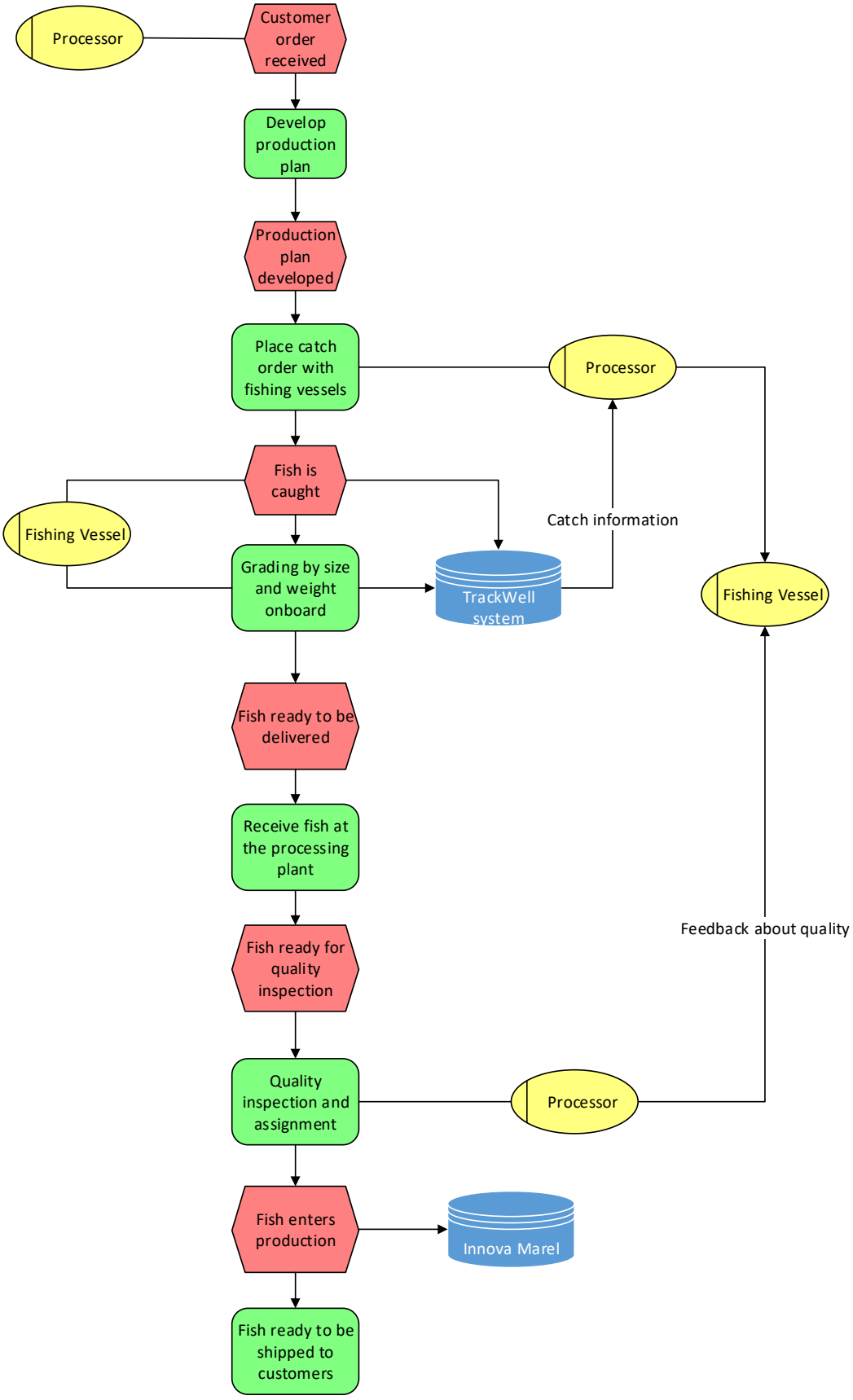

Figure 5. Information and material flow between the fishing vessel and the processor (Iceland).

5.1 Use of information management systems

5.1.1 On-board information systems

In Europe, electronic recording and reporting system (ERS) is used to record, report, process, store and send fisheries data. The key element is the electronic logbook where the captain of a fishing vessel keeps the records of the fishing operations. The records are then sent to the national authorities, which store the information in a secure database. These e-logbooks are basically an electronic edition of the paper based logbooks that have been used for decades.

The captain of the vessel usually enters information regarding the catch, by haul or days, depending on the type of fisheries. Catch reports are created with information on the catch volumes by species, catch location, date, weather conditions and other factors. Today, suppliers of seafood into the EU must also provide a catch certificate with each lot, to prove that their supply is not coming from illegal, unreported or unregulated (IUU) fisheries. The demand for these certificates will most probably further enhance the use of electronic logbooks in the N-Atlantic whitefish sector. The electronic logbooks create large amounts of data concerning the catch. It is therefore important for all stakeholders in the value chain to ascertain how they can get value from the use of electronic logbook data. When fish is processed on-board in freezing trawlers, information gathering is easy because there is only one stakeholder who is fishing, processing and labelling the product before freezing. So, most of the relevant information is stored in one system and the relevant information is put directly on the boxes. This however only covers only information components from the vessel and does not contain information regarding where and when the fish was landed, how it was transported to the marketplace etc. Therefore, information from other stakeholders should be added to tell this product story from catch to customer. When fish is landed fresh for processing many of the vessels are able to forward information that exceeds the data available within the basic version of the electronic logbooks. This is particularly practiced in integrated value chains, where the processor for example owns the fishing vessels. Softwares such as WiseFish and Innova can accept information from TrackWell (www.trackwell.com) logbooks.

Most Norwegian fishing vessels use the eCatch system for recording the catch data on-board and use this system for reporting to the authorities. eCatch system is approved by the Directorate of Fisheries in Norway and can be used to record and share the following information:

- Vessel name
- Trawling time
- Catch information: Species, Total weight, Product condition
- Catch area
- Trawling position (start and end)

However, currently this information is not communicated to the processors and is not available for making production planning decisions.

The Icelandic fishing vessels on the other hand use a similar system called Hafsyn from Trackwell to record the catch information. Being vertically integrated, the processor has access to all the catch data live and it can be used in their planning decisions regarding the fisheries, planning the processing of the catch and sales. Information collected by the Trackwell system and what is available is shown in Figure 6. This includes catch, trip, haul and gear information as well as the processing information and some environmental parameters like sea temperature, which can be of interest to the processors.

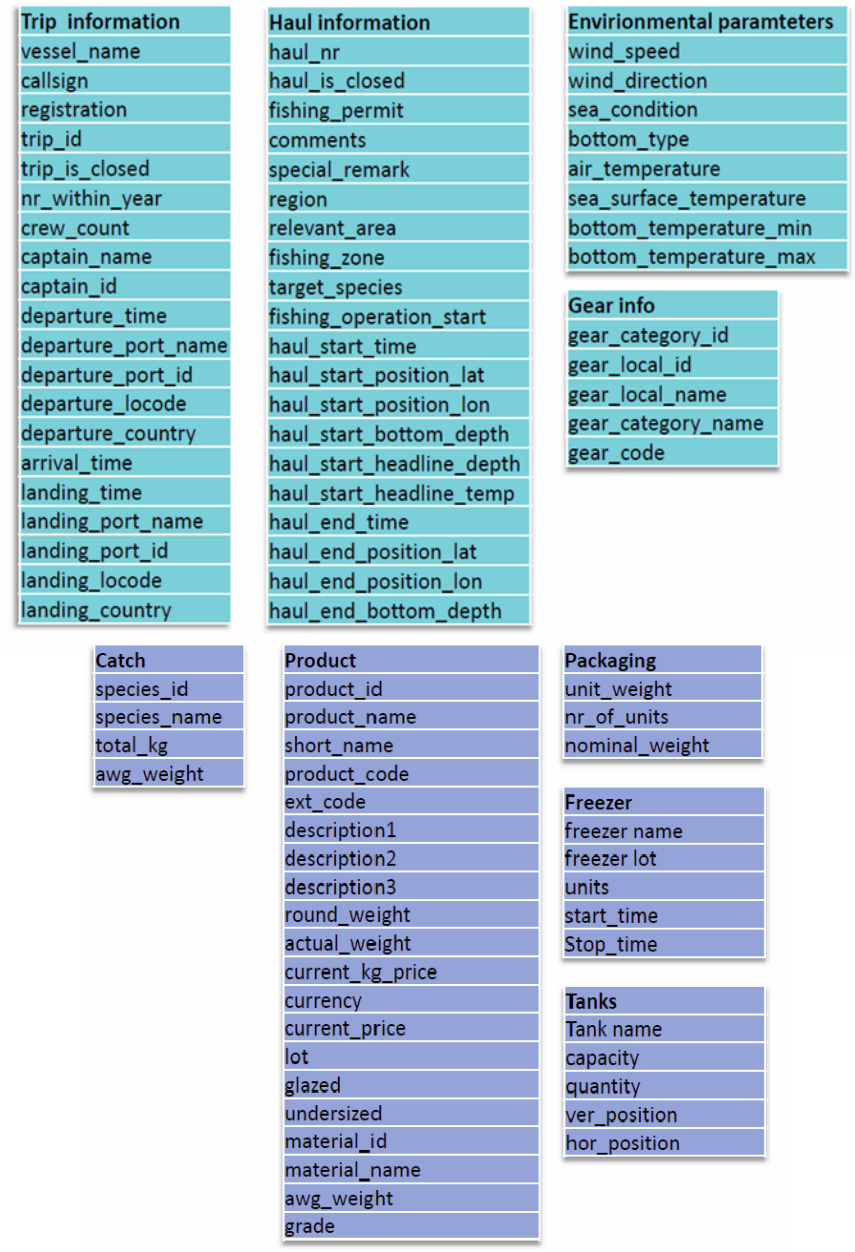

Figure 6. Information available from the Trackwell system (Gunnarsson, 2016).

5.1.2 Information systems in processing

Usually fresh fish is processed on land where there are many different Enterprise Resource Planning (ERP) systems used in the fishing industry around the world. In Iceland, the most common systems are the Wise system from Wisedynamics (formally known as WiseFish from Maritech), the Innova system from Marel and SAP systems. These systems vary greatly, but they all manage data from processing, inventory control, lot tracking, logistics and sometimes marketing. These systems are used to record usage of raw material/work in progress and all associated costs and maintain full product records including price, sales, and production history.

These systems are usually the backbone of each company, connecting data from different sources and therefore making products and information traceable through the different processes involved. After processing – the fish products are usually labelled in a similar manner as the ones frozen-at-sea. It is however usually not labelled with catching date, just processing date in Julian Day Calendar format, e.g. 99 day of the year is the same as 5. April. For fresh fish transported by plane, the labels include flight number and destination so there is more traceability information on these labels beyond the frozen-at-sea ones. Still, with only this limited information on the boxes, information from aforementioned systems have to be accessed to complete the story of the product through the value chain.

5.1.3 Information exchange practices in Norway

The process mapping in the whitefish supply chain provides several insights that are of great relevance for the industry. The most important finding is the lack of information exchange between the fishing vessels and the processors in Norway. The processor does not receive any quality information from the fishing vessel but only gets an indication of total weight and estimated quality. Although this information is available in the eCatch system on-board the fishing vessels but not shared with the processors. According to the fishing company, the buyers are not asking for additional quality information today. The quality report can be linked to the Catch date which is used as the Unique ID and this information can be useful for tracking the quality linked to catch area, season and catch method. From the processors perspective, if they have the quality information in advance, it is easier to determine what proportion of the catch can be used for fresh fillet production which is their main business and what proportion should go into other products or should be sold without further processing.

For the processor interviewed in this project, the raw material inventory status for different plant locations is not available making coordination between locations very time consuming and inefficient. A real-time raw material inventory system could be developed by tagging the tubs used to store the raw material which in turn would provide a transparent system for all locations and allow for efficient coordination. The information about quantity, grade and quality could also be linked to each tub.

5.1.4 Information exchange practices in Iceland

Due to the vertical integration in most Icelandic whitefish chains, the information exchange between the fishing vessels and the processors is seamless. All the catch information as well as the additional information about the trip, haul, fishing gear, etc. is available to the processors. However, most of this information is not used for improving the supply chain planning. For instance, the historical data available about each fishing trip linked to the quality of the catch can be used to plan the fishing trips in the future. There is no quality information available from the fishing vessels, but the quality check is done after landing. The haul time, haul size, sea temperature or time from catch till bleeding, could be used as an indicator of quality but this is not done today. The processor in Iceland buys about 20-25% of their raw material from the market and faces similar challenges related to lack of information as the Norwegian processors. In future, the goal is not to buy anything from the market but only use their own fishing vessels where the company has a better control over the catch quality. The Trackwell system is also used as a fleet management tool to determine delivery times for different vessels and improve supply chain efficiency by reducing wait times and supply the processing facilities with right amount of raw material at the right times.

5.2 Suggestion for improved information exchange between fishing vessels and processors

In Norway, improvement in information exchange between the fishing vessels and processors can have several benefits. The Icelandic processing companies that are not vertically integrated and buy fish directly from the market would also benefit from access to information from the fishing vessels. However, it is interesting to note that the vertical integration in case of the Icelandic processor does not necessarily mean better supply chain planning. A lot of information is available about each fishing trip but is not being used in an optimal way to improve either the fishing operations or the production planning. In addition, in both Norway and Iceland, detailed catch information such as temperature and product condition is available on-board the fishing vessels but is not shared with the processors. If available in advance, this information can be used by the processors to improve their production planning decisions. Based on the findings in this study, Figure 7 illustrates the suggested information exchange in the whitefish supply chain and how it can be used to improve production planning by the processor and feedback on quality can be provided by the processors to the fishing vessels. The information on quality and the fishing trip can be used to optimize the fishing operations, for example, selecting the best fishing areas. The information linked to each operation is already available in the existing systems that are used in Iceland and Norway such as the eCatch and TrackWell systems. The quality information is recorded by the processors in their internal databases.

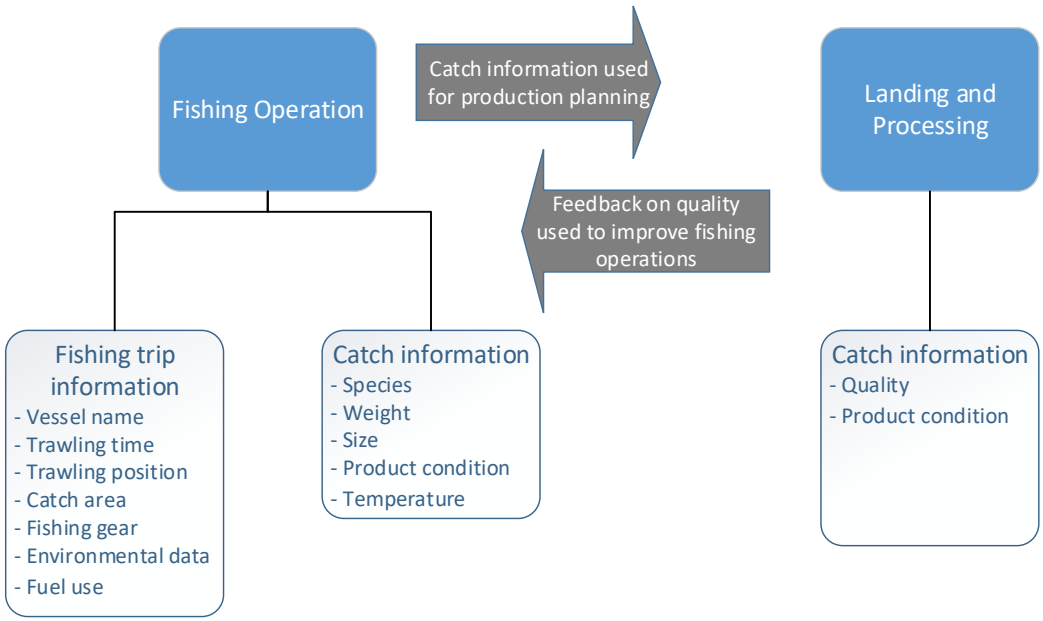

Figure 7. Suggested information exchange.

5.3 Benefits of improved information exchange

In addition to the improved production planning, improved information exchange between the fishing vessels and processors in the whitefish supply chain can potentially lead to various benefits. Some of these are listed below.

Product differentiation and marketing strategies

Currently, there is no special focus on product differentiation and marketing strategies in both Norway and Iceland. EU's labelling requirements for fish products require the catch area (country) but not landing information to be printed on the label mandatorily as shown in Figure 8. Therefore, catches from Norway and Iceland can be labelled with FAO catch area no. 27 or "caught in the Northeast-Atlantic", making it impossible for consumers to see which country caught the fish. This information although available in the supply chain is not used by processors on the label as it is not required by the authorities. If used, however, this additional information can be used to communicate the product origin and processing history (locations) to the consumers. Previous studies have shown the consumer interest in receiving additional product information. In previous project called WhiteFishMall (Vidarsson et al., 2015), consumers' preferences for supply chain information for whitefish were examined through qualitative and quantitative studies. These studies identified consumer needs for trustworthy information regarding origin, sustainability, quality and product history. They want the information to be verified or come from a trustworthy source. Since, a lot of data is available about the catch this can be used to communicate with the consumer and provide more information about the fish and its processing history – where was it landed, processed, packed etc. and to show consumer the people behind the product. Such data can provide a differentiation opportunity for the processors that are looking to capture a higher market share by telling a story about their product by means of a simple QR code.

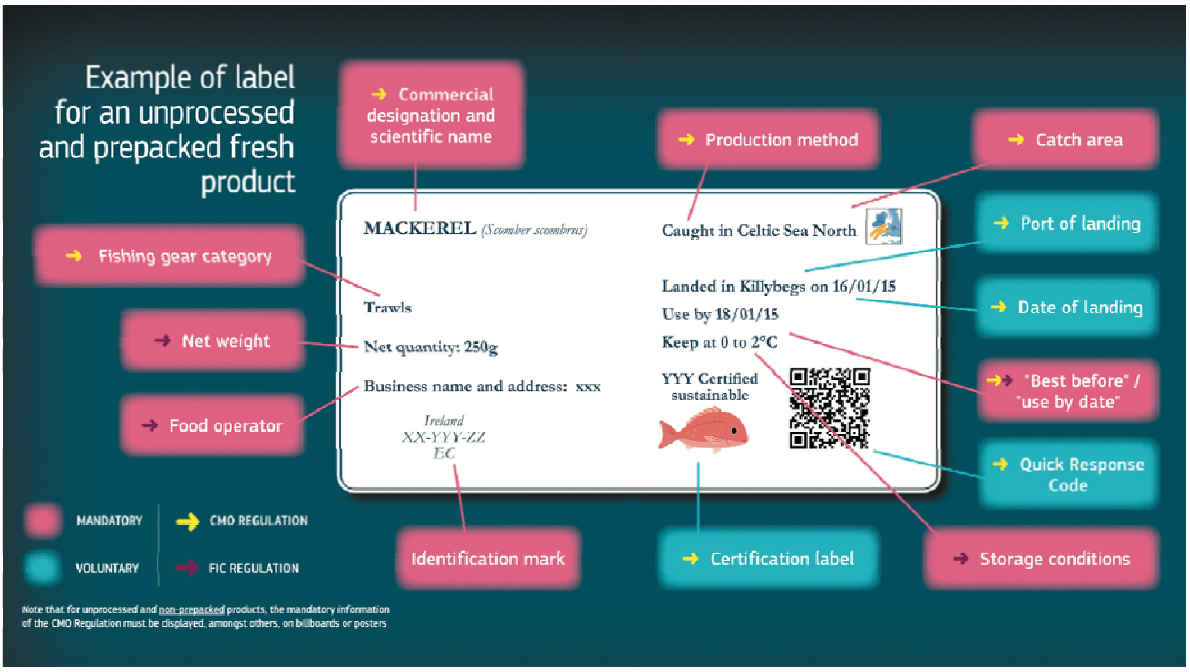

Figure 8. EU Labelling requirements.

Supply chain coordination

Access to real-time catch and fleet information can be used to harmonize fishing effort by many fishing vessels and can also be used to decide the delivery times and locations of the different vessels. Use of historical information about season, catch area and how that affects the catch quality for various species can be used to improve the fishing plans.

In addition, the on-board handling practices can be improved when specific information about the haul time, oil consumption and manpower used is available. This information could also be used to calculate the environmental impact and cost per kg of fish and in turn used to identify areas of improvement.

6 Discussion and future work

This paper follows a case study approach; however, the findings are representative of the whitefish sectors in Norway and Iceland. The companies selected in this study are major market players in the whitefish sector in Europe and provide a good representation of information sharing strategies that exist in this sector. Most fishing companies in Norway and Iceland use the eCatch or the Trackwell systems for on-board data collection. These systems are also used for reporting the catch information to the authorities. The suggestions for improved information exchange are based on the data that is already available but is either not being shared, in case of Norway or not being fully utilized in case of Iceland. The extent of supply chain integration plays a role in the willingness and ability to share information between the fishing and processing operations. The vertical integration in the Icelandic industry enables information sharing between the fishing vessels and processors which is not the case in Norway. However, Iceland is still not taking full advantage of the information that is available for marketing and product differentiation and companies can further improve their practices both on-board and in the processing plants for higher economic benefits, especially by use of catch quality information. In Norway, due to lack of vertical integration, information exchange between companies is more challenging. So, further work is needed to study the willingness to share information in the supply chains, barriers and opportunities for both parties – the fishermen and the processors. In absence of vertical integration, the concept of vertical coordination needs to be explored in the Norwegian case where fishermen and processors willingly share information for mutual benefit.

Recent projects like WhiteFishMaLL have reported on consumer willingness to buy whitefish products from the N-Atlantic, given certain communication parameters and product attributes. A key finding of the project is the gap which is between consumer needs regarding availability of information and what the suppliers, especially retailers are actually willing to provide. There is a reluctance especially from the retail sector to provide consumers with on-line, fully traceable information about the origin, date of catch and processes involved in bringing the seafood from the ocean to the retail store. The date of catch is a

sensitive issue and the retailers don't want to get too close to one provider of fish with good value chains transparency, they want to be able to switch between suppliers of fresh fish without the consumer noticing it. This gap between consumers, retailers and foodservice sectors is of fundamental interest to many stakeholders and policy makers. A relevant research topic for the future is to elaborate on how this gap can be closed. Some would argue for stricter labelling regulations, and others for some industry concession declaring that they are willing to increase value chain transparency**.**

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