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Optimizing access to raw material for value-adding processes of fish side streams

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Abstract
Under the double influence of the rapid growth of the population and the shortage of resources, people begin to pay attention to the utilization of existing raw materials. Seafood is one of the indispensable foods for humans to obtain protein. However, as much as 60 per cent of the fish side stream is discarded or produced as low-value products. In response, the EU invested in the WaSeabi project to study technical issues related to the optimal utilization of seafood by-products by designing new integrated production lines. At the same time, many start-ups and fisheries are interested in developing a new commercial economy. This paper aims to investigate and study the logistics activities related to fish side streams as raw materials for human food production. The research question focuses on how to effectively and safely carry out fish side streams logistics activities from the fishery processing plant to the fish side stream processing plant. The qualitative method was used to collect data, including interviews with heads of well-known fishing companies in Gothenburg, Sweden. The results show that the current logistics activities about the fish side stream food grade are not perfect and immature. Finally, the paper is based on the existing fish side stream logistics activities and food grade logistics activities of fish products, the construction and development of fish side stream logistics activities guidelines.

Keywords: *Fish Side Streams, Environmental Sustainability, Food Packaging, Transportation, Storage, Customs*

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Table of contents

1. Introduction

The purpose of the introduction is to provide an overview of the thesis topic regarding the fish side streams market and relevant logistics in the Sweden context. After that, the research questions will be proposed. A delimitation section will also be included to set boundaries and increase clarity for this study.

1.1 Background

We live in an era of unprecedented population growth. The world's population has tripled since the mid-twentieth century, reaching nearly 8 billion by 2022. United Nations projections suggest the global population could grow to nearly 11 billion by around 2100 (Niels et al., 2022). The population has grown exponentially over the past century. It does this mainly by producing large amounts of food, providing humans with abundant nutrition and learning how to control disease, and by the persistence of high fertility rates in many countries (Rabbinge, 2007; Welch, 2002; Welch & Graham, 1999; Holdren & Ehrlich, 1974; Simon, 2019; Armelagos et al., 1991). Because of rapid population growth, there will also be a rapid increase in the global demand for extra food. (Alexandratos, 2005). Among them, seafood is vital in feeding the world's growing population (Tidwell & Allan, 2001). In the last 50 years or so, from 1960 to 2014, annual global consumption of recycled products has more than doubled, to about more than 20 kilograms. Seafood protein is an important nutrient in many countries, especially those with low total protein intake (Guillen et al, 2019). In 2013, seafood provided at least 20 per cent of animal protein intake for more than 3.1 billion people. As a result, seafood is a direct source of micronutrients such as protein and can also make an important contribution to food security indirectly by paying for food on the job (ibid). Fish meal and fish oil are also linked to land-based food systems differently. For example, in 2009, 25 per cent of fish meal production went to pigs and 8 per cent to poultry (Naylor et al., 2009).

Fisheries include any industry or activity related to the capture, farming, processing, preservation, storage, transportation, marketing or sale of fish or fish products (Lange & Jiddawi, 2009; Paul et al., 2018). Fishing is also a primary industry which harvests or extracts raw materials from nature (Cleveland, 1991; Rebours et al., 2014). In order to ensure the availability of healthy fish stocks from healthy oceans and the resilience of these ecosystems and coastal communities, sustainable fisheries are essential (Nellemann &Corcoran, 2009;

Charles, 2008; Sumaila et al., 2021). Fishing is one of the most critical drivers of declining marine wildlife populations. Fishing is only harmful to the oceans if boats catch fish faster than stocks can be replenished, a situation known as overfishing (Perry et al., 2010; Mansfield, 2010). By adopting Sustainable Development Goal 14 (SDG 14) of the 2030 Agenda for Sustainable Development, United Nations (UN) member states agreed to end overfishing by 2020 and effectively regulate fishing practices scientifically (Virto, 2018). Implementing scientifically determined total allowable catch (TAC) for major species of commercial interest is considered an effective and transparent way to achieve this objective (Mardle et al., 2004).

Nevertheless, fishing is essential for people living in coastal areas and islands because there is much water in their area, and they eat mostly fish. It is easy to catch fish, and some people sell fish for money (Jennings et al., 2009; Fabinyi et al., 2017). Globally, therefore, fisheries and aquaculture production are important sources of nutritious food and the basis of livelihoods (Finegold, 2009; Béné & Heck, 2005; Little et al., 2016). It is also a significant driver of coastal and rural economic well-being. Examples include Nordic countries: Denmark, the Faroe Islands, Finland, Iceland and Sweden (Kettunen et al., 2012; Svedäng et al., 2018).

At the same time, seafood distribution networks are widely and intricately distributed around the world (Toner, 2015). Adverse weather and environmental conditions, global shipping capacity shortages, and fluctuating supply volumes make seafood logistics particularly challenging (Jennings et al., 2016). Among these, some seafood procurement operations lacked record keeping and did not have robust mechanisms to determine where, when, how, by whom, and what was caught by each vessel (Pramod et al., 2014; Roberson et al., 2020; Gilman et al., 2022). This has led to mismanagement of resources. These records are vital to determine the product's sustainability and legality and the inventory's health (Tsolakis et al., 2021). The data relating to the sustainability and health of the inventory determines how fast and in what manner delivery is required (Costello et al., 2016). To address these issues, suppliers should always require traditional logs that document the source of the catch as well as record total weight, price, and type information (Mangi et al., 2015). According to Cook et al. (2019), it is usually early in the logistics chain - on the deck of the fishing vessel, to be precise. Carriers often compromise on seafood quality to best use the limited space available.

They stack seafood according to size, depending on the fish's product, the catch date, and the harvesting process. Uninspected seafood is gathered to place them on the most profitable vessel, which runs counter to any effort at reliable and responsible storage (Cook et al., 2019).

In addition, cold storage facilities should be adequate and provide the correct temperature range required for each specific product (Mercier et al., 2017). Cold storage is critical for fresh seafood logistics (Feng et al., 2020; Selamoglu, 2021). Beyond that, the cost is one of the main challenges in shipping seafood (Allshouse, 2003). According to Hummels (2001), airfreight is faster but also an expensive option. Sea freight is much cheaper but takes longer to reach its destination. Even after optimizing the route, sea freight deliveries can take longer than expected due to port congestion, natural disasters, social unrest and severe equipment shortages (Hummels, 2001).

Moreover, ocean freight is more susceptible to disruptions, which can wreak havoc on overall shipping schedules and product viability (ibid). Fish has a concise shelf life compared to other products shipped under refrigerated conditions (Taoukis et al., 1999). To prevent spoilage, not only does a robust refrigeration mechanism and proper temperature control need to be put in place, but routes need to be carefully planned to complete deliveries within the required time frame (Taoukis et al., 1996). Therefore, logistical support for seafood markets must be efficient and flexible enough to respond quickly to changing conditions without compromising product quality (Christopher, 2002).

This paper focuses on the logistics-related activities in the Swedish fish side stream market. Because of fish origin and production factors, this paper focuses on the side streams of salmon and herring. According to Abdollahi et al. (2020), it was shown that fish processing generates a large number of side streams, which are divided into solid and liquid side streams. Since the discussion in this paper is about the value-added processing of solid fish side streams, liquid side streams will not be discussed, as can be seen. Figures 1 and 2 show, respectively, the types of side streams generated during the processing of salmon and herring.

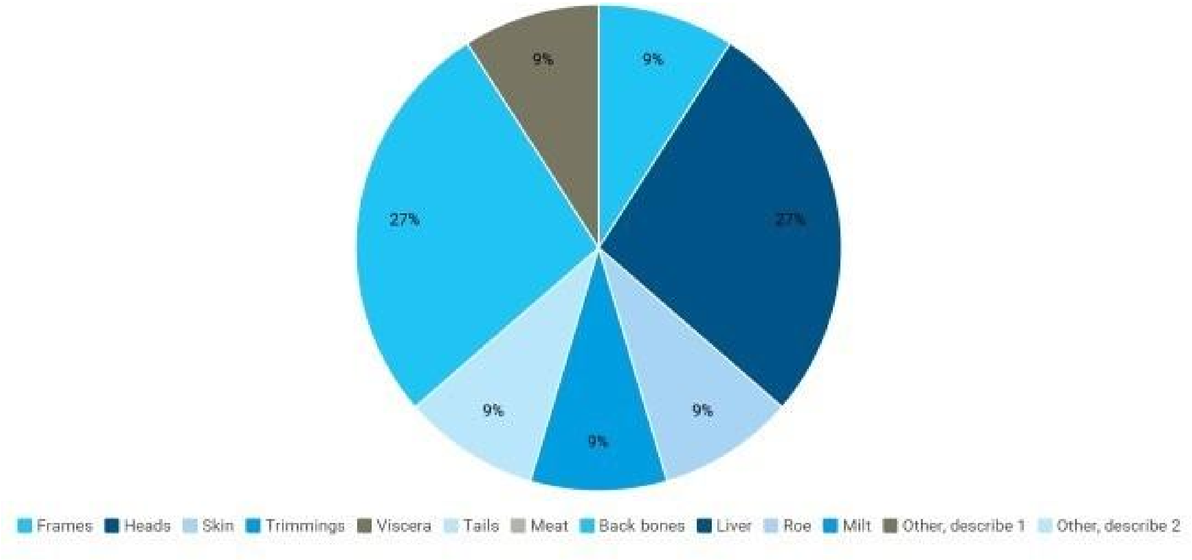

Figure 1. Select type of side stream generated during processing of SALMON (Abdollahi, 2020).

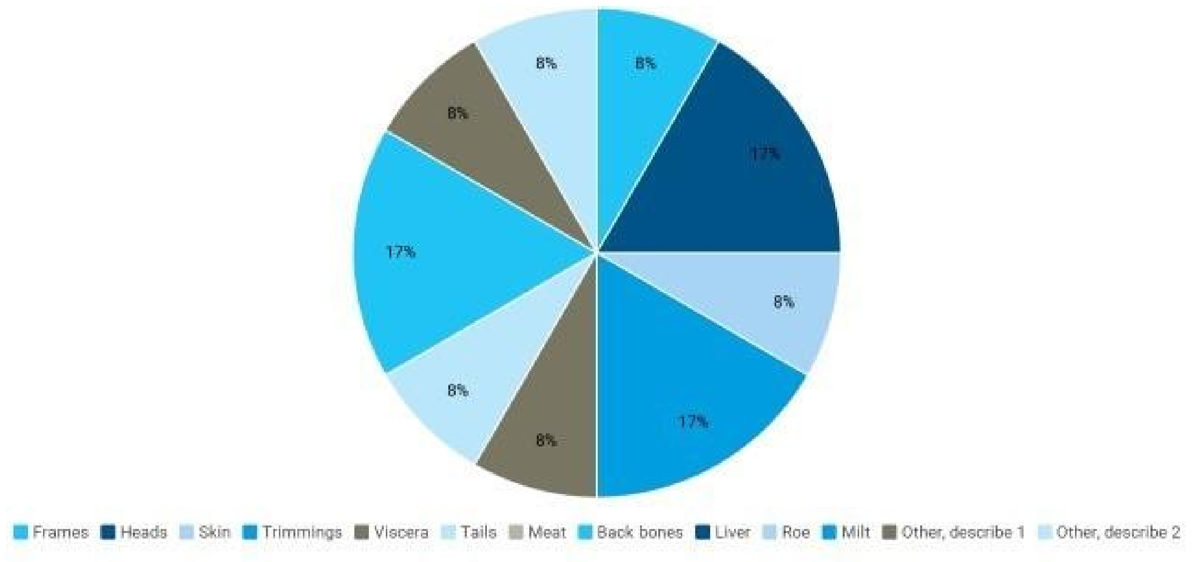

Figure 2. Select type of side stream generated during processing of HERRING (Abdollahi, 2020).

1.2 Problem Statement

Under the influence of many factors, such as climate change and competition for natural resources, the production of capture fisheries has been stagnated and aquaculture has been vigorously developed. Countries should focus on the consumption rather than the supply side of fish and seafood to expand and meet the food and nutrition needs of a growing world population (Guillen et al. 2019). According to Arvanitoyannis and Kassaveti (2008:1), in 2000, more than 60% of the world's total fisheries production was processed in some form, of which 97 million tons of 131 million tons of fish were consumed directly by humans, with the remainder used to produce non-edible products such as fish meal and oil. Because of their high nutritional value, they are used to make feed for livestock and so on. At the same time, fisheries produce more than 20 million tons of waste worldwide, equivalent to 25 percent of the total production of Marine capture fisheries. In addition to the broken nets, they mainly include a large number of solid and liquid side flows produced in the process of fish processing. This means that more than half of the raw material (fish) will not be used. However, fish, as a highly perishable commodity, requires more rigorous processing (Arvanitoyannis and Kassaveti, 2008, p. 1).

Furthermore, expanding marine-water fish farming worldwide has caused increasing concern about its environmental impact. According to Arvanitoyannis & Kassaveti (2008), waste from fish farms can affect the surrounding area, especially the liquid side flow, which directly pollutes water resources. At the same time, as the pollutants spread, they also spread to the wider coastal zone. For example, reducing the biomass, density and diversity of benthic, plankton and swimming organisms, and altering the natural food webs. In addition, industrial processes are always accompanied by wastes that pose significant environmental risks. Therefore, technology to treat these wastes, or even better, recycle some valuable organic materials before disposal, is necessary to reduce pollution (ibid). It is well known that the premise of all processing of aquatic side streams is to ensure the freshness of raw materials. Therefore, collecting, classifying, storing and transporting these aquatic side streams quickly and efficiently is crucial for regenerating food and expanding the utilization of raw materials.

Many studies tell of fish commonly traded live, fresh, frozen, cured or canned. It is shipped by sea, air or land to maintain the quality of the fish product or by various means of packaging. Currently, research on fish side streams is mainly used to produce products that are not edible for humans (e.g. compost and animal feed), and the raw materials for such products are usually transported without strict temperature control requirements. However, more efforts have been made to study the side streams of fish in the direction of human food to improve the overall optimal utilization rate of fish. Consider that in terms of the supply chain, food transportation has higher standards than other industries. Therefore, this paper attempts to study the logistics activities related to fish side streams as raw materials for human edible products.

1.3 Case Description – Upcyclr

With this objective in mind, the company – Upcyclr proposed to process fish side streams to reduce the production of fish waste, reduce production costs and expand the life cycle of food use. Then they sell the resulting products to food factories for reprocessing, adding nutritional benefits like protein to new food products. The main objectives of high-tech processing are to maintain food taste and colour, make these nutrient-rich foods edible and significantly increase their value, and provide rich nutrition for humans with high protein quality food.

In short, Upcyclr proposes to provide fish side streams solutions to primary food producers, maximizing the yield of raw materials through a unique set of patented technologies and processes. At this stage, Upcyclr is a start-up founded by two serial entrepreneurs with extensive experience and success in the food and seafood industry, who acquired the raw materials for the proposed project (Upcyclr, 2023). The one is Ola Ekman, a serial entrepreneur with over 20 years of experience at Entrepreneurship GU & Chalmers CIT. He is also the Founder and CEO of Scandinavian Enviro Systems AB From Innovation To Stock Market, CEO of Meltwater, Sweden, and CEO of First to Know (ibid). The other is Benjamin Bjorkenheim-Ajo, who has a master's degree in economics from the University of Gothenburg and an MBA from HULT International Business School in London. He has 18 years of experience in the seafood industry and is the CEO of major seafood companies in Northern Europe: Marenor (SE), Broderna Hanssons (SE), Escamar (FI) and Domstein Norge (NO) (ibid). Upcyclr has the advantage of owning exclusive rights to Nordic seafood technology solutions (Upcyclr, 2023). Therefore, the primary market size is limited to this market segment and geographic region.

Furthermore, according to Upcyclr's market research analysis (2023), the major primary seafood-producing areas have a total annual production capacity of 8.3 million tonnes of raw material. It is equivalent to a potential side stream of 4.1 million tonnes, of which 20% is used for upcycling from 1 SEK/kg to 20 SEK/kg. Its total market capitalization is estimated at SEk30bn.

Upcyclr is taking the Swedish market as its first step (Upcyclr, 2023). The Swedish seafood processing market amounts to 141,100 tons of raw materials, equivalent to about 70,000 tons of side stream, with 20% used for upcycling, from 1 SEK/kg to 20 SEK/kg. Its market value is estimated at 266 million Swedish kronor (ibid). They have an advanced time plan. The ultimate goal is a complete seasonal cycle of seafood (herring and salmon side streams), vegetables, fruits and berries (ibid). In this way, the utilization rate of existing biomass can be improved to reduce unnecessary food waste and production costs and ensure the nutritional composition and taste of the colour food.

Globally produced seafood accounts for a very high and increasing proportion of international trade compared to other commodities, mainly due to globalization and geographical differences between aquaculture production and seafood demand (mainly in Europe, North America and Asia) (Guillen et al., 2019). However, fish farm waste not only affects surrounding areas but is directly affected by sewage. It also alters the more expansive coastal zone at different ecosystem levels, reducing the biomass, density and diversity of benthic, plankton and swimming organisms and altering the natural food web (Vizzini & Mazzola, 2004). Therefore, effectual, cost-effective, and environmentally friendly preventive and bioremediation methods will be necessary to improve effluent quality before discharge into the receiving waters of sensitive areas (ibid). An important waste reduction strategy for the industry is the recovery of marketable by-products from fish waste (Arvanitoyannis & Kassaveti, 2008). According to Upcyclr's (2023) investigation, solid waste generated by fish processing can be as high as 50% to 80% of the original raw material, which is excellent for preparing high-value by-products. If these losses can be reduced, it will increase people's food supply and reduce waste and pollution. Therefore, it is a sustainable and innovative business plan. It follows the Times's sustainable development trend while considering the actual situation of the proposed project. Their customers are Business-to-business transactions and businesses, known as business-to-business (B2B). That is, they take raw materials from the owners of the side streams, process them and sell them to food factories to mix with other foods like burgers or meatballs to make new products for sale or to grocery stores, perhaps in the future sell them directly to end users.

1.4 Purpose and Research Questions

Upcyclr is a start-up company that needs a complete supply chain logistics system. Our research aims to investigate the most suitable and optimal solution for fish side stream processing factories (such as Upcyclr's) access to raw materials according to the current situation and related logistics challenges that it may meet in the future so that its logistics system can be carried out effectively and smoothly.

In order to comprehend a good insight into the supply chain and alternatives for fish side stream processing factories (such as Upcyclr's) approach of recycling fish side streams and adding value to the final product, the study will look deeper into how and what could give optimal inflow of raw materials.

The two research questions for this study will be formulated as follows;

1. When fish side stream is used as raw material to produce human edible products, how to develop its logistics activities?
2. What logistical challenges will be encountered?

1.5 Delimitations

In order to set a clear and feasible scope for this paper, it is essential to state the boundaries of the included elements and untouched areas discussed.

Since the target population of this study is the fish side streams of salmon and herring, the conclusions drawn from the selected population will only represent the logistics management involved in reusing these two highly nutritious side streams of seafood species. It is also worth noting that since salmon is a fish mainly produced in the North Atlantic and its surrounding rivers, combined with the fact that our target market is Sweden or Northern Europe. Therefore, the sourcing of raw materials can be influenced by the local, regional culture and values as well as the unique geographical characteristics of the customer.

The thesis examines the logistics management of the fishery, the access to raw materials, the storage of goods and products, and the supply chain issues involved in handling the fish side streams in question. The focus will be on the logistical management of fish side streams. This fact will influence the focus of the questions interviewed in the data collection since producing fish side streams into products that people can consume is an emerging project industry.

In addition, there are high and severe requirements regarding the assurance of safety and quality standards of raw materials, as well as the timeliness of logistics. Therefore, appropriate interviewee and interview questions were selected based on the characteristics and features of fish side streams.

1.6 Disposition

In the introduction section, the background, problem statement, case description and research questions are stated, as well as some research definitions to provide an overview of this study. The literature review includes storage and warehouse locations, transportation and customs, fish side stream recovery production structure and nutrition to provide a theoretical framework for the fundamental concepts of this study. In the methodology section, the methodology used in this study is briefly described, as well as the interview process and target respondent company. The following section discusses the data set of this study, i.e., the questions involved in the interview process and the analysis of their responses. The empirical analysis and results section discusses the empirical results and literary analysis of the interviewee, and the research questions are analyzed. The discussion section explains the analysis results and further compares the actual situation and the literature results. Finally, conclusions, contributions and limitations of this study are drawn.

2. Literature Review

The purpose of this chapter is to provide a review of the literature related to the research topic. Start with an overview of the overall recycling production structure and nutrition of fish tributaries. Then the literature about warehouse management is studied in depth. Finally, transport and customs theory will be discussed in the last part of the research framework of this chapter.

2.1 Fish Side Streams Recycling Production Structure & Nutrition

Demand for high-value seafood increases yearly, and the ageing population is shifting diets towards more protein (Henchion et al., 2017). However, expanding wild fisheries and aquaculture based on the endurance of our ecosystems is a challenge (Villéger et al., 2017). Thus, a growing focus is on using as much of the caught or harvested fish as possible directly as food, including converting non-fillet parts into food components (Gordon et al., 2013; Wu et al., 2022; Ayer, 2007). Fish processing practices produce increasing by-stream and waste such as skin, head, skeleton, gut and fillets (Siddiqui et al., 2023). And these may account for up to 70% of the fish used in industrial processing (Anna-Liisa et al., 2019). When the fillet is removed from the fish, valuable side streams remain and can be converted into fish chunks, minced meat, protein isolates or omega-3-rich oils. Low-value catches, and underutilized fish make up another source of tributaries (Leach & Nepszy, 1976; Jawad, 2021). While many options are available today for dealing with fish waste, emphasizing the value of using fish waste as a resource and encouraging ethical waste management procedures can be seen as a good opportunity (Arvanitoyannis & Kassaveti, 2008, p. 1).

Moreover, some studies have shown that side streams of fish contain valuable bioactive ingredients and components, such as fish oil, proteins and peptides, collagen, gelatin, enzymes, chitin and minerals (Siddiqui et al., 2023). Coppola et al. (2021) and Arvanitoyannis & Kassaveti (2008:1) show that despite their extraordinary potential, these products leave the food chain and end up as products of low commercial value, such as furbearers and aquaculture feed. In the worst case, they are discarded, leading to environmental and economic problems. Therefore, efficient and sustainable solutions are needed to optimize the recovery of valuable items from fish side streams while reducing their environmental impact. These compounds and ingredients may provide opportunities for the development of new applications for health-promoting foods, special feeds, health supplements, medicines and cosmetics. To make better use of side streams and low-value fish, both environmental and ecological sustainability of production will be improved. As a result, more and more industries are paying attention to opportunities in the side stream (Jayathilakan et al., 2012).

Figure 3 shows a schematic illustration of the theoretical framework for the partial recycling of raw seafood to different sources of value added (Arvanitoyannis and Kassaveti, 2008: 1). As can be seen in the figure, the fish excrement is initially treated in the pretreatment stage to remove impurities and enhance its physical properties. The size of the fish excrement is usually reduced, and any non-organic components (such as plastics and metals) are removed by mechanical and physical procedures such as washing, sieving and size reduction. To make subsequent treatment operations easier, acid and alkali treatments are used to remove lipids and oils and alter the pH of fish side streams (Arvanitoyannis & Kassaveti, 2008, p. 1). The treatment stage entails various procedures to convert fish side streams into valuable commodities. The figure depicts some treatment processes, including composting, pyrolysis and enzymatic hydrolysis. These procedures can be applied individually or in combination to produce different products from fish side streams (Arvanitoyannis & Kassaveti, 2008, p. 1).

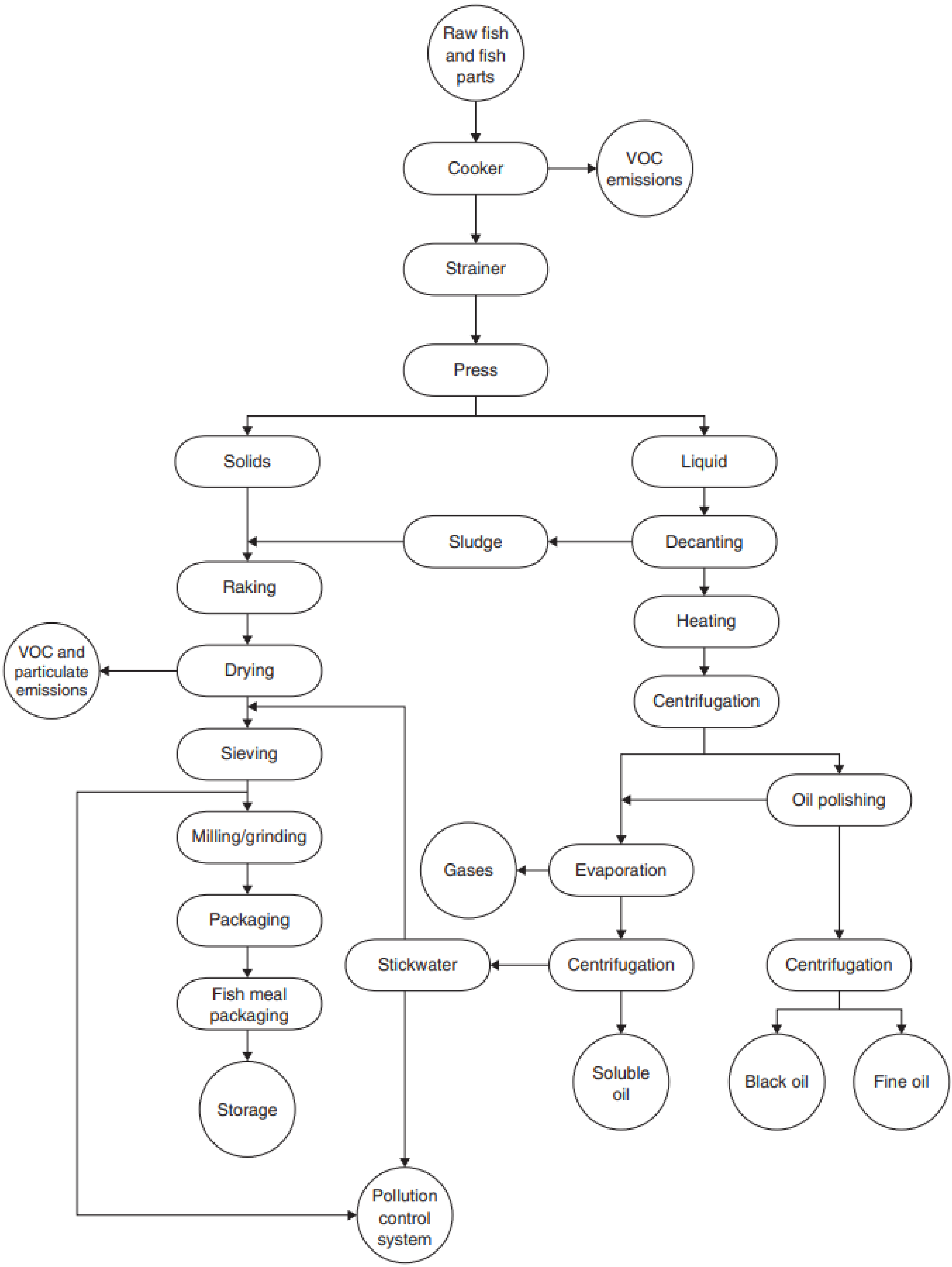

Figure 3 - "Flow diagram of fishmeal and fish oil production" (Arvanitoyannis & Kassaveti, 2008:1).

Therefore, according to Wu et al. (2022), new sorting methods should be adopted to carefully treat the whole fish like fillets, focusing on maintaining quality throughout the value chain. Instead of putting the various side streams into one container as by-products, they should be treated separately, as in the meat industry. Also, Wu et al. (2022) showed that this type of sorting technique is essential, mainly because it means that fish processors can avoid mixing extremely perishable side stream chips with more stable chips. In this way, the quality problems in the value chain of raw materials can be ensured as far as possible. The sorting here is the new technology proposed by Wu et al. (2022); the fillet, spine, caudal fin, head, ventral flap and viscera are separated.

Body Part (fish)	Reason	Production
Spine and Head	Most muscular	Ideal as a surimi or protein source
Abdominal Flap and Intestines	Rich in Marine Omega-3	Can be used for oil production
Caudal Fin	Have a lot of skin, bone, and connective tissue	Excellent for the production of marine collagen (in addition to food, marine collagen is also used in cosmetics and nutraceuticals, where it has been documented to have beneficial effects on our joint and skin health.)

Table 1 New sorting of fish side streams (Wu et al., 2022).

In Sweden, it is estimated that 30,000-60,000 tonnes of seafood by-products are produced annually, which is about 35-70 times the size of the Swedish cod catches. This number means that the current utilization of aquatic biomass for food needs to be higher (Laila & Mia, 2022). At the same time, that also indicates the urgent need to address the logistics management systems associated with fish side streams to meet the requirements of using fish side streams to produce high-value human edible products. A literature analysis regarding storage, transportation and customs will follow this part.

2.2 Storage Management

Fisheries play a vital role in the world's food supply chain, catching and processing millions of tons of fish each year (Thilsted et al., 2016; Jimenez et al., 2020). However, storing these products safely and efficiently is a complex challenge that requires meticulous management and attention to detail. Therefore, effective storage management is one of the key factors for success. Fisheries storage is a controlled preservation process designed to extend the shelf life and maintain the freshness of fish and seafood products (Ashie et al., 1996; Nagarajarao, 2016). Fish and seafood products, especially fresh fish, contain up to 80% water and are very perishable, in addition to the quality changes in newly caught fish due to autolysis and bacterial activity (Darvishi et al., 2013; Huss, 1988; Ghaly et al., 2010). The degree of this change determines its shelf life, so proper storage conditions are essential to prevent the spoilage of fish products (Sivertsvik et al., 2002). This requires multiple treatments to maintain quality and prevent spoilage, including high-pressure treatment, radiation, microwaves, ultrasonic treatment, vacuum packaging, and the use of enzymes (Ashie et al., 1996; Wiley, 1994; Zhao et al., 2019). In addition, there are many standard and straightforward methods, such as drying, smoking, salting, and refrigeration (Ghaly et al., 2010).

Various treatments are carried out in fish processing plants and storage industries to maintain product quality and prevent spoilage. Their energy consumption is mainly due to the use of cooling methods, i.e., they require careful attention through strict temperature control, specialized handling and storage to maintain their quality and safety. According to Ahadi & Setiadanu (2019), the study showed that the energy consumption value per unit of electricity used in cold storage is 4.2 kWh/ton. The electrical energy consumption of an air blast freezer (ABF) with a capacity of 5 tons is 91 Wh/kg. The electrical energy consumption in an ABF is strongly influenced by the suitability of the ABF (air blast freezer (ABF)) capacity to the amount of fish to be frozen, where the specific electrical energy consumption value increases by 50% to 145 Wh/kg for an ABF with a capacity of 5 tons if it is filled with only 2 tons or less of fish (ibid). However, proper storage methods are critical to ensure these products are safe for consumption and meet regulatory standards. However, the use of equipment, workflow, environmental conditions and choices can all affect energy consumption. Furthermore, as energy prices rise, producers seek opportunities to reduce production costs by conserving energy use (ibid).

At the same time, it is crucial to ensure both product quality and freshness in aquatic storage. Inadequate storage facilities can lead to improper temperatures resulting in product spoilage, food waste, reduced customer satisfaction, and financial loss to fishery owners. According to Setiawan, Thalib & Maarif's (2021) study, a real problem here is that seasonal factors lead to catching fluctuations, resulting in unstable fish prices and fishermen's income. In addition, the quality of fish deteriorates when there is not enough cold storage to store fish when they are plentiful. However, cold fishery storage is a piece of highly energy-consuming equipment. Ahadi & Setiadanu (2019) suggest that renewable energy (RES) options will be key for electricity because RES are cheaper compared to fossil fuels, especially grid-connected solar photovoltaic (PV). Also, even though fish and seafood products do not spoil, their quality can deteriorate due to exposure to air, light, moisture, and improper handling or processing (Masniyom, 2011).

Therefore, another challenge for the fishing industry is to ensure that proper inventory management is critical to ensure that products are rotated efficiently and that there is no overstocking or understocking. Inventory management theory focuses on managing inventory levels to have met customer demand while minimizing costs. Therefore, fish products, delivery dates and order fulfilment must be closely tracked and monitored, and this is because doing so avoids significant waste and financial loss (Atnafu & Balda, 2018). It is also essential to meet regulatory requirements, as fish products are subject to numerous regulations and standards, including food safety, labelling and traceability (Charlebois et al., 2014; Aung & Chang, 2014). HACCP, for example, is an internationally recognized food safety management system that focuses on identifying and preventing potential hazards in food production. Fish processors and warehouses must implement HACCP plans to ensure the safety and quality of their products (Unnevehr & Jensen, 1999; Panghal et al., 2018). The EU has strict regulations for producing, processing and marketing fish products (Frohberg et al., 2006; Mazzeo & Siciliano, 2016). These regulations cover many areas, including sanitation, temperature control, packaging and labelling. Fishing companies must then follow proper sanitation and personal hygiene protocols to prevent cross-contamination, which can compromise the safety and quality of their products (Arvanitoyannis & Varzakas, 2008; Cheftel, 2005). Inadequate storage facilities can also pose health and safety risks to workers and consumers. For example, poor ventilation can lead to a buildup of harmful gases, while improper handling can lead to injury or illness. Therefore, it is critical to comply with these regulations to avoid fines, penalties and legal issues (ibid).

Added to this is the environmental impact, especially if it is not adequately designed or managed. Issues such as water pollution, waste management and energy consumption are all relevant here (Arvanitoyannis & Kassaveti, 2008). Also of particular importance are economic considerations, as fishery storage can be a significant expense for fishery owners, especially if they need to invest in specialized facilities or equipment. Otherwise, the economic viability of the fishery will also be affected by corruption, declining quality and market demand.

2.3 Optimal Warehouse Position

In addition to the challenges faced by warehousing mentioned above, its location is one of the critical factors. One of the most common theories used in supply chain management when finding the right warehouse location is network design theory, which focuses on designing and optimizing the structure of a supply chain network to meet business objectives. Network design theory considers transportation, inventory, facility, and customer service levels when designing a supply chain network (Baghalian et al., 2013; Farahani et al., 2014; Pishvaee et al., 2011).

This theory helps companies evaluate different warehouse locations based on several factors and determine the optimal location based on business objectives. First, proximity to the fishing grounds was needed to minimize the transportation time and cost of getting the catch to the plant. Furthermore, this also helps ensure that the fish is fresh and high-quality. Second, transportation infrastructure. The fishery plant location should have good transportation infrastructure, such as roads, railroads or seaports, to facilitate the transportation of fish products to market. Third, storage capacity, the fishing plant needs sufficient storage space to store the products and install infrastructure & equipment. Fourth, labour availability, fishery plants need a large amount of labour, both skilled and unskilled workers, to process and pack fish products. Therefore, the availability of skilled labour and labour cost are essential factors in selecting a storage location. Fifth, market demand, i.e., the fishery plant, needs to be close to the target market to reduce transportation costs and ensure that the product reaches the market on time. Finally, environmental regulations may also play a role in the choice of storage location, as specific locations may be subject to waste disposal or discharge restrictions.

It is worth mentioning here that supplier relationship management theory also impacts the location of warehouses, as building and maintaining strong relationships with suppliers ensures a reliable and efficient supply chain (Park et al., 2010; Yang et al., 2008). One success story about this is the Icelandic seafood company HB Grandi, located in the Icelandic port city of Reykjavik with easy access to fishing grounds in the waters of the North Atlantic. The location also offers good transportation infrastructure, with a deep-water port and international airport nearby. In addition, Iceland has a highly skilled workforce and a favourable business environment, which makes it an attractive location for seafood companies. HB Grandi has invested heavily in modern processing and storage facilities to ensure its products are of the highest quality and freshness (ARNARSSON, 2023; Molenda, 2013).

2.4 Application of Packaging and New Technology

An important waste reduction strategy for the fishing industry is to recover marketable by-products from fish waste (Arvanitoyannis & Kassaveti, 2008). Minimizing or reducing waste in fish processing plants and achieving "zero waste" is one of the goals of almost every fish processing plant. Fish processing plants generate side streams such as fish heads, bones and trimmings while processing their products. In the past, these side streams were often discarded as waste. However, these side streams are also valuable, containing high protein levels, minerals and other nutrients. However, there are significant challenges regarding properly storing and handling fish side streams. For example, one of the main challenges of fish side stream storage is the risk of bacterial growth and spoilage. These fish side streams usually contain high moisture content and are prone to bacterial growth if not stored properly. Therefore, most companies achieve "zero waste" by selling or reselling the side streams to other processors for reuse, reprocessing into pet food products, or composting (Nappa et al., 2013).

However, as the population increases and the world suffers from food shortages, fish is considered essential for nutritional supplementation. A study by Tomczak-Wandzel et al. (2015) found that quick freezing and vacuum packaging systems can be implemented to maintain the quality and nutritional value of fish heads and other fish side streams. Rapid food freezing is done by exposing it to cold air at shallow temperatures through a quick freezer. The benefits of quick-freezing include maintaining the quality and freshness of the product, preserving nutrients and extending shelf life; this is because the quick-freezing process prevents the formation of ice crystals, which can damage food and affect its texture and flavour (Ucak et al., 2021; Hassoun et al., 2022; Gong et al., 2020). Quick-freezing also reduces the risk of bacterial growth and contamination, making it a popular method in the seafood industry. The side streams are then frozen using a vacuum seal to prevent and reduce contact with air, thus reducing the risk of spoilage (ibid).

In addition to temperature control and proper (vacuum) packaging, many new technologies are being developed to improve the storage of fish by-products. For example, implementing HPP (High-Pressure Processing) systems, a non-thermal food processing technology, uses high pressure to inactivate microorganisms, enzymes and other harmful ingredients in food while maintaining its quality, nutrition and flavour (Lee, 2002). The process involves placing packaged food products into an autoclave and subjecting them to pressures ranging from 100 to 800 MPa for a few seconds to several minutes, depending on the product type and the desired outcome. Thus, companies can use the HPP system to preserve the nutritional value of the side streams of fish, such as heads and frames. In addition, HPP is becoming increasingly popular in the food industry, especially for ready-to-eat and fresh products such as meat, seafood, fruits and vegetables (Jermann et al., 2015; Silberbauer & Schmid, 2017; Wang et al., 2016). Because the technology is considered an effective and safe alternative to traditional heat treatment methods, which can damage the flavour, texture and nutritional value of food products (Roobab et al., 2021), and HPP can also extend the shelf life of products and reduce the need for preservatives and additives (Abera, 2019). Therefore, companies can use these storage methods to more safely and efficiently secure the side streams of fish to produce high-value human edible or nutritional products (protein powders) that meet human needs for essential nutrients while reducing waste.

2.5 Transport Mode

Sweden has its fish farming industry, although on a smaller scale than Norway (Paisley et al., 2010; Blanco Gonzalez & de Boer, 2017). The Swedish salmon farming industry mainly focuses on producing Atlantic salmon, the world's most commonly farmed salmon species. However, despite having its salmon farming industry, Sweden still needs to import large quantities of salmon from Norway to meet domestic demand (Lorentzen, 2007). This is due to several factors, including Sweden's higher production costs, lower salmon production, and the country's focus on producing other types of seafood, such as herring and cod (ibid). Herring is a wild-caught fish that is not usually farmed like salmon or other fish. Therefore, while Sweden does not have its herring farms in the traditional sense, it is simultaneously a major producer of herring. Sweden's strong fishery targets wild-caught herring and processes it for domestic consumption and export (Thrane et al., 2009).

Due to its location, Norway has a long coastline with deep fjords and cold, clear waters ideal for salmon farming. This unique geography provides a natural barrier against storms and strong currents, thus creating ideal conditions for salmon farming (Dempster, 2009). In addition, the Norwegian government has provided significant support to keep salmon farms at the forefront of developing advanced technologies and techniques for salmon farming, such as automated feeding systems, underwater cameras and remote monitoring (Bailey & Eggereide, 2020). With these technologies and financial support, Norway has achieved economies of scale that have resulted in lower production costs and competitive prices. As a result, the Norwegian aquaculture industry is the global leader and the most cost influential producer of salmon (Iversen et al., 2020). The EU is the world's largest importer of salmon, absorbing about 60% of Norway's salmon exports, mainly fresh whole fish. Moreover, many of the world's largest salmon producers are Norwegian companies and Norwegian companies primarily own Iceland's salmon farming industry (Gudbrandsdottir et al., 2021). Then the quality, price and proximity of Norwegian-farmed salmon to Sweden make it a popular source of seafood imports.

The method of seafood delivery depends on various factors, such as the type of seafood, the distance it needs to be transported, and the urgency of the delivery (Hallman, 2015). Typically, seafood companies choose a refrigerated delivery vehicle based on the distance of the transportation trip (Yao et al., 2019). The farther the voyage, the more critical it is to maintain the proper temperature and environmental conditions to keep the seafood fresh and safe to eat (Pavlath & Orts, 2009). For example, a small refrigerated van or truck may be sufficient to transport seafood if the trip is within a local or regional area. However, for longer journeys, such as between countries or across continents, a larger refrigerated trailer or container may be required to maintain proper temperature and humidity levels for extended periods. According to Tsang et al. (2018), distance can also influence the choice of transportation method. For shorter distances, road transportation may be the most practical option, while for longer distances, ocean or air transportation may be more appropriate. In all cases, however, the choice of refrigerated transportation is critical to ensure the quality and safety of seafood during transport (Tsang et al., 2018).

In Northern Europe, refrigerated transport trucks are a popular and effective way to transport fish products because trucking allows for more flexibility and can be easily arranged and adjusted to meet the specific needs of seafood companies (Limbo et al., 2009). For Norwegian seafood companies transporting salmon to Sweden, trucking is often more cost-effective than other modes of transport (such as air or sea) for such short distances. Also, the shorter delivery time for trucking can significantly reduce the risk of product spoilage while keeping costs low (Tsang et al., 2018).

2.6 Customs

Norway is part of the EU single market (it is a member of the European Economic Area), but it is not part of the customs union (Emerson & Woolcock, 2002). It imposes customs duties on goods imported from outside the single market. However, Norwegian goods (except agricultural products and fish) are imported into the EU duty-free (Farsund, 2013). Therefore, shipping salmon from Norwegian seafood companies to Sweden usually involves multiple customs procedures to ensure the legal and safe transportation of the fish. Since each country/region has regulations for importing and exporting goods, this also includes fish by-products. In addition, through the EEA agreement, Norway, Iceland and Liechtenstein are equal partners in the internal market and enjoy the same terms as EU member states. Then this includes access to the four freedoms of the internal market, i.e., the free movement of goods, persons, services and capital, which means that exports of fish by-products to other EEA countries are subject to EU trade regulations. Thus, this means that exports of fish by-products to other EEA countries are subject to EU trade regulations (Emerson & Woolcock, 2002). Export of fish by-products for trade purposes requires a certificate of origin that indicates the country of origin of the product, an export declaration or pro forma invoice stating the value and quantity of the exported product, and customs documentation, including import and export permits and licenses, if necessary (Vedder & Folz, 1997; Ababouch, 2005).

In Norway, exports of fish by-products or fish processing by-products are regulated by several government agencies, including the Norwegian Food Safety Authority and the

Norwegian Directorate of Fisheries (Holm, 1995; Ahuja et al., 2020; Olafsdottir et al., 2019). Includes food safety regulations, meaning that all fish products, including by-products, must comply with Norwegian food safety regulations. These regulations cover a range of issues, including product safety, hygiene and labelling. Mattilsynet or other authorized government agency requires an export certificate, i.e. Certificate of Analysis (CoA) for the product stating its composition, quality and safety standards (Hansen, 2019). Exports of fish side streams must also comply with Norwegian environmental regulations. These regulations include requirements related to waste management, pollution control and sustainable resource use (Ziegler et al., 2013). In addition, the Norwegian Directorate of Fisheries (Fiskeridirektoratet) is responsible for regulating the harvesting and processing of fish in Norway. The agency is responsible for enforcing quotas, monitoring fish stocks and ensuring sustainable fishing practices (Gismervik et al., 2020). Companies must comply with these regulations when exporting lateral stream fish to ensure the product is legally harvested and processed.

Furthermore, as an EU member state, Sweden must comply with EU regulations and requirements for importing fish and fish products (including fish side streams) from countries outside the EU, which means that fish by-products must comply with the EU's strict food safety regulations, which cover all aspects of food production, including hygiene standards, labelling requirements and traceability (Barrett et al., 2002). In addition to complying with food safety regulations, fish side streams must comply with EU veterinary regulations designed to protect animal health and welfare, including compliance with regulations on disease control, animal welfare and the use of veterinary drugs (Charlebois et al., 2014). Fish side streams must also comply with EU environmental regulations designed to protect the environment and prevent pollution, including compliance with waste management regulations, energy efficiency and sustainable production (Dudek et al., 1992; Kissinger et al., 2011). Moreover, it must comply with EU trade regulations covering customs procedures, tariffs and import licensing requirements. Furthermore, this includes compliance with the EU's Common Customs Tariff, which sets out the duties that must be paid on imported goods (Plummer, 2007). In addition, fish side streams must be labelled following EU regulations, which include country of origin labelling requirements, product descriptions and any relevant safety information. Labels must be clear, accurate and not misleading. Therefore, to import fish side streams into Sweden, importers must work closely with experienced customs brokers and professionals familiar with the relevant regulations and requirements. They must ensure all required documentation, including veterinary certificates, health certificates and other import permits, are available.

3. Theoretical Framework

This chapter serves as the basis for the research and outlines the theoretical framework, covering the key concepts studied in this paper and evaluating and interpreting different concepts. Finally, the theoretical framework of this paper is created.

According to Tien et al. (2019), compared with the supply chain, logistics is a subset, mainly responsible for the work needed to move and locate inventory. According to the definition of Winkelhaus & Grosse (2020), logistics is the process of products (goods or services) from the place of origin to the hands of consumers, whose main purpose is to enable the process to be effectively transported and stored. This usually involves planning and scheduling the process and doing the best possible to meet consumer requirements. In 1992, Langley & Holcomb defined logistics as the process of creating value by positioning inventory regularly; It is the combination of the company's order management, inventory, transportation, warehousing, material handling and packaging across the entire facility network. Logistics planning links and synchronizes the entire supply chain as a continuous process, essential for effective supply chain connection. Logistics management can be divided into material management and logistics distribution, in which material management includes raw materials, storage and production, and logistics includes warehousing and markets. Therefore, according to Waters's (2021) definition, a logistics system consists of four main activities: purchasing, inventory, warehousing, and transportation.

Among them, Langley & Holcomb's (1992) definition is most relevant to the purpose of this study because they emphasize logistics as a process to create value and pay more attention to detailed steps. Usually, scholars and researchers pay more attention to transportation mode, storage and inventory management. In addition, according to the literature analysis, the logistics study of fish side streams in this paper involves suppliers from Norway, so the customs issue is added, discussed, and studied. The comparison of these steps with the current logistics activities of the fish side streams and the expected prior interactions determine the theoretical support for the logistics activities involved in the fish side streams as a raw material for human food. Therefore, this paper defines logistics activities as creating value in the logistics network through inventory, transportation, storage, material handling and packaging, and customs.

3.1 Definition of Inventory

Inventory is products, materials, or supplies stored in a warehouse before production, transportation, or sale (Ogbo & Ukpere, 2014). Inventory can be understood as the short-term storage of goods to be sold for profit by merchants (Wild, 2017). Moreover, for the whole supply chain, inventory management is a very important component. Inventory involves moving from the manufacturer's warehouse to the point of sale's warehouse (Lee & Whang, 2000).

3.2 Definition of Transportation

Transportation involves physically transporting or moving a product from one place to another (Stefansson, 2006). It is part of a more extensive logistics system and considers factors such as the safe packaging of items, the best delivery route and the most appropriate mode of transport (Lee & Song, 2017).

3.3 Definition of Warehousing

A warehouse is a place where products (real goods rather than services) and raw materials are stored (Anjelina and Amri, 2016). Warehouses are needed and used by almost all types of companies, primarily for temporary storage of products before shipping them to other distributors or consumers (Higginson & Bookbinder, 2005).

3.4 Definition of Material Handling

Material handling, also known as material movement, usually takes place over short distances, such as within a building or between a building and a transport vehicle (Kay, 2012). Specific examples include loading trucks, placing individual items on pallets for unit loading, retrieving products from shelves for transportation, etc. (Baudin 2005). It is worth noting that although it is a short distance movement, the cost can be reduced and the safety of the product can be protected to the greatest extent through a well-designed system, thus avoiding the risk of some accidents and improving customer satisfaction (Dza and Kyeremeh, 2018).

3.5 Definition of Packaging

Packaging protects and preserves the product to minimize the risk of damage and loss during transportation, handling, and storage (Azzi et al., 2012).

Fundamental principles of packaging (Coles et al., 2003):

- Protection principles: Protect products from physical damage.
- Preservation principle: Maintain product quality and avoid product decay.
- Principle of efficient use of space: Optimize the utilization rate of space during transportation and storage.
- Comply with laws and regulations: the material of packaging and label printing meet the safety requirements.

3.6 Definition of Customs

A customs office is a place at a port, airport, or border where government officials control purchases, people (travellers), and other goods (Sela et al., 2020). Customs was the government agency responsible for issuing and clearing goods for import and export (Heaver, 1992). Designates the government agency that regulates the movement of goods to and from a country and collects the tariffs that a country imposes on imports and exports. At the same time, according to local laws and regulations, the import and export of certain products may be restricted or prohibited, and the customs agency will enforce these regulations (Widdowson, 2007).

4. Methodology

This section of the paper explores the research methodology. Thus, a detailed methodological description of this study is presented, including the literature review method, data collection through interviews, interview question design, and data analysis methods. The final part of this chapter discusses the qualitative considerations for this study.

4.1 Research Method

According to Gammelgaard & Flint (2012), qualitative research is about using interview data in research and how people perceive qualitative data, the theoretical perspectives through which analysis is conducted, and the data analysis process. When it comes to research in supply chain and logistics, there is an approach to approach the discipline which is considered to remain positivist (ibid). Although, there are more ways to conduct research that can expand and enrich the knowledge base of SCM. However, when questions about a phenomenon require a qualitative research approach, a qualitative research approach should be chosen. Therefore, using qualitative methods in the toolbox can raise more research questions and help reveal more complexities of today's supply chain networks in the fish side stream domain (ibid). The qualitative approach was chosen for this thesis because the data was collected through a literature review and interview format, and no quantitative measures were involved in collecting and analyzing the data.

4.2 Data Collection

This section deals with the data collected for the literature review and interview with the directors of the fish processing plants (companies). Since the interview was conducted for this thesis, these can be considered primary data.

4.2.1 Literature Review

A systematic search was conducted using Scopus, Wiley, Springer, Elsevier and MDPI databases to find peer-researched analysis articles related to the research topic. In addition to articles, books such as "Sustainable fishery systems", "Global food projections to 2020: Implications for Investment" and "The Economics of population growth" was used to clarify the development potential of fish side streams and the challenges they face concerning logistics activities and some countermeasures (Charles, 2008; Rosegrant et al., 1995; Simon, 2019). In addition to the collected articles and books, several web resources were found to complement the publications of books and articles. In addition, the available literature provides important insights into how fish products are transported, warehouse management, and tariff issues for import and export while also helping to provide definitions for these terms. Finally, a project funded by the European Union, known as WaSeaBi, is covered, in which the project participants published papers as their aims and findings are closely related to the research in this paper (WaSeaBi, 2023). This project aims to develop and test new concepts to ensure that by-products from the aquaculture, fisheries and aquaculture processing industries can produce new products and raw materials (ibid). Although the main focus of this project is to address technical issues related to the extension of the shelf life of fish laterals, there needs to be adequate research in the area of fish side streams as a raw material for the production of human edible food. The results of this project support the significance of research in logistics related to fish side streams as a raw material for human consumption. Therefore it is highly relevant and contributes to the purpose of this study.

The reference search framework prioritizes articles from most recent to older because older publications may not present good new efficient logistics approaches, present the opposite world political and economic context, thus having some wrong laws and regulations, or even present no longer applicable findings. This is because there is a lack of research on the logistics of producing fish side streams for human food. Therefore, in this paper, the study of fish product logistics activities will be studied in depth, one reason being that fish side streams are also fish by-products and another reason being that the study at this time is directed at human food products. This means that the research in this paper has the exact logistics requirements for food safety level as fish products.

4.2.2 Fishey Company Interview

Qualitative research also involves using interview data in the study as a form of data collection. Interviews are the most common way to gather information in qualitative research. The use of in-depth interviews is beneficial when the empirical data relates to opinions, perceptions, feelings, and personal experiences (DiCicco-Bloom & Crabtree, 2006). This paper adopts the recommendations of a documentary approach, using in-depth interviews as a context for gaining insight into business practices, focusing on logistics macro-processes, such as inbound logistics and outbound logistics in large fishing companies (ibid). The authors emphasize authenticity as a key attribute of the method. By exploring logistics macro-processes, the interviews provide insight into how logisticians deal with the tacit knowledge of a given process in a way that observation alone is insufficient. Moreover, the exploratory qualitative interview research technique helps to understand issues from an insider's perspective rather than an outsider's.

Semi-structured and unstructured are qualitative research interviews (Low, 2019). Semi-structured interviews include a range of topics and key questions that the researcher wants to answer (ibid). In these interviews, the order of the questions can be changed, and some questions can be omitted depending on the specific organizational context. It also requires the interviewer to remain active, as additional questions may need to be added during the interview to answer the research questions. An excellent way to obtain interview data is to record audio, usually done in semi-structured interviews (Choueke & Armstrong, 2000). In this study, semi-structured interviews were conducted, allowing the interviewees to freely describe any relevant issues, events, challenges, or actions in their own words.

The authors took the form of an online video, recorded with the respondent's consent, to collect empirical data. This allowed them to ask follow-up questions and encouraged respondents to expand their answers. Furthermore, the respondent responded affirmatively to disclosing their identity in the dissertation study. First, the fishery company interview guide was constructed based on a selection of warehousing, packaging, and shipping aspects from the literature review. In addition, the whole interview was divided into three parts, how the fish was obtained, how it was stored and processed, and how it was transported.

4.2.3 Transcript

After the interview, it is helpful to transcribe what was said by listening to the recorded video and writing down the actual content (Smith & Sparkes, 2016). By doing this, the author can improve the data quality, so the transcription must be well executed, as performance will affect the quality of the transcription and, ultimately, the data quality. When transcribing the interview, it is also important to pay attention to the tone of speech as this will add contextual information to the data, but sometimes certain words may be missed. This is not considered a problem because the interview is audio and video recordings so that the authors can listen to the interview repeatedly. The video recording also noted the interviewee's tone, and this transcription method allowed the authors to collect more detailed data that would benefit the results of this paper (Ranny et al., 2015).

4.3 Research Logic

Achieving valid and trustworthy conclusions through applying research logic is the key to research (Carcary, 2009). Logic comprises theories, and inductive and deductive are two common types of research logic (Hempel, 1958). Among them, inductive logic refers to concluding events or objects that have not yet occurred or are yet to be observed based on previous observations of similar events or objects (ibid). Deductive logic refers to concluding available information, thereby forming conclusions through the logical application of premises (ibid). In simple terms, the former is a known individual speculating about a group, and the latter is a known group speculating about an individual. However, deductive logic is applied in this thesis. This is because deductive logic supports step-by-step recursion from definitions of fundamental laws, etc., and the conclusions are rigorous and reliable and reflect the characteristics of things (Carnap, 1962). This is consistent with the knowledge related to fish product logistics activities applied in this thesis to the logistics activities involved in using fish side streams for the production of human food to reflect the relationship between the particular logistics activities investigated and the general logistics activities.

4.4 Data Analysis

After the fishery company collected data from the interviews, data analysis was performed on the collected material. The fishery company interviews were transcribed so that as much valuable material as possible could be obtained and made known to the authors of the papers. How detailed the transcriptions are depends on the purpose of the material and how the transcriptions were reviewed for that purpose (Poland, 1995). In addition, because there are many differences between spoken and written language, it is challenging to transcribe everything verbatim. Since the research question did not focus on language, transcription was done so that the text was easily understood. No body language or pauses were added to the transcript as it was not considered to add any value to the paper.

4.5 Quality of Research

All studies have limitations, which can negatively affect the quality of the results the author derives from data analysis (Tang et al., 2016). Qualitative study designs are evaluated based on validity and reliability (Sandelowski, 1986). In addition, the quality of a study depends on how well the design objectives are achieved, which may depend on a practical design (ibid).

4.5.1 Validity

Typically, the overall research design, specific research questions, methodology, coherence, and consistency of results affect the type and quality of evidence produced (Noyes et al., 2018). There are usually three potential threats to the validity of research, namely internal validity, external validity, and construct validity (Onwuegbuzie, 2000). External validity refers to the extent to which findings can be generalized to other settings (ecological validity), to others (demographic validity), and over time (historical validity) (ibid). The data collected in this thesis were analyzed for objective assessment mainly through data collected from the literature review and interview transcripts. Furthermore, the findings of this thesis can be extended to apply to other sites and settings, for example, a study of fish side streams development as a human-usable food logistics activity at a fish processing plant in Iceland. In addition, all collected materials will also be compared with the reviewed literature to improve validity in answering the research questions.

4.5.2 Reliability

Reliability in qualitative studies refers to the stability of the response to multiple encoders of a data set (Duban et al., 2019). It can be enhanced by the use of recording devices and detailed field notes from transcribed digital files (ibid). Reliability refers to the consistency of measurements, meaning that the study is reproducible to a high degree through multiple replications as well as the results (ibid). This type of critical commentary is complex in a qualitative study such as this paper because the respondent's responses may have certain geographical limitations and technical specificity implications. In addition, the topic of this paper is relatively new, but this is about to or may become a new trend. Thereby changing the potential attitude of the interviewee when the researcher conducts the interview afterwards, the interviewees provide differently. Being involved in the interview process as a thesis author may impact the reliability of the collected material. Therefore, it is important that the interviewer takes as few actions as possible to guide the interviewee or observe the participant during the interview and that there is as little interaction as possible during the observation (Roulston, 2010). However, in order to be able to obtain similar results in the replication of this study, the methods used are described in detail in this chapter.

5. Empirical Findings

This chapter covers a brief introduction about the respondent fishery company and the empirical findings. The first section presents an overview of the respondent company and interviewee. The other sections show the interviewee's answers and discussion of some questions from quality conversation and sustainability of fish products, processing & packaging, storage, transport and fish side streams business and innovation aspects. Lastly, present fish side streams from a bigger visison.

5.1 Respondent Company Introduction

Västkustfisk SVC AB was founded in 1930 as a fishing group under the Swedish West Coast Fishermen's Central Association (SVC) umbrella and consists of several companies active in all aspects of the fishing industry (West Coast Fish, 2023). The Central Association of Swedish West Coast Fishermen (SVC) was established to defend the interests of the west coast fishermen so that they could work together against buyers (ibid).

At the same time, the organization has developed into a dynamic group in the fish farming industry - Västkustfisk SVC AB, which is owned by the members of the Swedish West Coast Fishermen's Central Association (SVC) and today includes the entire chain - from fishing and processing of fish and shellfish to marketing Sweden Seafood i GBG AB, Bua Shellfish AB Sweden Pelagic AB, Göteborgs Fiskauktion, Östersjöfabriken AB, Fastighetsbolaget Sjötungan and Sjömansfrämjandet are all part of this group (West Coast Fish, 2023).

Sweden Pelagic AB, located in Ellös, Orust, specializes in herring processing (West Coast Fish, 2023). The main products are herring fillets and herring fillets in barrels with vinegar or seasoning (ibid). According to West Coast Fish (2023), Sweden Seafood AB was founded in 2007 and had been developing new technologies and processing the highest quality Norwegian salmon. In addition, they own and manage Fisket's house in Fiskhamnen and some properties in Västervik (ibid).

The interviewee in this interview is Peter Sjöholm, CEO of Västkustfisk SVC AB, chairman of the board of Göteborgs Fiskauktion, CEO of Sweden Seafood AB and also chairman of the board of Sweden Pelagic AB (West Coast Fish, 2023). In the rest of the sections in this chapter, Peter Sjöholm is referred to as Interviewee X by the author.

5.2 Quality Conservation and Sustainability of Fish Products

According to interviewee X (Appendix 1), the traceability system starts with the catching area the government demands. Based on this requirement, the first-time buyer has to report to the responsible government about this, and then the first processor or first buyer might also be. However, interviewee X explains that in their case, they are the first buyer and also the processors in and to all their factories. Furthermore, they have to report their sales to the next buyer and how the products are sold, whether in filet, whole rounds, frozen or what products have been produced. Ultimately, they need to report that also into this traceability system. Although the government did not give clear guidance, interviewee X said they had always followed this approach to record keeping.

There are many environmental impacts associated with fishing activities, so to ensure the sustainability of fishing activities. Interviewee X explained that they try to work mainly with MSC (Marine Stewardship Council), whether possible. However, more often, it depends on market demand.

There is no salmon outside on the West Coast and in the Baltic. Moreover, catching for commercial or production is forbidden; only fishermen are permitted to catch minimal volumes of it. In addition, Norwegian is the only one who is farming salmon on a big scale. According to interviewee X (Appendix 1), the supply of salmon comes from a Norwegian farm. Since the salmon is bought fresh, the distance to the supplier is considered when choosing a supplier. At the same time, the Norwegian supplier's price is another important factor. Then interviewee X expresses that they usually purchase around 4-5 kilograms of certain-sized salmon. Typically, salmon are slaughtered in Norwegian slaughterhouses, and then Norwegian will clean the guts of the salmon, leaving the head and the rest of the body. Salmon treated in this way is called HOG (Head on Gutted), the most common way to purchase salmon in Sweden. According to interviewee X (Appendix 1), they make fillets from the salmon they receive.

It is important to ensure the quality and freshness of the fish throughout the supply chain. According to interviewee X (Appendix 1), the Västkustfisk SVC AB has taken some measures to ensure the quality of the fish, such as they have complete documentation about the salmon received. Furthermore, the documentation explains that the salmon are slaughtered at what farm and on what date. So, as interviewee X previously described the traceability system required by the government, Norwegian salmon suppliers do the same thing. This also reinforces that doing so helps to ensure the quality of the fish. Besides that information, interviewee X expresses that they will do a quality check based on smell and colour when the salmon arrives at their factory. In addition, Västkustfisk SVC AB has a quality insurance system that sets standards of how they should work within their fixed standards. It became clear from an interview with X that the fish products are traceable from when they are caught in the catching area to the final buyer.

5.3 Target Market of Fish Products

Furthermore, interviewee X introduced that they have three product types respectively are salmon, which supply by Norweigian produced in Sweden Seafood factory; herring, which supply by fishing vessels; and shellfish factory, where they boil shrimps, peeled shrimps and Norwegian lobster by treating them in different ways. Furthermore, when talking about the target market of Västkustfisk SVC AB, interviewee X explained that the main customers of herring are canning factories in Sweden and export markets, such as Germany and Poland, which will be their largest buyer market. Moreover, they ship their products to Germany and Poland by truck. However, salmon is only for the domestic market, retailers and wholesalers in the Swedish domestic market.

5.4 The Processing

According to interviewee X (Appendix 1), the processing and packaging of the fish ensure that it remains safe for consumption. Speaking about salmon processing, interviewee X expresses that their production facility has a temperature controller. Thus, when they do work, keep 6 degrees where they do the trimming and then into the next step where it is 2 degrees. Furthermore, all these stages monitor the temperatures and alarm when some temperature is not at the right level. Furthermore, interviewee X introduces the processing of herrings. Herring is caught by the vessels at sea, and then fishermen directly deliver from the fishing vessel to their factory, where they make grading and filleting; sometimes, they receive by a truck, but most of the quantity arrives by ship. Then they will pump herring from the storage tank on board the vessel. And the respondent indicated that slaughtering fish usually takes two days at the factory in Gothenburg. Usually, there is 70% fillet weight; the rest contains the head and backbone, which are sold mainly for smoky. And their herring product fillet is placed in marinated and put in barrels, then delivered by a truck to their customers.

5.5 Packaging

Furthermore, about packaging, interviewee X explains that when they receive salmon from a supplier, they do it quite a way in temperature, which means that almost immediately when it arrives, it is packed in stereo with ice. Then they unpack it, make the fillet, pack it in the vacuum bag or without the vacuum package, and ice it.

5.6 Storage

According to interviewee X (Appendix 1), different from regular warehouses, they have a mountain cave where they place these barrels. Furthermore, interviewee X explains that these barrels must stay for at least 35 days for processing to be fulfilled in the pellets. Thus, the mountain cave is quite a good way to store because it is always cold inside. Just in case, they add some extra chilling, but if they turn off these refrigerators, this cave still has 8 degrees (Celsius). Thus, this is quite an economical way to do storage.

5.7 Transport

It is important to control the temperature during the whole transportation process. Interviewee X expresses that their delivery depends on the customer's request. When the customer wants delivery, they will order a truck; usually, they have a full truck every time they deliver. Thus, they do not have a truck fleet system. According to interviewee X (Appendix 1), they distinguish between handling fish side streams with normal fresh fish products. Because fresh fish products are used for human consumption, they must ensure that the temperature is correct throughout the process from them to the customer. On the other hand, the fish side streams are more tolerant of temperature because their customers use it in Denmark to produce fishmeal, so they choose to transport it at normal temperature.

5.8 Fish Side Streams

5.8.1 Percentage of Fish Side Streams

According to interviewee X (Appendix 1), the fish side streams account for 60% of total production; herring side streams account for 60%; salmon side streams account for 70%; among them, 30% is the salmon head and backbone, which are also useful for the other customers. It became clear from an interview with X that their experimentation and innovation are very important for them to have maximum payment for the offcuts. Thus, interviewee X expresses that they check the market to get the best price for these offcuts. Furthermore, interviewee X explains that they do some production with the herring backbone:

1. Separate the backbone of the herring from the offcuts production.
2. They take that and rinse it in water.
3. Dip it in antioxidants.
4. Press the meat out of the bowl.

In the end, interviewee X expresses sadly that it is difficult to find customers for the herring side streams minced meat, which is not a common product.

5.8.2 Fish Side Streams Business

Interviewee X explained that there is nothing new about fish side streams related to economic activity. Typically, they sort the fish side streams, for example, by placing the salmon's head, backbone and guts in three different containers. In addition, they use different systems in different plants to develop measures for capturing and utilizing fish side streams. For example, when they want to make pellets, the head of the salmon will fall on one conveyor and the backbone on another; when they want to make salmon fillets, the body will fall on another conveyor. Overall, the conveyors have different measures, with the regular fish product flowing one way and the fish side stream flowing another way and then being split into different parts. And the respondent continues to explain that their neighbour work at the fish port, so it is rather convenient to deliver to their neighbour.

According to interviewee X (Appendix 1), the fish side streams from herring; if they do not do minced meat from the backbone, then they separate all the offcuts and send it by conveyors to a trailer, and then send that to Denmark, where they make the fish meal from this. The fish meal factory can accept higher temperatures; the respondent also highlighted that herring could stay at normal temperature for a couple of days without a problem. Based on interviewee X's (Appendix 1) explanation of normal temperature, for example, in the summertime, like August, the temperature could be warm to 20 or even 30 degrees (Celsius). In addition, when one truck is full, it might stay in that temperature for 5-6 hours, and then they send it to Denmark. Of course, the quality of the fish meal will be better if the temperature of the offcuts is lower. However, it is always a challenge to control temperatures. In addition, interviewee X continued to describe that all these offcuts were just pumped on board a trailer or truck, like bulk packing.

The fish meal factory wants to have as much blood and intestinal as possible because it prefers to have as much protein as possible to go with the fish. Thus, interviewee X expresses that they do not do the cleaning for the fish side streams. Furthermore, the fish meal factory would sample it and check the quality when fish side streams arrive, and then the fish meal factory pays the price depending on the quality.

5.8.3 Fish Side Streams Business Innovation

In the end, interviewee X expresses positively that they developed herring with Chalmers in the WaSeabi project, as mentioned before, with the soaking antioxidants. So that is the new part, and in the meantime, they have been working a lot with Chalmers on different projects, for example, to see if they can disperse the proteins in the wastewater. The wastewater comes from the process water because it takes a lot of water to pump the fish and a lot of water to get the fish into the processing plant and the filleting machine. So, there is much blood, minced fish, and things like that in that water. They are hoping to find some of that useful. So they have been working on research, although the technology is quite expensive to test in those studies, and there may not be a market for the end product. It became clear from an interview with X that they try to reduce waste and minimize the environmental impact of supply chains.

5.9 Bigger Vision of Fish Side Streams

According to interviewee X (Appendix 1), the bigger vision of fish side streams is that salmon side streams have high demand compared with the herring because salmon side streams have more richness in protein and omega-3. And Asia has a high demand which is the Philippines and Vietnam. Furthermore, the backbones used to have a high demand from Russia; now, interviewee X expresses that they have no market there. However, in Eastern Europe, they still like to take care of it because it is easy to sell with this size.

5.9.1 Specific Case of Fish Side Streams

In this case, at Västkustfisk SVC AB, the author explained and presented Upcyclr's ideal vision to the interviewee and asked him how he felt about the idea and whether it was acceptable and triable in light of their company's current situation.

First, Upcyclr wants to bring equipment and technology to fishing boats. When the fishing operation on board is finished, they go to work processing the fish side streams from the slaughtered fish. The processed product is then transported to Upcyclr customers on land (e.g. food processing plants) using other transport vessels. Alternatively, they can bring Upcyclr's equipment and technology directly into their plants.

Interviewee X indicated that this depends on the size of the Upcyclr facility; he is willing to do this if there is enough space to support it. This is because interviewee X believes that the closer to the production material, the better, and it would also help them to solve the problem of fish by-products. However, since they buy their fish from Norway or fishermen, he did not comment much on the first idea.

6. Discussion

The focus of this chapter is to explain and evaluate the results based on empirical studies and to show how it relates to the literature review section and the thesis topic. The first part presents emerging trends in fish side stream utilization. This will be followed by a description of existing and established fish by-product operations with the aim of exploring the differences between their logistical activities and those of human edible products. Finally, the discussion will focus on the logistics activities of fish products. From this, logistical information corresponding to fish side streams as raw material for the production of human edible products will be derived.

6.1 The Value and Challenges of Fish Side Streams

In recent years, salmon and herring side streams have become an increasingly valuable resource for the seafood industry. This is due to the fact that these fish side streams are rich in nutrients such as Omega-3 and protein. The business of fish side streams started very early, with the existing and established fishmeal, fish oil production and organic fertilizers. Moreover, gradually, there is a trend to use it as a raw material to produce edible products for human consumption. A large part of this is that fish side streams account for 60% of the fishery production. Fishing companies or fish processing plants are willing to try new production models and make changes to increase their product's profitability, so they are willing to look for higher prices for fish side streams in the market.

Moreover, several factors make fish side streams popular in Asian markets. Another main reason is to satisfy the human protein supplement, especially in the context of today's scarce resources. Therefore, it is necessary to study the differences between the logistic activities of fish side streams as a raw material for producing human edible products and those of fishmeal as a raw material for producing fishmeal and the logistic challenges faced.

Because there are no completely improved studies on the logistical activities of fish side streams when used as raw materials for the production of human edible products, and because the study subjects need to meet high food safety standards. Therefore, a literature review and a comparative summary of empirical findings are presented next from two perspectives. The first perspective is to complete and improve existing fish side stream logistics activities, and the second perspective is to imitate the logistics activities of reference fish products to draw conclusions related to the research questions.

6.2 The Processing of Fish Side Streams

From the interviews, it was learned that fish processing plants sort and collect fish side streams simultaneously as they process the fish. However, since fish side streams are used as raw material for fishmeal production, fishmeal processors are willing to retain as much protein as possible. Therefore, fish processing plants do not clean the fish side streams or control the temperature during transport. This is because fishmeal processors have a more significant temperature tolerance. Based on the literature, it is beneficial to stabilize the solid lateral streams by cleaning, sorting and storing them separately. The shelf life of fish side streams is short because they carry bacteria and water. So, effectively extending the shelf life of fish side streams is one of the challenges of fish side stream logistics activities. Analysis of the literature shows that HPP (High-Pressure Processing) systems can be implemented to maintain its quality, nutrition and flavour while inactivating microorganisms, enzymes and other harmful components in the food using high pressure. However, according to the information provided by the interviewee, their fish processing plants use antioxidants to soak herring side streams to extend their shelf life. HPP systems are recommended because this method is more famous for fresh products such as meat and seafood. However, the latter is more convincing than the antioxidant-soaked method that has demonstrated results and effectiveness. With this problem solved, according to the interviewee, one of the obstacles and bottlenecks before adding value to solid side streams is the lack of end product market and space.

6.3 Customs Issues Involved in Fish Side Streams

Regarding the supply and origin of salmon, there is agreement from literature and interview, respectively, that salmon is imported from Norway. In addition, according to the interviewee's description, the salmon will be slaughtered in Norwegian slaughterhouses. They often receive salmon in the form of HOG (Head on Gutted), which means that the salmon side streams only have a head and tail in the Swedish market. So if fish side stream processing factories want to get the whole salmon side streams for value-added processing and sale to food processing plants, they need to import the salmon side stream from Norway.

Salmon side streams and fish products are considered the same type of products, with similar processes and challenges in importing and exporting. In addition, it is known from the literature that transportation cost accounts for a large part of the total cost of fish side streams trade. Logistical decisions such as modes of transport and routes can significantly impact these costs, as differences in route choice may involve documentation requirements for transit declarations of fish transported through third countries. Since regulations on the import and export of fish side streams may differ from country to country, this may affect the stability of trade and the timeliness of logistics.

It is understood from the literature that there is a need to provide customs with clear documentation of fish products and a range of traceable information showing the fish from capture to slaughter and in what form they are sold. This is consistent with the information in the interview about the need for fisheries to provide traceability information systems to the Governments concerned. In addition, customs regulations play a crucial role in determining the efficiency and cost-effectiveness of fish side stream trade, and documentation requirements and regulatory compliance add complexity to the process. This results in suppliers and purchasers bearing the burden of possible delays in the delivery and receipt of goods due to the laws, regulations and documentation required to meet the requirements. This means there is an increased risk of poor product quality. In short, transport and customs regulations pose significant challenges to supply chain participants involved in transnational fish side streams trade.

Despite many uncertainties and challenges, the transport of fish side streams between countries also presents many opportunities for the Nordic seafood industry, such as reducing the costs of fish processing plants (including waste disposal charges) or the potential to expand markets and reach new customers through increased costs by trading and reprocessing fish side streams into high-value food products to compensate for world food shortages. Therefore, it can be seen from the interview process that respondents are interested in carrying out value-added projects of fish side streams.

6.4 Storage & Packaging Involved in Fish Side Streams

Regarding the supply and source of herring, there is a consistent result from literature and interview that the supply of herring is obtained locally in Sweden and delivered directly by fishing vessels to the fishery processing plant. Fish side streams need to be treated and preserved in a food-grade manner for the same reason. This relates to the warehousing and packaging steps in logistics activities. Due to the lack of relevant studies on side streams storage of fish, the information obtained from interviews and the storage management of fish products shall prevail here. During the interview, storage was not mentioned in the fish side stream processing steps. However, the processing process was described, emphasizing that there were temperature monitors in all processing processes to control the temperature correctly. The factory's internal insurance security system supervises the whole process. Therefore, the authors believe that fisheries do not currently store fish side streams. Regarding transportation, respondents said the fish was sidelined to a trailer on a conveyor belt and then transported to Denmark. It is also clear that there will be no special packaging for the fish side stream (for example, vacuum packaging, etc.).

This is another major obstacle to stabilizing fish side streams in food applications. According to the literature, everything from the location of the warehouse to how to manage the storage is essential to solving this obstacle. Therefore, according to the packaging needs of fish products, food-grade packaging, namely vacuum packaging or ice it, must be carried out on the fish side stream. Because, at present, fishery processing plants and companies do not store fish side stream. This aspect is therefore explained by the key point of the storage of fish products, namely the need to control the temperature and the need to control the stock. Warehouses must have enough space, refrigeration devices, and a perfect infrastructure. This is much the same as the description of his warehouse in the interview. In addition, based on the literature, the optimal location of the warehouse should be close to the fishing processing plant and have a good transportation infrastructure to ensure the convenience of cargo transportation and the shortest time to transfer the goods.

6.5 Transporting Involved in Fish Side Streams

In terms of transportation mode, consistent results have been obtained from literature and interviews, namely, truck transportation mode through refrigerated transport vehicles and temperature control at 2 degrees Celsius. Since it is known from the interview that the fish side streams delivered to the fishmeal processing plant are transported at normal temperature, it does not help to realize the purpose of this study. Therefore, the same treatment will be applied to the mode of transport concerning fish side streams as for fish products. This means choosing the size of the refrigerated transport vehicle according to the size of the volume delivered, but what is not chosen is the need for strict food-grade transport temperature control of the fish side streams throughout the transport process.

7. Conclusion

This section introduces the research conclusions. The research question and purpose of how to carry out the logistics activities of fish side streams when it is used as raw material for producing human edible products will be discussed. The primary endpoint is the combination of the empirical results of this study with the literature analysis and the realization of common differences. Finally, the limitations of this study and the future research direction will be discussed.

7.1 Concluding Remarks

By analyzing the transportation activities and requirements of fish products, the paper compares and improves the existing logistics activities of the fish side stream to make it reach the food level and meet the prerequisite of adding value to the fish side stream, namely, the stabilization of the fish side stream. This paper shows how the side stream of fish, directly and indirectly, affects how humans obtain nutrients. This study illustrates the logistics and transportation activities involved in producing human food by fish side streams. It analyzes and discusses in detail storage & warehouse locations, packaging applications and the use of new technologies for transportation modes and customs issues.

There are many challenges and difficulties in optimizing raw material acquisition for value-added fish side stream processes. For example, fish side streams are sorted and cleaned on different conveyor belts while processing. In addition, extending the shelf life of fish side streams is faced with technical problems, the strict control of temperature during storage and transportation and the supervision of inventory. Laws and regulations related to the environment and customs issues involved in importing and exporting, as well as supporting documents, add to the complexity of transportation. At the same time, this activity brings many opportunities and benefits for fisheries, other by-product producers, and consumers. The analysis in this paper confirms that value-added projects on the fish side streams are driven by more than one incentive, both at the industry level and the firm level.

Meeting the human demand for protein, increasing fisheries' profits, and reducing environmental pollution are the most important incentive factors. However, from the point of view of transportation and production efficiency, quality safety and cost of raw materials, it is ideal for Upcyclr and similar fish side stream processing companies to bring technology and equipment into the fish processing plant. This will ensure maximum freshness of the ingredients. However, there are still many uncertainties about the implementation of this idea. For example, fish processing plants may need more space to accommodate the necessary infrastructure and equipment and enough people to operate and control the process. Alternatively, the location of the fish side stream processing plant near the fishery processing plant, rather than becoming a neighbour, is also a good choice.

However, there are often many obstacles to realizing the ideal way, such as the lack of space for fishing processing plants and the lack of another land that can be legally used as a neighbour to fishing processing plants. Then, the fish side stream should be handled and packaged correctly and transported to the fish side stream processing plant flexibly and efficiently by a refrigerated transport truck and the remaining raw materials for food grade storage and strict control of the quantity and quality of inventory to initiate upstream orders. In the face of the logistics activities of the side streams of imported fish, we should reasonably plan the route and avoid third-party countries, which will increase the complexity of logistics activities. Finally, it is necessary to prepare the documents the customs require in advance and cooperate with mature intermediaries or third-party logistics to ensure the timeliness and stability of the logistics activities.

7.2 Limitation

The limitation of this paper is that it focuses on the supply chain-related issues involved in the reuse of fish side streams of herring and salmon in a Swedish market-based context. Salmon is a fish mainly found in the North Atlantic and its surrounding rivers, so the raw material source is limited to this area. Furthermore, the current study only focused on the side streams of the two seafood products, and their origin was limited to Sweden and Norway. Also, since we can not have more contact with other fishing companies from Norway or Denmark, thus there are enough interviews and knowledge about the real growing environment of salmon farms and slaughterhouses and how the corresponding company plants handle salmon and herring side streams.

7.3 Future Research

The scope of this study is to discuss the supply chain management issues involved in fish side streams of salmon and herring based on the Swedish market. Inspired by this, future academic research could explore and adapt the study to a broader market and other countries, for example, cod side streams and, even more so, fruit side streams. Furthermore, this is especially true in the context of limited land, scarce resources and population growth. These findings may address the development of more sustainable protein and vitamin supplementation and make effective changes accordingly.

As mentioned earlier, the results of this study suggest that although science and technology are needed to effectively eliminate the pathogens carried by fish side streams and extend their life cycle as long as possible, it is undeniably a sustainable idea that can benefit consumers and suppliers. Therefore, future work should continue to investigate how to effectively coordinate logistics management to extend the fish side streams' life cycle and find the right customer groups in the market. Further research using this result may be beneficial to promote green food.

Another noteworthy is the need for more literature studies on how research plants produce fish side streams as a high-value product. This brought much trouble when the authors tried to identify and use appropriate case studies in their research. Finally, regarding the limitations of the number of respondents, the information provided by the researchers needs to be more comprehensive to make a comparative evaluation of the Nordic fisheries regarding the handling of fish side streams and logistics-related issues. Further work could expand the diversity of findings by investigating solutions and behaviours of fish processing plants in other national contexts in the context of sustainability studies.

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Appendix

Appendix 1.
Interview Guide for Fishery Company

Background and Information

Good afternoon! Thank you very much for participating in this interview and contributing to my research. It's my pleasure. My name is Gao Ruodi, from China, studying for Master of Logistics and Transportation Management at the University of Gothenburg. Right now I'm doing my master's thesis on logistics activities that add value to fish side streams at a startup called Upcyclr. This interview is for research purposes, so it's only for me to hear. And the recorded video and transcript will be deleted after I process the material. Do you mind being recorded? Would you mind not keeping your ID anonymous during the preparation and defence of your thesis?

The interview will be used for data collection for my master's thesis. This interview is mainly divided into three parts. The first part is about some problems in the supply chain related to seafood (especially herring and salmon). The second part is about some problems in the supply chain related to the by-flow of fish produced in the production process of herring and salmon. At the end of the interview, we will briefly introduce the relevant schemes of Upcycr and discuss the feasibility of the schemes. Do you have any questions before we start?

Questions

Quality Conservation and Sustainability of Fish Products

1. Can you describe the different stages of your supply chain, from the moment the fish is caught to when it reaches the end consumer? Is there any logistics information system used in this process?
2. How do you ensure the sustainability of your fishing practices?
3. Do you have your own fish farm, or do you only catch wild salmon?
4. What measures do you take to ensure the quality and freshness of the fish throughout the supply chain?

Target Market of Fish Products

5. What seafood business do you currently have?

The Processing

6. How do you handle the processing of the fish to ensure that it remains safe for consumption?
7. How long does it usually take to slaughter fish? Do you have specific figures? And what is the approximate percentage of fish waste produced in this process?
8. How do you transport the fish from the fishing vessel to the processing plant and then to the end consumer?

Packaging

9. How do you handle the packaging of the fish to ensure that it remains safe for consumption?

Storage

10. How do you store it? At what temperature?
11. Are there any special rules to deal with this, and is it placed in the warehouse in the form of shelves or how?

Transport

12. how to transport fish products?
13. Is there any difference between handling fish side streams with normal fresh fish products?
14. How do you ensure the safety and quality of fish side streams throughout the supply chain?

Percentage of Fish Side Streams

15. How do you define fish-side streams, and what types of fish-side streams does your fishery produce?
16. What measures are in place to capture and utilize fish side streams, such as fish heads, bones, and offal?
17. Can you describe the processes and technologies you use to handle fish side streams, such as sorting, cleaning, and processing?

18. How to store and transport them?
19. How do you ensure the safety and quality of fish side streams throughout the supply chain?
20. What products do you make from fish-side streams, and how do you market and distribute these products?

Fish Side Streams Business

21. What to do with these fish side streams?

Fish Side Streams Business Innovation

22. What plans do you have for future development or expansion of your fish side stream supply chain, and what are the potential challenges or opportunities you see in this area?

Specific Case of Fish Side Streams

Upcyclr plan：

Upcyclr wants to bring technology and equipment to fishing boats. When the fish is salvaged for processing and planning, the fish waste is processed, and then the processed raw materials are transported back to the food processing factory on land by the transport ship. At the same time, fishing boats continue to fish in other available sea areas, and the cycle repeats. Thereby ensuring the freshness of raw materials to the highest degree. Do you think the plan to implement Upcyclr is currently feasible? What challenges do you face? If it is possible, can you tell me how to do it?

Or bring technology and equipment to the fish factory. Do you think the plan to implement Upcyclr is currently feasible? What challenges do you face? If it is possible, can you tell me how to do it?