QUALITY MANAGEMENT ON VALUE CHAIN OF FROZEN COD FISH PROCESSING IN ICELAND, CASE STUDY ON VALUE CHAIN OF FROZEN TRA CATFISH (PANGASIUS HYPOPHTHALMUS) PROCESSING IN VIETNAM.

Nguyen Thi Thong Tri
NTSF Seafoods Joint Stock Company
Lot C3-C5, Thot Not industrial Zone, Can Tho City
thongtribd@gmail.com

Supervisor:

Margeir Gissurarson
margeir@matis.is

ABSTRACT

The fishery industry in both Iceland and Vietnam have experienced strong and rapid development in recent years with representation is Cod fish wild catch from the sea in Iceland and Pangasius (Tra catfish) raise farm in Vietnam, although there are have the basic different between wild catch and cultured but both of countries have been constructed supply chain from catching to export, especially the cod fish of Iceland had been extremely successful in construction of value chain system become one of the country export cod fish products with very high value in the world. While in Vietnam in many recent years the pangasius farming and exporting activities have many difficulties due the major causes come from stringent requirements of the export markets, this is not only challenge but also is the opportunity mandatory processing companies if want to continue must to change and innovation to meet demand of the markets, not only focus on quantity but also enhance quality, sustainable development and environment friendly by eco-labeling. Although the pangasius product of Vietnam has a significantly position in the international market but cognitive of the customer about organic pangasius image brand is not reality strongly yet, hence the reputation is vulnerable and the market easy impacted.

This paper should be cited as:
Nguyen, T. 2020. *Quality management on value chain of frozen cod fish processing in Iceland, case study on value chain of frozen Tra catfish (Pangasius hypophthalmus) processing in Vietnam.* UNESCO GRÓ-Fisheries Training Programme, Iceland. Final project. http://www.grocentre.is/ftp/static/fellows/document/Tri19prf.pdf

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Ever since open market international integration in 1990 (UNIDO, 2013) the seafood industry in Vietnam has experienced a strong development. In particular, the pangasius aquaculture sector has rapidly developed, not only on the domestic market but also in export markets such as USA, Europe and Japan, Australia that have strict quality requirements. To adapt to these requirements, pangasius processing companies in Vietnam need to adopt innovative technology to enhance the quality of products and collaborate with competent authorities in the fisheries sector, and continue to follow the trend of consumption like demand, wish of customers, and requirements from the import markets. Construction of vertical integration with the aim of sustainable and stable development and consider environment friendliness that is the trend of development in the future. Presently, Vietnam has constructed a successful paradigm of vertical integration on the pangasius farm, the number of vertically integrated farms is continuing to increase (Bosma et al. 2011).

Ever since 2003, the pangasius industry in Vietnam has developed and currently is important to the country's economy in general and the Mekong Delta area specifically, along with other agricultural operations in the region. Figure 1 shows the distribution of the pangasius industry sector in Vietnam. The farms and processing companies are mostly concentrated in the ten provinces Dong Thap, An Giang, Can Tho, Ben Tre, Vinh Long, Tien Giang, Hau Giang, Soc Trang, Tra Vinh, and Kien Giang, and two provinces which do not belong to the Mekong Delta are Tay Ninh and Quang Nam. According to statistical data in 2018 the total pangasius farming area is around 5,400 hectares, total harvest was 1.3 million tonnes, and total export reached 2.26 billion USD. In 2018 revenues from the main importers, that is US, China, Hong Kong, Europe, ASEAN, Mexico, Brazil, Colombia, and UAE, reached 1.82 billion USD, accounting for 80.5% of the total export value (FAO,2018).

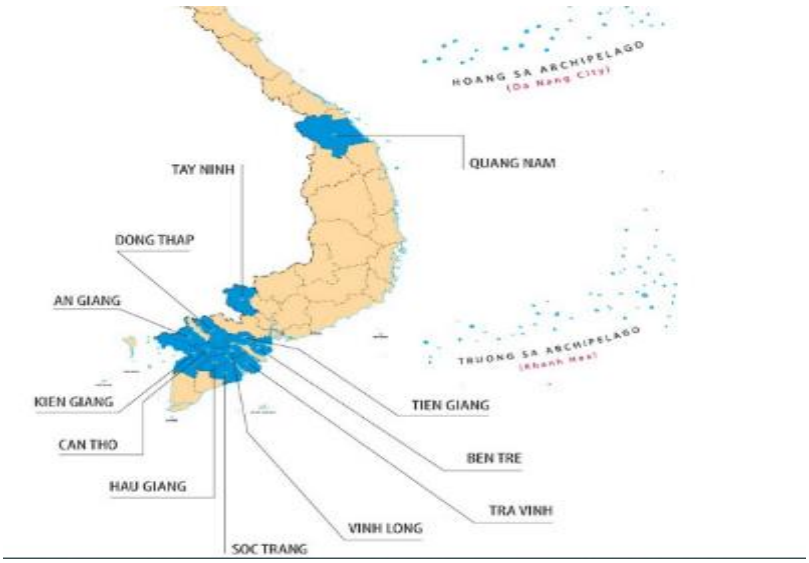

Figure 1: Location of pangasius aquaculture regions in Vietnam (VASEP, 2013).

The improvement of quality standards for Pangasius has been controlled by the implementation of quality management systems for farming ponds such as Aquaculture Stewardship Council (ASC) as well as international standards like Global Good Agricultural Practice (GlobalGAP) and Best Aquaculture Practices (BAP) (VASEP, Overview of seafood industry in Vietnam, 2018). The product is controlled from fingerling stage to final product by food quality and safety standards. The operation of processing factories is based upon the HACCP system.

Although some pangasius companies have applied new technological machinery in the production line, in general the process is still manual, the workers are the main labour force, with an average of 400 workers in small scale production and 1,000 workers in large scale (Thi, et al., 2013). Hence, there are still some issues to face, such as production operation is dependent on the workmanship and awareness of the workers and the time for handling and processing is long, on average 4-5 hours from raw material to frozen fish. Without good temperature controls the quality of fillet fish will decrease, the microbial content can contaminate and grow, e.g. Listeria monocytogenes and Shigella flexneri, the risk of contamination from workers is high if there is a lack of stringent control by quality control staff. The quality of the product depends on the knowledge, skill, and number of QC staff at each step.

The pangasius sector in Vietnam is experiencing problems in export due to issues related to trade from the important markets. According to FAO statistics in figure 2, the pangasius industry has rapidly developed production volume. from 2003 onwards with a production increase of 163 thousands tonnes more than seven-fold increase between 2003 and 2008 up to 1,250 thousands tonnes. Increased competition from other markets caused export decrease and unstable development after 2008 until current times. The future trends are that consumers are demanding quality, sustainable development, and environmental friendly production, which are the challenges the companies have to face. Hence, there is a need to concentrate on investment in quality instead of quantity to enhance the brand of the product (VNS, 2019).

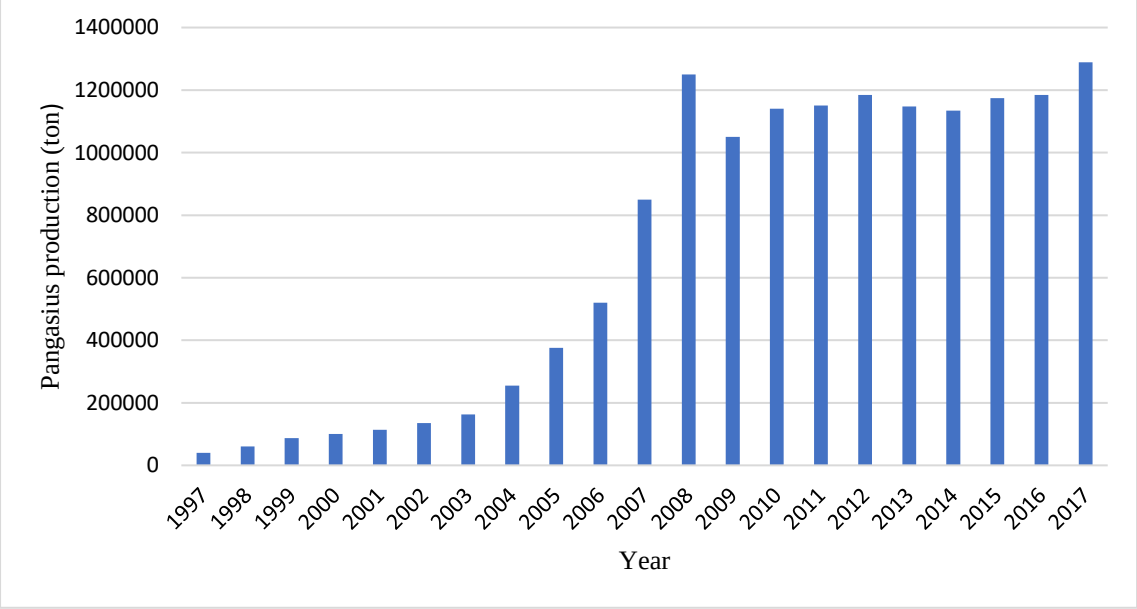

Figure 2: Production volume of pangasius in Vietnam from 1997 to 2017. (FAO, 2019).

1.1 Scope of the project

The project focuses on describing the value chain for cod fish processing in Iceland and pangasius processing in Vietnam with emphasis on the quality management system applied to monitor and control the processing to ensure product quality and safety in both countries. Further to evaluate the role of the competent authorities and how they contribute to the safety of the final product. Comparison of the different processes in the two countries may provide recommendations for improving the current limitations and future planning of strategy towards sustainable development of the sector in Vietnam**.**

1.2 Objectives

The objective of the project is to conduct a comparative study on the quality management systems in fish processing in Iceland and Vietnam and evaluate the possible benefits regarding food safety and quality when applying advanced technology in the processing system.

The specific objectives are:

• to study quality management system and traceability procedure of codfish processing companies in Iceland.

• to analyse the benefits of applying advanced technology to optimise the quality of the product.

• to suggest some solutions to promote quality management in the pangasius industry in Vietnam, to consider the application of advanced technology and information technology (IT).

• to examine the model effectiveness management of IT in Iceland and its suitable application in Vietnam.

1.3 Purpose of project

Although the pangasius industry in Vietnam has significantly developed in recent years, the vertically integrated paradigm to control the entire process is experiencing some difficulties and limitations in quality management process due to production being mostly manual. While the fisheries industry of Iceland, specifically cod fish industry is very successful in quality management by applying high technology, hence through a comparison some solutions will be proposed to help improve current limitations of the pangasius industry in Vietnam.

2. LITERATURE REVIEW

Vietnam is the world's leading export country for pangasius products (Khoi, 2017). The processing companies are concentrated mainly in Mekong Delta River, which has many canals and ponds with 649,430 ha brackish water area and 366,590 ha freshwater area (VASEP, 2018), including the provinces An Giang, Dong Thap, Can Tho, Vinh Long. The seasonal flooding usually begins in September until the end of October which is very rich in alluvial advantages for agriculture and saltwater washing for water resources used in aquaculture operations (UNIDO, 2013).

The pangasius (Figure 3) in Vietnam belongs to the genus Pangasius (e.g. Catfish) (Phillips, 2002). Before there were two species used for commercial aquaculture, *Pangasius hypophthalmus* and *Pangasius bocourti*, which grow mainly in freshwater. Due to the lower economic value of *Pangasius bocourti* compared to *Pangasius hypophthalmus*, at present *P. hypophthalmus* is the main species processed for export (Nguyen & et.al, 2017) (Khoi, 2017) which increased from 72 % in 2002 to 90% in 2007 (Young and Son, 2002) (VASEP, 2009).

Figure 3: Pangasius hypophthalmus *(VASEP, 2019).*

The pangasius product is popular because of its colour, flavour, high nutritional value and affordability (Thi, et al., 2013). Products are certified in accordance with strict quality standards in international markets such as Aquaculture Stewardship Council (ASC), Best Agricultural Practices (BAP), Global Good Agricultural Practices (Global GAP), British Retailer Council (BRC) (Trifković, 2014). These products are exported to many countries including high-end markets such as USA, Europe, Japan, China, Australia. In 2017, the pangasius production of Vietnam reached 1.2 million tones, with an export value of approximately US$ 1,976 million (VASEP,2018). Pangasius is mainly exported frozen including frozen fillets, whole frozen fish, frozen bread fish, fish rolled, steak fish frozen, and portion cutting fish among those frozen fillets. (Nguyen, Tram Anh Thi; Nguyen, Thien Chuong Phuc Bui; Jolly, Curtis M; 2017).

Iceland has a highly developed fish industry, a fishing area around 758,000 km2 with a total catch of 1.7 million tons annually (Hameri & Jóhannes, 2003). The fishery industry has played a key role in the national economy, total export of marine products reached 670,775 tones and accounts for 40% of the value of exported goods in 2018 (Fisheries I. R., 2019), there are a decreasing number of workers working inside the processing plants with only 8.7% of the labour force that participate directly in the fishery industry (Hameri & Jóhannes, 2003). The cause for this is that the industry has applied advanced technology and more automatic systems in catching and processing (Wolf, 2013). Each vessel has a monitor device controlled directly by the competent authorities in the fishery sector and processing companies. (Hameri, A. P.,

& Pálsson, J. 2003). The fishery industry is meeting 2% demand of the fish on a global scale (FAO, 1999).

Codfish (in figure 4) is the common fish in the northern waters of Iceland , spawning in warm water along southwest coast of Iceland, after growing, they will migrate to the west and east areas of Iceland (HÞV, 2019). Nowadays, cod fish is the main species for exporting, including salted fish, dry fish from back bone and head, frozen fish, and fresh fish. Among that, fresh fish is the main export product with high quality and nutrient value.

Figure 4: Codfish *(responsibleFisheries, IcelandIc FIsherIes, 2013)*.

In simple terms, quality means fulfilling consumers expectations and quality management systems of various steps are set up to secure that consumer expectations are met. This includes product control, process control, control of environment and equipment, management commitment and customer focus (David Hoyle, 2009).

Regarding food quality the customer expectation can be divided into Food Safety and Food Quality. All consumers require safe food and the globally accepted HACCP system aims at securing consumer safety. Quality characteristics required by the consumer can however vary between consumer groups and marketing areas. To fulfil these different attributes in food, close communication with the market is needed and requirements built into the food quality system. This is usually done through product specifications.

2.1 Food safety management

Food safety management plays a very important role to ensure that the food is safe to eat. There is a legal requirement with all commercial food that is required from inspecting agencies of the importers and exporters around the world, as well as a systematic approach to controlling foodborne hazards from 'farm to the table'.

Today, the intervention of competent authorities in the food industry is much stronger in anticipating and preventing foodstuff disease. Table 1 shows the number of alert notifications of the cases delinquent in foodstuff from countries around the world. In 2012 there were 522 case alerts by the Rapid Alert System for Food and Feed (RASFF) and the table shows the growth trend in the past years.

year	alert		border rejection		information for attention		information for follow-up	
	original	follow-up	original	follow-up	original	follow-up	original	follow-up
2012	522	2312	1712	906	679	664	507	1325
2013	584	2376	1438	525	679	763	429	1493
2014	725	3280	1357	581	605	670	402	1377
2015	748	4028	1376	417	475	538	378	1222
2016	817	4659	1159	421	573	704	372	1504
2017	927	5781	1570	771	683	979	586	1586
2018	1118	6513	1401	692	675	957	493	2141

Table 1: The number of original case notifications and follow-up by RASFF. *(RASFF, 2018)*

The former approaches to ensure food safety usually relies mainly on final product testing, this did not thoroughly resolve the prevention and occurrence of foodborne illnesses. Therefore, in 1971 a system originated from the U.S.A to help to guarantee better food safety. Following that, similar versions from other countries were established, such as in the EU the name is 'Own Check', in Canada it is 'Quality Management Programme (QMP)', in Japan it is 'Advance and Diverse Sanitary Control System' (Hussain, 1997). Although these versions had different names but used the same the basic elements of the HACCP system with the aim to anticipate the hazards and identify the control points.

The HACCP system is now globally accepted for import into all main marketing areas and requires that food establishments have generated and implemented a HACCP plan.

Food safety management based on the principle of the Hazard Analyses and Critical Control Point (HACCP) system is used to identify and control hazards such as microbiological, chemical, physical from raw material, during processing, storage, and distribution to the customers. The HACCP combined with a Prerequisite Program (PRP) forms the HACCP System. A Quality Management System is formed when a HACCP System is combined with the principles of ISO 9000 (as in figure 5):

The HACCP is based on a set of seven principles that are used to develop HACCP plan for food. These principles are:

- Conduct hazard analysis.
- Determine the critical control points (CCP).
- Establish critical limit.
- Establish monitoring procedures.
- Establish the corrective actions procedures
- Establish procedures for verification
- Establish documentation and record keeping procedures

Figure 5: Structure of food safety management system *(Jo, 2009)*.

Prerequisite programs provide the basic environmental and operating conditions that are necessary to produce safe and wholesome food. Some of these programs are required by regulations. Prerequisite programs are procedures, including Good Manufacturing Practices (GMPs), that address environmental and operational conditions and provide the foundation for the HACCP System.

The HACCP system is a science-based system, which allows the identification of specific hazards and provides measures for good control, by preventing, eliminating or reducing the hazard to an acceptable level. The system focuses much more on prevention than testing the final product. The HACCP system can be used for all food processing both manual and automatic processes.

2.2 Quality management

Food quality are the characteristics of food, it may be known as specification of product. Food quality is regulated by establishments and this is different from the demands of the customer. Normally, establishments have their own food quality manuals, which create the basic standard for quality characteristics of food.

Some characteristics are regulated by government to ensure the product is correct with labelling information for display on the market. This is very important to prevent fraud and guarantee safety for human consumption in the proper way.

Common indicators of quality characteristics of food include:

- Gross or net quantity of each unit product
- Rate glazing
- Ingredients in the product
- Size, colour, smell, bone, texture
- Shelf life of product
- Packaging
- Labelling

Quality management systems include quality improvement activities, quality control and assurance activities. Some companies use basic quality control programmes, and some use more complex quality management systems like ISO 9001:2000 Quality Management System to achieve quality of food of their company. These systems can combine with GMP and HACCP system to monitor and inspect quality of product (Alli, 2004).

3. METHODOLOGY

Information from documents related to the development of the cod fish and pangasius industry will be collected and analysed. This includes laws, regulations from the competent authorities in fisheries which respective to Vietnam is The Minister of Agriculture and Rural Development (MARD), and in Iceland (MAST). Regulations and standards of the important import markets such as USA and Europe will be analysed. Scientific articles, reports, websites, journal articles reviews about the operation of fisheries in both countries. The data available in the processing industry in Iceland and database from FAO statistics will also be collected and used. Along with knowledge obtained from visits to the Visir processing company in Iceland. Preparation of questionnaires for interview. Interview questionnaires will be submitted to management and workers to understand their knowledge and awareness when participating in the production.

4. THE PANGASIUS VALUE CHAIN IN VIETNAM

There are three main government organisation working groups in the pangasius industry:

1. National Agro-Forestry-Fisheries Quality Assurance Department (NAFIQAD),
2. Directorate of Fish (D-FISH), and
3. Department of Animal Health (DAH) founded by Ministry of Agriculture and Rural Development (MARD).

NAFIQAD is responsible for the slaughtering and processing plants to be certified eligible for products export to the US (Lai, Pham , Nguyen , Duong , & Pham , Fisheries Subsidies, Supply Chain and Certifycation in Vietnam, 2009). D-FISH is responsible for on-farm inspections including oversight of proper usage of veterinary drugs, certification of farms, and oversight of manufacturing, distribution, and usage of feed, fingerling, and environmental impacts. DAH is responsible for manufacture and distribution of veterinary drugs.

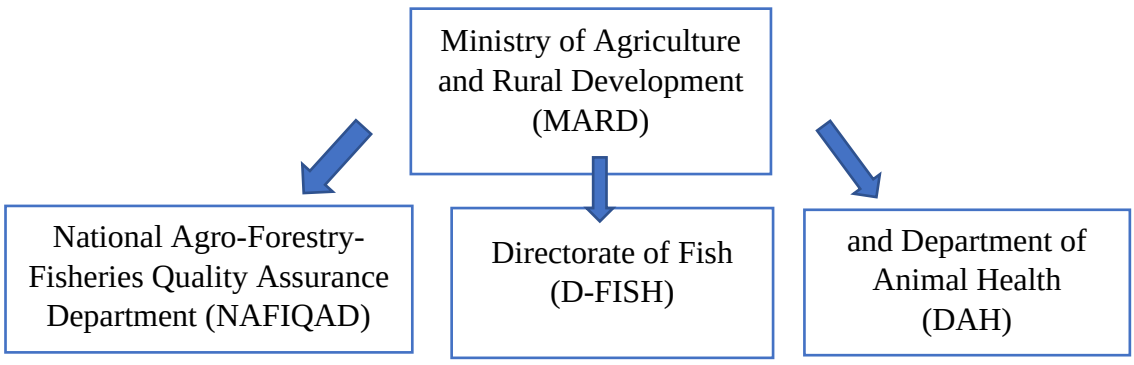

Figure 6: Three main government agencies working in pangasius industry in Vietnam.

The first step in the pangasius value chain in Vietnam is the state-owned hatchery. There, seed production takes place. The hatchery uses advanced research techniques on the quality of broodstock (Sanh & Tu , 2011). Farmers then buy juveniles from the hatchery which are healthy and disease-free, with a contract demonstrating origin (UNIDO, 2013). The linking of factors in the pangasius value chain in Vietnam is shown in figure 7.

Fish feed used at grow out facilities, the second step in the pangasius value chain, must contain all the necessary nutrients that fish need to grow and remain resistant to disease. Grow out facilities comply with quality management program requirements adopted for the farm or global GAP. Many farmers use feed supply from the feed processing factory from domestic or foreign companies which ensure the feed quality (Khoi, 2017). Feed is produced with modern machinery and technology bought to create suitable high-quality feed supply for the markets (UNIDO, 2013). When making feed, farms comply with national technical standards QCVN 0178:2011/BNNPTNT on animal feed which contains criteria on safety and the maximum level of pharmaceuticals in the feed (Tra, 2014). Water samples are regularly collected and tested for contamination by Research Institute number 2. Based on the results obtained, farmers know whether or not the water from the Mekong Delta River is safe to use in operation on their farms (Tra, 2014).

Farmers contracts with processing companies is the next step in the value chain. The company monitors and supports laboratory tests for disease in the fish, and provides guidelines for good management practice on pangasius farms (Khoi, 2017) (NedaTrifković, 2014). Two to three weeks before harvest the NAFIQAD province and establishment under HACCP plan will take samples from these ponds to analyse residual chemicals, harmful substances, antibiotics in laboratory and contemporary checking of the fish culture diary (Duijn, Rik , & Willem , The Vietnamese seafood sector a value chain analysis, 2012) (Binh, Marijke , Stijn , & Luc D'Haese, 2010). If the testing results do not detect harmful substances, the processor will buy it. Conversely, if the testing shows there are harmful substances, they will not purchase the fish and end the contract.

In the face of stringent quality standards from world markets, proactive sourcing of quality raw material is key. Nowadays, most processing plants own their source farms. 78% of farms are owned by processing companies (VASEP, 2018; Nguyen & et.al, 2017) which apply technology and stringent international quality standards such as ASC, Global GAP, BAP on their farms to meet the requirements of the Japanese, United States, EU markets (Trifković, 2014). This vertical integration allows processors control over all the value chain.

The fish is inspected before it is taken into the processing. There, the fish is bled and filleted. Under the HACCP plan, stringent sanitary process, each step of the process is monitored and controlled by quality management staff (QC), each result is recorded according to the GMP form and stored for at least 2 years.

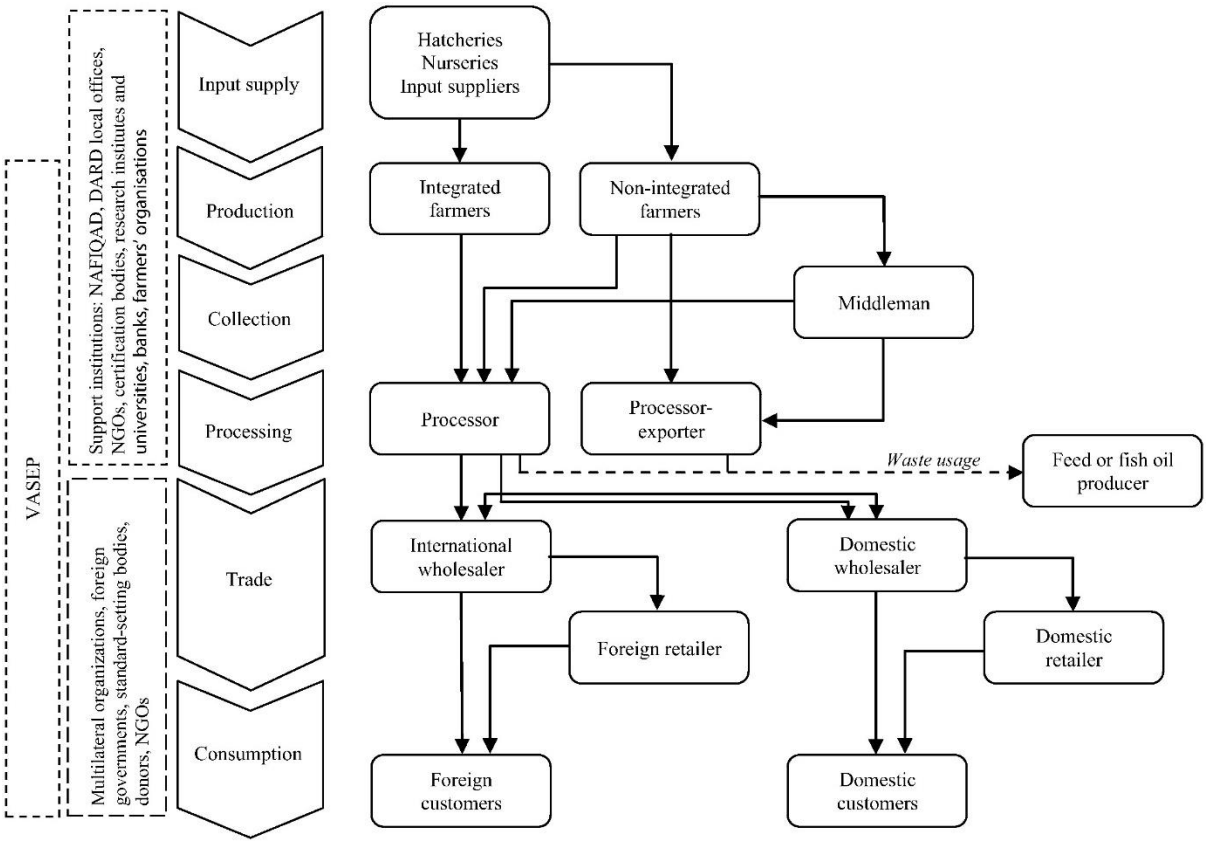

Figure 7: Vietnamese pangasius value chain *(NedaTrifković, 2014)*.

5. LEGAL FRAMEWORK COMPETENT AUTHORITY OF FISHERY IN VIETNAM

The Government and competent authorities in Vietnam have promulgated many decrees, circulars, regulations and standards aimed towards the development of the fishery industry in Vietnam. Some adjustments and additions have been made to harmonise the requirements to meet market requirements, but no significant changes have been made since 2013.

The Government of Vietnam on November 21, 2007 promulgated law No. 05/2007/QH12 which regulates the rights and obligations relevant to the food supply chain relating to organisations, individuals producing and trading products or goods, and customers. The law also stipulated the rights and obligations on objects related to the quality of products or goods, control and management quality of products and goods in the operation of production, import, export, distribution circulation on the market and for consumption.

Circular 10/VBHN-BNNPTNT promulgated April 27, 2015, by The Minister of Agriculture and Rural Development (MARD) regulating production conditions in the fishery business.

The Ministry of Agriculture and Rural Development promulgated Circular No 48/2013/TT-BNNPTNT dated November 12, 2013, regulating the inspection and certification of food safety for export fishery products.

With regards to quality management, the inspecting and monitoring of residue toxic substances of animal and reared aquatic animal products, the effect on health and safety of customers, the Ministry of Agriculture and Rural Development (MARD) promulgated Circular 31/2015/TT-

BNNPTNT dated at October 6th , 2015. This regulates the role and obligation of stakeholders relevant in the chain of production and the using of chemicals, bioproducts, treated and renovated substances have to comply with the list legally circulated in Vietnam, implementing declaring, inspecting, monitoring, analysing sampling with certain harmful substances in reared aquatic animals and its products. This Circular is the alternative to Decision 130/2008/QĐ-BNN promulgated previously.

Continuation with regulation above, on June 1st, 2016, the Ministry of Agriculture and Rural Development (MARD) issued Circular No. 10/2016/TT-BNNPTNT which stipulated the list of allowed and banned veterinary drugs in Vietnam and announced the code number for veterinary drugs imported in Vietnam. This circular is also an alternative Circular 28/2013/TT-BNNPTNT promulgated former by MARD.

Decision No. 2744/QD-BNN-HTQT of the Ministry of Agriculture and Rural Development (MARD) dated on 8th September 2008 about establishing the National Agro-Forestry – Fisheries Quality Assurance Department (NAFIQAD) with the functions, tasks, powers and organisational structure, responsible for inspection and certification complying with regulations and standards regulated by state bodies and the export markets. NAFIQAD is recognised by the EU, America, Japan and has six branches throughout provinces or cities important for export, these branches are responsible for control, inspection and certification of the quality and safety of fishery products for export, condition of hygiene and safety of facilities production of each locality in the fishery.

6. QUALITY REQUIREMENTS FROM MAIN IMPORT MARKETS ARE BEING APPLIED FOR PANGASIUS PRODUCTS

The pangasius processing companies that want to enter foreign markets must fulfill their safety and quality requirements, which mainly come from Europe and United States, China, and Japan. The main requirement of markets is to ensure food safety through HACCP systems. In addition, some markets also request specific standards for their market. The customer also requests the company has a quality manual to fulfill characteristics of the product. Particularly of standards and certifications as detailed below:

- Standards for farming:

Global Good Agricultural Practice (GlobalGAP) was promoted from EuropeGAP, recognised not only in European nations also in many countries around the world. This standard is about good aquaculture practice, the lowest impacts on the environment by farming operatations such as reduction of using chemical compounds, waste diposal, responsible for labour health and safety, animal welfare.

The Aquaculture Stewardship Council (ASC) was founded in 2009 by WWF (World Wildlife Fund) and IDH (The Sustainable Trade Initiative). The standard applies for pangasius farms practice management to bring the best for the environment, community, food safety, and traceability in aquaculture through consumer labeling.

Best Aquaculture Practices (BAP) was developed by Aquaculture Certification Council and includes standards and guidelines which apply to pangasius pond farming producers, responsible for environment, social, welfare, animal health, food safety. It also includes

requirements for using the land, water, labour, construction, waste disposal, and feed management during farming operations.

- Standards for processing:

Hazard Analysis and Critical Control Points (HACCP) is the main system to ensure safety of the food industry worldwide. This system promulgated and applied the guidelines created by the Codex Alimentarius Commission, and is a tool related to quality management. It includes principles and guidelines for an entire system of seafood processing operations to analyse and control biological, chemical, physical hazards from raw material to final products.

The Halal certificate ensures that the pangasius products contain no banned substances under Islamic law and meet the requirements of hygiene conditions during production.

British Retail Consortium (BRC) initially is a standard representing British retailer's requirements about food safety from processors and suppliers, but nowadays that is a global standard for food safety, quality, operations and is recognised by the Global Food Safety Initiative (GFSI).

ISO 9001 Quality Management System developed by the International Organisation for Standardisation (ISO).

ISO 17025 ISO standard for the competence of testing and calibration laboratories.

ISO 22000 ISO standard for food safety management.

IFS required by German and French markets.

7. QUALITY MANAGEMENT OF PANGASIUS PROCESSING IN VIETNAM

7.1 Food safety management

The production activities are based on HACCP system (Bremner, 2002) to identify which hazards have an effect on safety and quality of products such as chemical, physical, and biological. Combined with GMP guides they implement standards at each step to meet specific requirements, and with SSOP guidelines and requirements of ensuring sanitary and frequency monitoring in the entire operations of processing (LLC, 2019).

In pangasius processing critical hazards can happen from before receiving raw material with residue of chemical substances, parasite examining with the disease inside the flesh of the fish, and metal-detecting with micro metal possible mix inside of the products. To control these hazards the company relies on HACCP system to take the correct action, and QC staff must strengthen inspect and monitor stringently in these steps respective to these hazards.

7.1.1 Good Manufacturing Practices GMP

The term Good Manufacturing Practices (GMP) is the guideline and requirement used in Vietnam and covers the same issues as the prerequisite program during processing to monitor and ensure production activities are correct and suitable according with requests of HACCP. The GMP measures are setup on forms that are used to monitor the activities during processing. The forms may be used for a single product or group of products that are processed under

similar conditions. The forms explain the objective of the monitoring activity, the parameters that need to be obtained, control measures, corrective actions and temperature of fish and wash water at each step. The QC is responsible for recording all measures stated on the form by taking random samples to check if the product characteristics are according to the product specifications and procedures.

The GMP measures include the following:

- Describes clearly and in detail all processing steps and specifications at each step.

- Describes exactly the controls and procedures needed to ensure safety and quality of the product being processed,

- The QC division is responsible for implementing and monitoring GMP with the date and time respectively.

The implementation of the GMP measures is verified by the Quality Department through random sampling of raw material and during processing towards the final product. The results are compared to the previous records performed by QC.

7.1.2 Sanitation Standard Operating Procedure SSOP

Each processing plant has a hygiene norm, that are the procedures mandatory to implement in the processing facilities with the main points below:

- Quality of water used in production.
- Quality of ice-water used in production.
- Sanitary surface of utensils and equipment contact directly or indirectly with the product.
- Personal hygiene and health.
- Prevention from cross-contamination in the production area.
- Prevention from harmful animal e.g. flies, rat…
- Hygiene of packaging material and labelled product.
- Management of stores and usage of the chemical compounds.
- Sewage management.

a. Procedure of sanitary applied in pangasius processing

Cleaning and disinfection of the surface of the instrument, which contacts directly and indirectly the fillet fish two hours in the hot water tank 70ºC. At the end of production shift, all the instruments are immersed into a water bath. The concentration of chlorine is 0,5 to 1 ppm (Thi, et al., 2013). After that in the next production shift, the workers take these instruments dipping into the tank hot water 70ºC. During the continuing processing process, at every two-hour interval the workers clean their gloves and plastron under continuing stream of hot water or in a warm water bath. At the end of production process, the sanitary worker team belonging the company, clean everything by using soap, and use chlorine with concentration at 10 ppm to disinfect. They use scrapers, brushes and sweepers, flush pump, and pressure pump to clean floors, walls. The next day before starting production, the workers use clean water to clean everything again. These activities are under the strict monitor of QC staff.

b. Procedure of sampling the testing of microbiological

Most pangasius processing factories have their own laboratory with modern equipment and are accredited according to the ISO 17025 standard for laboratories. For the higher chemical testing indicators, they submit samples to an officially authorised laboratory for testing.

For each fish pond lot transported to the factory, the laboratory staff from the company will take samples of the whole fish before it is delivered to the factory to test residue chemicals and antibiotics. Samples are also taken of the filleted fish after skinning, trimming, treating with additives, and after freezing respectively with the pond lot to test microbial and chemicals. Each production shift takes samples of hands, skin, plastrons, and facemasks of the workers, of the instruments and equipment which contact directly with the fillet fish to test microbials. Especial priority is taken in the processing areas, where there is a lack of strict control. If the testing results indicate hazards in any steps, the representative of the laboratory department announces to the production director a temporary stop to that step and separation to resolve again the issues (Thi, et al., 2013).

7.1.3 Product recall and traceability

The operation of three competent authorities in pangasius industry posts regular updates publicly on the website to ensure recall and traceability if necessary. Monthly, the DAH takes randomly 4 to 5 samples of water and fish from each region for analysis. The results are sent to farmers about the disease status of fish by email, letter, and on the website (Khoi, 2011).

Before hatching fingerlings or grow-out farming, the D-FISH are surveyed to consider the appropriate action for farming operation. If these farms are satisfactory, they will be issued a certification with a unique code number for each farm with full of information about name of farmer, address location, and the phone number of farmers. This information will be updated on the intranet site and shared with the DAH and the NAFIQAD, so in case of recall or traceability identification can be traced to the pond level.

During the farming process, monthly the NAFIQAD province and the processing plant come down to the farm area to take samples for testing sensory assessment, flesh of the fish, skin for a parasite, and chemical compound analysis. All the results are recorded in the document and put on the computer system.

When the farmers sell fish to processors, declaration of sale is provided which proves the origin of fish and farm. They also provide full information along with farming operation including the farmer's name, address of pond, type of feed, date stocking fry in the pond, date of harvest, and weight of fish. This way, the processors can continue to keep track on the flow of the product in all the chains. All operations related to farming involve feeding, water quality analysis, fish disease monitoring, assessment to harvest are recorded in the fish farming logbook which correctly enters the time required. (UNIDO, 2013)

The activities of receiving of raw material and processing inside factory are controlled, monitored and inspected by the quality management department (UNIDO, 2013). The documentation of GMP and SSOP are recorded along with validation of the contracted farm. This information is validated and saved at the quality department for at least two years with the aim to help keep track of products on the market.

Before shipment to the market, the inspector of NAFIQAD comes to the processing establishment and reviews the document of the establishment and takes random samples of

each shipment for inspection. The testing indicators are both physical, such as weight, size, labelling, packing and sensory parameters such as texture, taste, and colour. They also test for microbiology indicators and residue of chemical substances on final products. If these indicators are satisfactory then the inspector certifies that the shipment is eligible for export.

Each shipment is labelled according to the market requirements and has a unique sequence of number (that also called code number). The sequence of numbers contains information on material batch, date and time production of shipment. The labelling is clearly to identify production condition, date of export, the ingredient of the product (percent of solution), producer address, certification or standard for farm and the product, and the product is safe to eat. Products are stored in cold storage separately from one another before shipping. All the information regarding shipment is saved as document at the quality department and on the company's computer. In this way traceability and recall is possible for each shipment.

7.2 Quality management

The quality of the product depends on the requirement of customer. The company get contracts from customers requesting specific indicators for product that they want to buy. The market demands are various, but the main quality relies on colour, texture, health of fish as regulated in the quality manual of the company.

The QC is responsible for the quality of product. They let the worker know how the specification of products should be. When the workers conduct grading quality, the QC stand next to them to monitor. Sometimes they take samples after the task is finished by workers to check it is correct according to requirements or not. They do that regularly. The results of the checks are recorded on GMP form.

Each company has an inspection team belonging to the QM department. Their duty is to control quality of shipment in storage. They also support inspector of NAFIQAD checking shipments that the company want to export. The inspection team take random samples of each shipment batch checking on texture, colour, bone, size of fish, weight of box, all the information indicated on the label should be correct according to the requirements of customer and production condition. If something wrong is found, they announce it for the person who is responsible for production to solve. They also write a report to make to ensure the production division have the correct action.

8. INTRODUCTION FISHERY SECTOR OF ICELAND

Fisheries in Iceland plays an important role in the country's economy. In the past, Iceland was one of the least developed countries in Europe which had many difficulties in disputes with other countries on their territorial water (Margeirsson, 2008). Today, Icelandic fisheries is one of the most developed systems in the world (Geirsson, 2011). The important catch fishing grounds are off the south western coast, off the Westfjords and off the south eastern coast. The fishing grounds of codfish are shown in the figure 8. The marine exclusive economic area increased from 25,000 km² before 1952 to 758,000 km² (Hameri & Jóhannes, 2003). Good management of the marine resources alongside applied innovation and technology in catching and processing and creation of an integrated system have all helped to shape this development. Fisheries accounted for 11% total GDP of the country in 2011 (Central Bank of Iceland,2012).

The fisheries sector provides jobs for around 7,800 (Statistics Iceland, 2017) people which accounts for nearly 4,5% of the total labour force (Fisheries R. , 2013). The marine sector is focused on development of high value species such as codfish and salmonid fish, the main products are fresh fish and smoked fish respectively of both species.

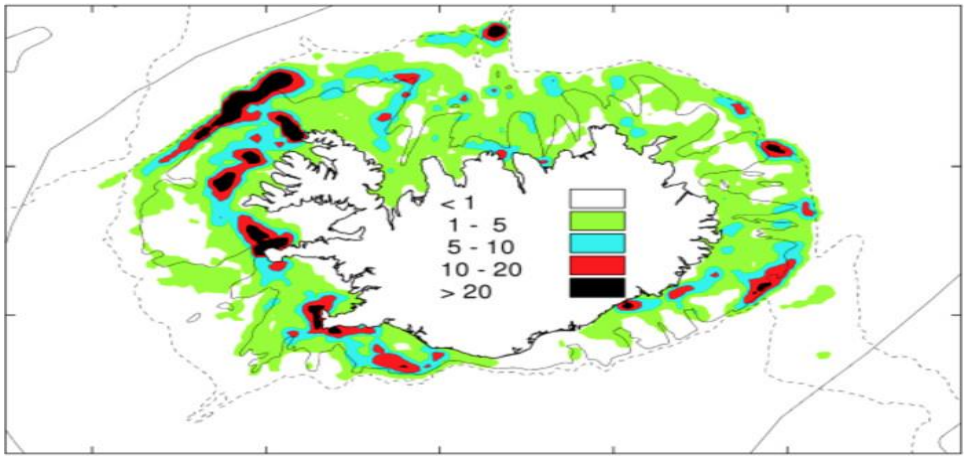

Figure 8: The fishing grounds of codfish in Iceland in 2017 (Marine Research Institute).

Through the application of modern information technology (IT) in fishing and processing there is a decrease in catch volume, however value continues to have a high increase (Bjarnason,2010).

Cod is one of the largest fish stocks in the North Atlantic. In figure 9, the total catch of codfish gained 26,798 tonnes in 2018 (Iceland, 2019). Export value of codfish reached 390 million USD (Statistics Iceland) (Holland, 2019), and accounted for about 44% of Iceland's total of marine production in 2018 (Statistics Iceland, 2018) (Fisheries I. R., 2019). The products are mainly exported to the European, US, and Japan markets (Hameri, A. P., & Pálsson, J. 2003).

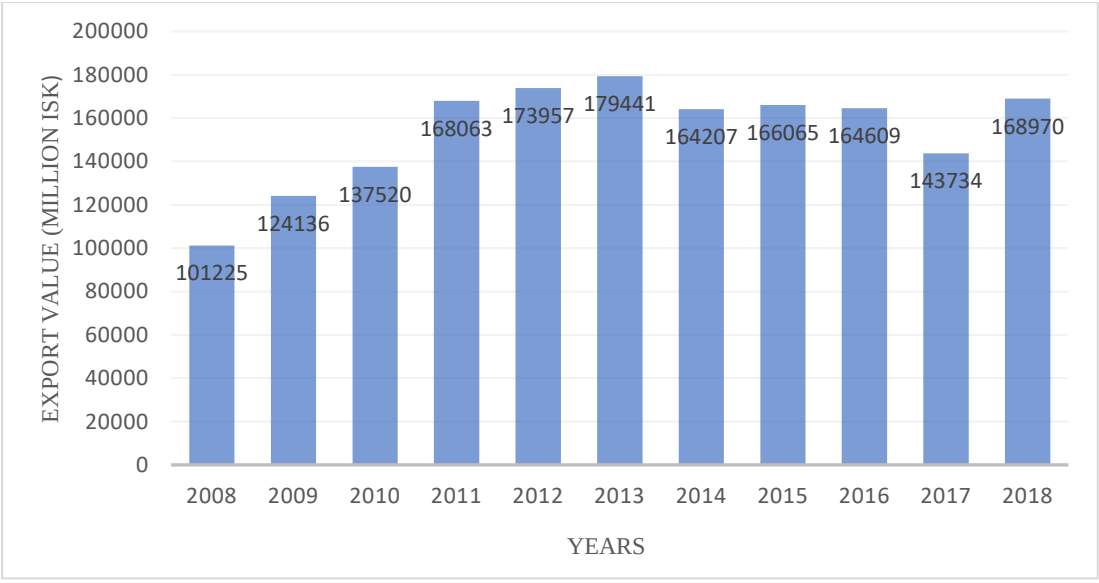

Figure 9: Total export value of fresh, chilled, frozen in Iceland from 2008 to 2018 *(Ridder, 2019)*.

9. COD FISH VALUE CHAIN IN ICELAND

The codfish in Iceland are exploited by two methods that are trawler and long-line. Both these methods are almost completely owned by the large processing companies, which are equipped with modern machine equipment such as radar used to locate the fish on the sea, electronic diaries are used to monitor and collect data during the process of catching the fish at sea (Geirsson, 2011). This way, companies can share information from the vessels to the processing plants, captains or fisheries authorities. Companies rely on this database to decide where to fish and how much and establish plans for processing each day.

When it is caught, the fish undergoes the first handling, including gutting and bleeding. The fish are stored in labeled tubs. The catch data are transmitted to the Fisheries Monitoring Centre via Vessel Monitoring System (VMS) by the satellite system every one or two hours each time (FAO, 2011). This ensures that vessels comply with requirements that limit volume allowed for export. The model of value chain in the codfish industry in Iceland is shown in figure 10.

Cod is typically landed 2-6 days after it is caught. Processing companies weigh and transport the fish to the processing area, which is equipped with machines to automatically head, fillet, and skin the fish. It is then further processed, depending on the quality standards for the end product. The fish may be individual quick frozen (IQF) or block frozen and then stored in a freezing storage. The entire process is connected to a computer system. The heads and bones removed from the fish are dried for export to Nigeria.

The price of cod has been rising due to consumer demands for quality fish products which are harvested in an environmentally friendly way. To supply fresh fish for the market, the processing companies have developed good control of volumes caught for processing each day.

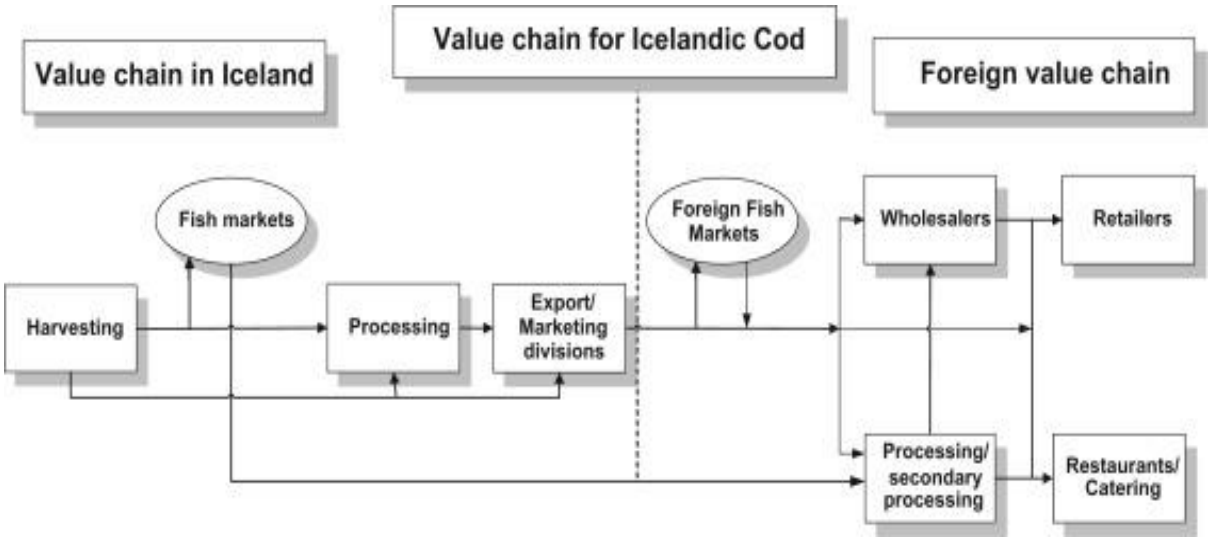

Figure 10: A value chain of codfish in Iceland *(Knútsson, Gestsson, & Kristófersson, 2015)*.

10. LEGAL FRAMEWORK IN ICELAND

The competent authority for the fishery sector in Iceland has promulgated many laws and regulations to ensure food safety and issues related to food safety for consumption from marine products. To ensure quality and safety of foodstuffs, on 28 June 1995, the Ministry for the

Environment promulgated Act no. 93/1995 which requires full labelling of information. All ingredients used in products and other information about operating production and distribution must be correct and satisfactory. On 28 January 2002, the European Parliament and the Council has promulgated Regulation No. 178/2002 which includes general principles and requirements of food law, established by the European Food Safety Authority on procedures concerned with food safety. Regarding food safety, there are also many Regulations and Acts such as Regulation (EC) No 852/2004 and 853/2004 on the hygiene of foodstuffs, Act no. 60/2006 on preventive measures against fish diseases, and Act no. 93/1994 on medicinal products, Act on hygiene and pollution control, No 7/1998. Iceland, being a part of the European Economic Zone, has enforced all European Regulations regarding food safety.

11. QUALITY MANAGEMENT SYSTEM OF COD FISH PROCESSING IN ICELAND

11.1 Food safety management

The company (Visir) has applied quality management standards to ensure food safety and food quality that follow the HACCP system, IFS Food version 6.1, MSC. The quality management in codfish processing facilities is based on the HACCP system.

11.1.1 Sanitary procedure as applied in codfish processing

The workers use single gloves, clean their hands with soap and disinfectant, dry by towel paper before they enter the factory. One challenge is that the complex machinery used in Icelandic processing facilities is difficult to clean. The workers clean machines using cool water and alkaline soap containing sodium hypochlorite (klov 15%). The machinery is then disinfected with Quaternary ammonium compounds (Alfaquat 30 000 ppm) overnight. The next day, before starting processing, the quality management team checks all the equipment and records the result on a hygiene monitoring form.

The quality management team takes samples on the surface in every location from receiving, filleting, heading, trimming and IQF areas to test for presence of ATP once a week according to the sanitary manual. Corrective actions are based on the following values of the ATP testing:

- Lower than 10: normal
- Between 10-30: caution, need to clean again.
- Over 30: False, need to clean again and retest.

11.1.2 Procedure of sampling the testing of microbiological

Iceland belongs to the European Vocational Training Association (EVTA) group, the procedure to take sample tests on microbials and chemicals are straightforward. In the company Visir, according to the sanitary manual there only take samples once per week. The samples are sent to laboratory in Iceland. They do not conduct microbial tests on the final product.

11.1.3 Product recall and traceability

Traceability system relies on code systems implemented by each company, there are three divisions with main responsibility for the information flow of product from raw material to consumption, that are QA Division, Sourcing Division and Logistic Division (LIU, 2002).

The QA Division is responsible for quality control of production activities and conducts inspection based on the EU and Iceland regulations and standards. QA records results and stores them on the computer system. The producers, customers, or inspection authority can access the system to get information on the status of the product. The information includes a description of the product, loading information, and packaging specifications.

The Sourcing Division provides an internet system to share information between producers and customers about ordering and shipping. With access to the system, the customer can track their shipment information and transport status. The Visir company owns seven vessels, all of them longlines. They use Trackwell software to monitor the vessels. Innova software is used to monitor from receiving raw material, processing, labelling, and distribution. Wise Fish is used for orders from the customer and invoices. All databases are saved on the system.

The Logistic Division is responsible for the distribution of the shipment. They receive the contracts from buyers through the internet system, collect information relevant to the shipment provided by QA Division on the computer system, submit to the competent authority to certify, and for planning to transport the shipment and the tracking process.

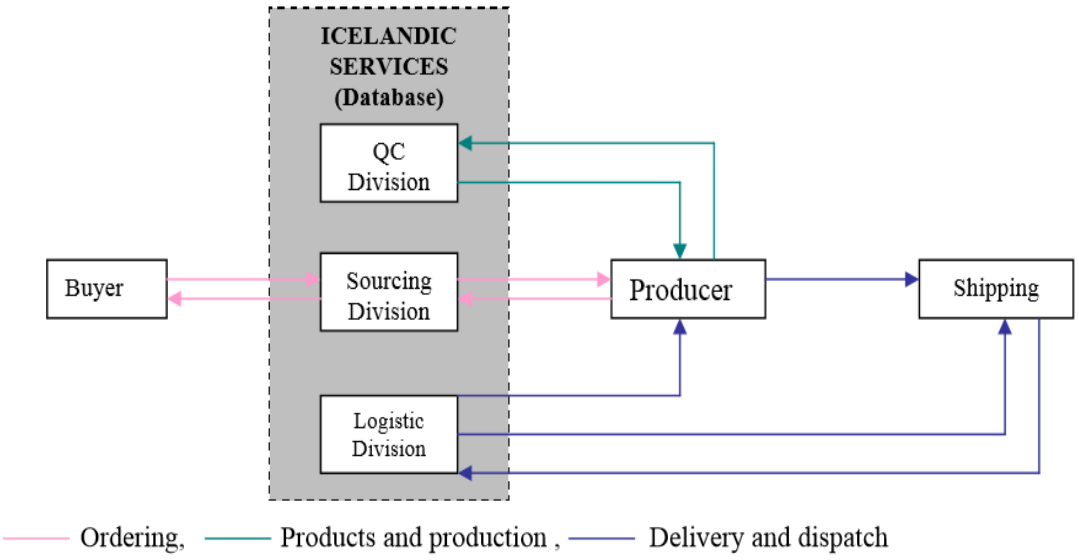

Figure 11: The information flow in Iceland Services *(LIU, 2002)*.

11.2 Quality control at the processing factory Visir

At the processing facilities a HACCP system has been set up to control the safety of products produced. The quality of products is controlled through advanced machinery and automatic systems that are connected to the Innova software. The data is linked throughout all steps. After landing, each tub has a label indicating the date of catch and name of the vessel. It is transported into the factory where the quality control staff get data from the vessel including the date of

receiving raw material, place catching, name of vessel, date own fish, the data is transferred into the Innova software.

The QC staff take the box on the final line to check weight, size, temperature, texture, bone, spot blood of the fish (as in table 2**)** and send the results from the screen of computer directly to the quality management as in figure 12.

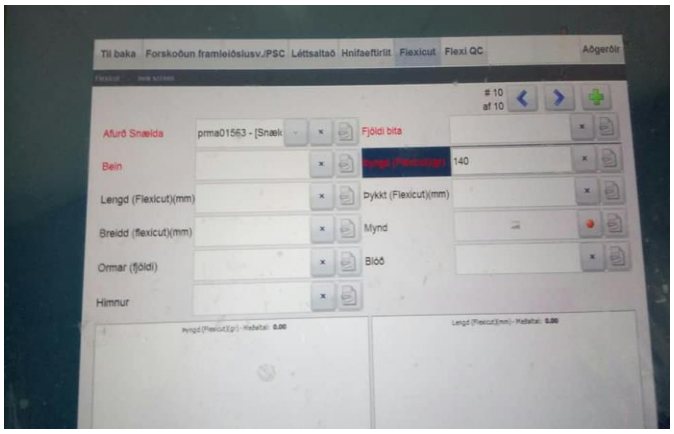

Figure 12: Quality control on Innova software.

At Visir, there are two X-ray machines which detect bones before cutting and weighing. This ensures no bones are in the finished product. After hand trimming, the fish go through the X-ray, if bone is detected (< 2mm) (as in figure 13) the flexi cut machine will cut off the defect and the X-ray machine contemporary sends a notification to the trimmer who is delivered the fish portion containing the bone.

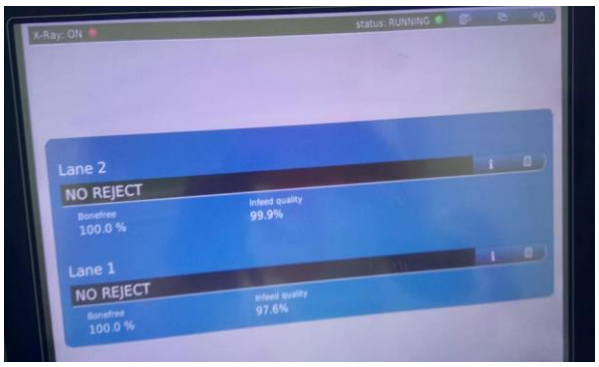

Figure 13: X-Ray control bones of the fish before sizing.

The total bones detected by the X- ray machine per day is shown for each worker on the trimming line (Table 3). Sizing and weighing are performed by robot. The quality control staff set up the qualifications of the products into the Innova software, which feeds the information to the robot sizing and weighs the portions and delivers exact portions.

Product	
Raw Material Areal	
Date and Time of production	
Grade	
Number of samples	
Weight of sample (kg)	
Lot Number	
Item	**Result**
Date	16.1.2020
Species	Cod
Catch method	Long line
Landing date	16.1.2020
Age of raw material	4 days
Quality raw material	Good
Taste testing	9,500
Good for human consumption	Yes
Raw material cooler	0,200
Processing area	8,4
Receiving area	-0,7
Temperature in IQF (spiral freezer)	-34,000
Filleting	0,9
Trimming	1,5
Packing	2,0
Before freezing	4,000
Freezing storage	-22,000

Table 2: Quality inspection in processing.

Name of workers	Intake (kg)	A-product (Output) (Kg)	B-product (Bone) (kg)	Time	Defects (kg)	Kg/hour
	108,3	106,2	2,2	00:30	1,67	214,8
	165,7	158,3	7,4	00:31	1,86	320,7
	86,5	80,2	6,3	00:31	2,50	162,4
	113,5	109,5	4,0	00:30	1,67	222,8
	128,3	118,5	9,8	00:34	2,07	221,8
	76,0	63,1	12,8	00:30	1,67	147,5
	102,1	96,7	5,4	00:31	1,74	196,3

Table 3: Form of quality inspection line on Innova software.

The time in processing before freezing is very short, or 2-5 minutes; the temperature of fish is always kept between 0-4ºC. Human contact with the product is very limited. Hence, the quality of fish (texture, smell) is high and microbial hazard is not significant.

12. DISCUSSION

Food safety management	Vietnam	Iceland (Visir)
HACCP	There are three critical control points in processing: receiving raw material, disease examination, metal detecting.	The company does not have critical control point, there are only control points that controlled during processing.
GMP	GMP is used to monitor the activities during processing and recorded as document.	GMP implemented by data collecting and connected at each step and saved on Innova software.
Sanitary procedure	Machine and equipment in pangasius processing is easy to clean. The workers have procedure clean their gloves, plastron, utensils (knife, cut board) every two hours.	Machine system in cod processing is complex to clean. The workers use single gloves which do not need cleaning during processing.
Procedure for sampling	The companies test samples are stringent and frequent.	The company's sample testing is very simple, just once per week.
Traceability and recall	The data collected and recorded as document will take more time to go through process.	The linking of database through software from the vessel, processing, and ordering is very convenient to monitor and traceable.

	Difficult to have an overview of production in real time.	
Food quality management	Controlled by QC staff working as a small group for each step. Inspection team responsible for quality of product in storage.	Checking by quality control and controlled by using software to connect data from each workstation.

Table 4: Comparison of quality management between Vietnam and Iceland.

12.1 Time and temperature in processing

The temperature in pangasius processing and cod processing is very different, due to different characteristics of both fish and input. The Visir company receives raw material that have been gutted and bled on the vessel and kept in ice at 0ºC or below the same as the temperature of the ambient environment, during processing the temperature is maintained at 1 to 4ºC. In pangasius company, the fish are received still alive, the water content is low, the fat content inside the flesh is high. During processing the temperature for fish handling from cutting to trimming is very wide range from 5 to 18 ºC. In tumbling and grading the maximum is 4ºC or below, in cooler is 1 to 4ºC.

The time for handling and processing in pangasius plants is longer than in Iceland (Visir). The average time from receiving to cooler is about 2 to 2.5 hours. While the time processing cods due to use of automatic production lines take average 10-15 minutes (before freezing), the temperature in the centre of the product was always kept at 0-4ºC. The temperature inside codfish processing area is 7 to 9ºC, while in pangasius processing is 18 to 20ºC.

12.2 Microbial contamination

The main cause for microbiological growth is poor temperature control. Moreover, microbes can contaminate, and cross contaminate from the environment around, humans who come in direct contact with the product, from gloves, plastron, surface of table, including utensils and knife, if there is a lack of strict hygiene and instruction of Good Manufacturing Practices (GMP).

Due to pangasius processing supplying ice manually, contrary to codfish processing where the time is short, so they do not need supply ice during processing. If in the filleting and trimming steps the control on temperature is not good this may be the cause of microbial growth.

12.3 Physical impact on product during processing

Pangasius processing plants in Vietnam operate manually, with workers in direct contact with the product during all stages of production. The product may be damaged by improper handling that can affect the product quality such as texture. Despite this, it does not mean that product

goes directly to customer as the wrong quality, but it is the challenge of losing costs that the company face.

At Visir, machines and low human contact with the product result in higher quality of end product. Table 5 show there is no broken texture of fish during processing in Visir.

Name of Worker	Number of Fillet	Worm	X-ray Bone	Spot Blood	Membrane	Broken Texture	Grade
	608	5	726	0	0	0	731
	511	0	610	0	0	0	610
	370	1	426	0	0	0	427
	25	0	32	0	0	0	32
	750	1	937	0	0	0	938
	31	0	33	0	0	0	33

Table 5: Quality management inspection.

12.4 Quality management/ control

The quality management of both the company in Iceland (Visir) and in Vietnam is under HACCP system. Control quality through GMP and SSOP (in Vietnam)/ hygiene procedure (in Iceland). The difference is due to the company in Iceland (Visir) applying automatic machine system and advance equipment. The GMP is implemented by the data collected and connected to every step and saved on Innova software. Because of this, the quality of the product is good and controlled from receiving raw material to final product in real time.

By using X-Ray and other advanced machines, the system connects between workstations to software on computer, analysed and sent directly with the exact result to the person who conducts the quality management. Based upon this, both of them know how many mistakes they have made, in that way quality management will have the correct action for training.

In Vietnam, there are many quality control staff at each step of production. The GMP is recorded by hand and saved as a physical document. The average number of workers working at each step in the factory compared between Iceland and Vietnam is shown in table 6. Specification of product is conducted by hand. The quality control depends on the workmanship of the worker, qualification, experience, and number of QC staff.

	Iceland (Visir)	Vietnam
Filleting	4	20
Skinning	4	2
Trimming + parasite examination	30	130
Sorting	0	12
Grading + sizing	4	82
Freezing	7	48

Table 6: Number of workers conduct directly on fish processing factory in Iceland and Vietnam.

12.5 Sanitary procedure

Sanitary procedures are the same for the company in Vietnam and Iceland (Visir) because the procedures both follow the requirements of the HACCP system.

Visir and two companies in Vietnam both have sanitary team working for the company. The machines and equipment in Visir are more complex and difficult to clean. The workers must use flush pump water and soap to clean. On the other hand, the equipment in the Vietnamese companies is easy to clean.

The Visir company uses Alfaquat 30 000 ppm for disinfection. Other disinfectants can be used, such as chlorine but that compound is highly corrosive and not good for expensive equipment.

At Visir, the workers at all stages take breaks at the same time, when they go out and go in, this means easily controllable hygiene. But in the company in Vietnam, the break timings are different according for each step, the sanitary QC who is responsible for the control of hygiene must oversee when people enter the processing area.

12.6 Sampling for microbial and chemical testing

The sampling procedure varies greatly between Vietnam and Iceland. Visir uses ATP to test on site. Microbial testing takes place once per week. Raw material is not tested before processing, and no chemical tests are conducted.

Although the company applies automation there are still workers touching the product directly without facemasks. This is a risk for microbial contamination. In the trimming step, the worker removes nematodes by hand on a candling table. It may not be possible to guarantee that all nematodes are removed in the trimming step and therefore the product may be unsafe if eaten raw.

The testing system in processing plants in Vietnam is stringent and frequent. The procedure for taking samples for disease and chemical antibiotics happens before receiving live fish. Samples are taken at each step when filleting, skinning, trimming and before and after fish freezing and on the raw material batch for microbial and chemical testing. Before transport to the market, the company and the NAFIQAD inspectors take samples to test depending on the requirements of the import market.

12.7 Traceability and product recall

In general, the procedures concerning traceability and product recall in the companies of both countries are the same. Almost all processing companies have their own vessels in Iceland and farms in Vietnam. This is important for tracking sources of the raw material. The linking database spanning the origin of fish to distribution is necessary to trace and recall products from the market when needed. A small difference is because the companies in Iceland use software the data is collected in real time.

Processing companies in Vietnam collect and document data at all steps in the supply chain with physical documentation rather than electronically. In this system, it takes more time to go through the process and can be difficult to get an overview from day to day of the production, which means slower reaction times when something goes wrong.

13. CONCLUSION

Both cod and pangasius companies have procedures to control the origin of fish from the sea or farm. In both cases, companies are proactive with regards to raw material sourcing from supply through processing. That is the first important step to ensure the possibility of keeping track of products throughout the whole supply chain.

The database collection and connection system throughout the entire value chain of the cod industry in Iceland has been working more efficiently and prevents mistakes in a timely manner which can occur at any stage. It is also efficient for the traceability and recall of products on the market.

The cod producers in Iceland own their vessels. By using software linking between the vessel, the processing and ordering stages, they have a tool to provide an overview during the processing process with real-time information. In Vietnam, the data is not connected between steps, which makes monitoring of production as it happens more difficult.

The quality and safety control systems in cod processing are performed under quality management by monitoring through computer system and through data collected from each workstation. While in pangasius processing there are many QC staff working as a small group for each step.

In Iceland, specifications of product can be controlled by using robots at the step related to technical requirements of the product, such as size of fish, weight of each box, bones, etc. Quality control staff set up the data on software with the parameters of the product required.

Sample-taking procedure for microbial testing in Iceland is simpler when compared to Vietnam. It has been observed that once innovative production lines are installed, and advanced machinery is applied, the hygiene problems become limited and control measures become simpler.

14. RECOMMENDATIONS

Researchers conducting microbiological tests in pangasius processing have shown that, E. coli was found in the filleting step from gloves, the surface of tables and knife contact with the product. But in the cooling and packing step this was not found (Thi, et al., 2013). The reason for that could be because when filleting takes place over a long time the temperature can increase and microbial contamination can grow, so:

- After the bleeding step, consider removing visceral prior, then wash fish in a tank of clean water containing salt, but the rinse concentration needs further research due microbial contamination from break in intestines.

- Increase frequency of washing of workers' gloves and utensils which are used for processing (knife, cutting board) at least for one hour under a hot continuous stream of water.

To improve the quality and safety of products, the necessity of implementing Good Manufacturing Practices (GMP) should be much more stringent and correctly performed to prevent contamination and cross-contamination during processing and ensure that the specifications of products are carried out correctly as required.

It is necessary to consider alternatives to using chlorine in favour of other organic disinfectants such as Peracetic acid and Ozon.

Use sensors to control temperature and supply ice or automatic chill system to keep the temperature of fish always stable in all steps of the processing.

Investment in machinery, technical automation used in the production line to shorten processing time, especially in the step requiring the exact specifications of the product.

Apply quality control software in processing to overview and monitor the operation of production in real-time. This also helps identify the mistakes that could happen and to solve any action that needs to be taken in a timely manner.

ACKNOWLEDGEMENTS

I would like to say thank you to my supervisor Mr. Margeir Gissurarson from Matis for his kindness, dedication, guidance, and support. Without him, this project would have been difficult to finish.

I especially acknowledge Mrs. Margrét Kristín Pétursdóttir and her co-workers in the Visir company. Thanks for their kindly reception, patient explanations to my questionnaires and for giving me the chance to develop a deep understanding of advanced machine systems in the field of quality control. In addition, many thanks to Geir Þráinsson and Asgeir Benediktsson at Marel for the help on Innova software.

I am deeply grateful to Tumi Tómasson and Bjarni Eiríksson for giving me a chance to join this course. I particularly grateful to Thor Asgeirsson, Mary Frances Davidson, Beata Wawiernia for pointing me on the path towards improvement and for accompany us on this six-month journey. I also want to say thank to Julie Ingham for supporting me with accommodation and resolving finance issues.

I thank the lecturers from UNESCO-FTP and Matis for communicating knowledge and giving me valuable lessons. Thanks to the library staff, computer service staff, UNESCO-FTP fellows for their help and encouragement during my stay in Iceland.

REFERENCES

Alli, I. (2004). food quality assurance. CRC.

Attaie, H., & Olivier , F. (2003). *Guidelines for value chain analysis in the agri-food sector of transitional and developing economies.* Rome: FAO.

Authority, E. S. (2017). *Competent authority control systems in the areas of food and feed safety, animal health and animal welfare.* Brussels.

Binh, T. V., Marijke , D., Stijn , S., & Luc D'Haese. (2010). *The Influence of Changes in the Market Environment on Economic Production* . Ghent : Ghent University.

Bremner, H. A. (2002). *Safety and quality issues in fish processing.* Cambridge: Woodhead Publishing Limited .

Duijn, A. P., Rik , B., & Willem , P. v. (2012). *The Vietnamese seafood sector A value chain analysis.* The Netherlands : CBI .

EFTA. (2017). *Competent authority control systems in the areas of food and feed safety, animal health and animal welfare.* Brussels: EFTA SURVEILLANCE, AUTHORITY.

EUR-LEX. (2002, January 28). *Access to European Union law*. Retrieved from eur-lex.europa.eu: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32002R0178

EUR-LEX.europa. (n.d.). *Access to European Union law*. Retrieved from eur-lex.europa.eu: https://eur-lex.europa.eu/eli/reg/2004/852/2009-04-20

FAO. (2010). *Fisheries and aquaculture department*. Retrieved from www.fao.org/fishery/culturedspecies/Pangasius_hypophthalmus/en

FAO. (2013). *All FAO VCA-tool* . Retrieved from www.fao.org: http://www.fao.org/docs/up/easypol/432/value_chain_analysis-brochure-e-version.pdf

fisheries, I. r. (2019). *Export statistics*. Retrieved from Iceland responsible fisheries: https://www.responsiblefisheries.is/seafood-industry/export-statistics

Fisheries, R. (2013, Septemper 30). *Icelandic Fisheries*. Retrieved from Iceland.is: https://www.iceland.is/files/icelandic-fisheries-press-kit-enska-30-sept-2013.pdf

Geirsson, G. (2011). *Case study of the Iceland integrated system for monitoring, control and surveillance.* Rome: FAO Fisheries and Aquaculture .

Genschick, S. (2011). *Pangasius at risk gorvernance in farming and processing and the role of different capacity.* Bonn: University of Bonn.

Gudmundsson, E., Frank, A., & Nielsen , M. (2006). *Revenue Distribution Through The Seafood Value Chain.* Rome: FAO Fisheries Circular No. 1019.

H.H.Huss, L.Ababouch, & L.Gram. (2014). *Assessment and management of seafood safety and quali ity Assessment and management of seafood safety and.* Rome: FAO.

Hameri, A.-P., & Jóhannes, P. (2003). International Journal of Logistics: Research and Applications.

Holland, J. (2019, July 16). *Iceland exports more seafood, earnings increase* . Retrieved from seafoodsource: https://www.seafoodsource.com/news/supply-trade/iceland-exports-more-seafood-earnings-increase

HÞV, E. (2019). *Cod*. Retrieved from Sea.Iceland: https://seaiceland.is/what/fish/codfishes/cod

Hussain, M. M. (1997). *Quality control and marketing of fish and fish products: needs for infrastructure and legal support.* Rome: FAO.

Iceland, s. (2019, November 15). *Fish catch in October was 92 thousand tonnes*. Retrieved from statistics Iceland: https://www.statice.is/publications/news-archive/fisheries/fish-catch-in-october-2019/

IfM, C. (2019). *Management Technology policy*. Retrieved from www.ifm.eng.cam.ac.uk: https://www.ifm.eng.cam.ac.uk/research/dstools/value-chain-/

Japanese. (2008, June 5th). *Guidelines on Hygiene Control of Import Processed Foods*. Retrieved from Guidelines on Hygiene Control of Import Processed Foods: https://www.mhlw.go.jp/english/topics/importedfoods/guideline/01.html

Jo, K. B. (2009). *Review of food safety assurance and application of HACCP in prodcution of sea frozen squid in DPR of Krorea.* Reykjavik: UNU-FTP.

Khoi, L. N. (2009). *Quality standards for fish supply chains : the case of organic Pangasius in the Mekong River Delta, Vietnam* . Can Tho : Can Tho University.

Khoi, L. N. (2011). *Quality management in the Pangasius export supply chain in Vietnam.* Groningen: SOM research school.

Khoi, L. N. (2017). Can Tho: Can Tho University.

Lai, T. P., Pham, T. N., Nguyen , T. T., Duong , T. L., & Pham , V. T. (2009). *Summary report.* Hanoi: Fisheries Subsidies, Supply chain and certification in Vietnam.

Land Information Authority Act, 2006 (Act No. 60 of 2006). (2010). Retrieved from www.informea.org: https://www.informea.org/en/legislation/land-information-authority-act-2006-act-no-60-2006

LIU, J. (2002). *Investigation on traceability of fish products in Iceland- a traceability study for fish processing industry in China.* Reykjavik: UNU-FTP.

LLC, V. (2019). *Basics of HACCP and Prerequisite Programs.* 22000-tools.com.

Margeirsson, S. (2008). *Processing forecast of cod.* Reykjavik: University of Iceland.

Margeirsson, S. (2009). *Processing forecast of cod.* Reykjavik: University of Iceland.

MAST. (2019). *The Icelandic Food and Veterinary Authority (MAST) Fields of work and legal basis.* Retrieved from www.mast.is: https://www.mast.is/static/files/library/Fræðsluefni/Fields_of_work_and_legal_basis.pdf

Ministry of Health, L. a. (2008, June 5th). *Guidelines on Hygiene Control of Import Processed Foods.* Retrieved from go.jp: https://www.mhlw.go.jp/english/topics/importedfoods/guideline/01.html

NedaTrifković. (2014). *Certified standards and vertical coordination in aquaculture: The case of pangasius from Vietnam.* Copenhagen: University of Copenhagen.

Nguyen, Tram Anh Thi; Nguyen, Thien Chuong Phuc Bui ; Jolly, Curtis M;. (2017). *Food Safety and Vietnam EU Pangasius strategy* . NhaTrang : Nha Trang University.

ÖgmundurKnútsson, Daði, M., & Helgi, G. (2015). The effects of fisheries management on the Icelandic demersal fish value chain. *ELSEVIER, Ltd*, 714.

RASFF. (2018). *Annual report 2018.* The Rapid Alert System for Food and Feed .

responsibleFisheries. (2013). *IcelandIc FIsherIes*. Retrieved from responsibleFisheries.is: https://www.iceland.is/files/icelandic-fisheries-press-kit-enska-30-sept-2013.pdf

Ridder, M. (2019 , Aug 27). *Export value of fresh, chilled or frozen fish from Iceland from 2008 to 2018*. Retrieved from www.statista.com: https://www.statista.com/statistics/606564/export-value-of-fresh-chilled-or-frozen-fish-from-iceland/

Sanh, N. V., & Tu , B. V. (2011). Aquaculture Market and Development Strategy: The Case of Pangasius in the Mekong Delta, Vietnam. *Journal of Economics and Development*.

Sven Genschick. (2011). *Pangasius at risk gorvernance in farming and processing, and the role of different capacity.* Bonn: University of Bonn.

Thi, A. N., Bert , N., Sibarashe, S., Nguyen , B. L., Katrien , B., Geertrui , R., . . . Frank, D. (2013). *Microbial ecology of Vietnamese Tra*, 145.

Thong, N. T. (2018). *International seafood trade: The global value chain of pangasius.* Denmark.

Tra, L. T. (2014). *Pangasius 26 Q & A* . Ha Noi: Agricultural Publishing House.

UKESSAYS. (2017, April 24th). *UKESSAYS*. Retrieved from https://www.ukessays.com: https://www.ukessays.com/essays/management/the-concept-of-the-value-chain-management-essay.php

UNIDO. (2013). *Meeting Standards, Winning Markets Regional Trade Standards Compliance Report* . UNIDO.

UNIDO. (2015). *Seafood industry in Vietnam.* Austria: UNIDO.

vanbanphapluat. (2013, November 12). *circular-48-2013-tt-bnnptnt-inspection-certification-safety-fishery-food-products-export*. Retrieved from vanbanphapluat.co:

https://vanbanphapluat.co/circular-48-2013-tt-bnnptnt-inspection-certification-safety-fishery-food-products-export

vanbanphapluat. (2007, november 21). *law-no-05-2007-QH12 product-and-goods-quality*. Retrieved from vanbanphapluat.co: https://vanbanphapluat.co/law-no-05-2007-qh12-of-november-21-2007-on-product-and-goods-quality

vanbanphapluat. (2016, June 1). *circular-10-2016-tt-bnnptnt-list-veterinary-drugs-permitted-marketed-banned-hs-codes-veterinary-drugs*. Retrieved from vanbanphapluat.co: https://vanbanphapluat.co/circular-10-2016-tt-bnnptnt-list-veterinary-drugs-permitted-marketed-banned-hs-codes-veterinary-drugs

VASEP. (2014). Pangasius 26 Q & A . Hanoi: Agricultural Publishing House .

VASEP. (2018). *Overview of seafood industry in Vietnam*. Retrieved from Vietnam Association of Seafood Exporters and Producers: http://vasep.com.vn/1192/OneContent/tong-quan-nganh.htm

VASEP. (2018). *Vietnam Association of Seafood Exporters and Producers*. Retrieved from Characteristics of the sector: seafood.vasep.com.vn/673/onecontent/sector-profiles.htm

VASEP. (2019). Retrieved from seafood.vasep.com.vn/

VNS. (2019, January 21). *Pangasius firms fishing for markets*. Retrieved from vietnamnews.vn: https://vietnamnews.vn/economy/484127/pangasius-firms-fishing-for-markets.html#r4u1BTzxK22GZtc3.97

WHO. (2019, June 4). *Food safety*. Retrieved from World health organization: https://www.who.int/news-room/fact-sheets/detail/food-safety

Wolf, M. (2013). *Iceland' Integration Into The Common Fisheries of The European Union.* Reykjavik: Reykjavik University.