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ASSESSMENT OF THE "FULL" UTILIZATION OF HAKE REST RAW MATERIAL IN NAMIBIA

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ABSTRACT

The Namibian 5th National Development Plan goal for the fisheries sector is to increase value addition and maximise economic returns from marine resources. With limited fish stocks, it is important to maximise utilisation of the catch, by considering processing rest raw material. Possibilities for utilisation of rest raw material are arising in various countries (Kim, 2014). This study is therefore aimed at identifying the potential possibilities of the underutilised and wasted raw material and describing management tools that support economic gains from RRM. An analysis was done to identify the influencing factors of the Icelandic cod fishery's full utilisation and it was compared to that of the Namibian hake. Data was gathered on the current level of utilisation of the hake industry in Namibia and Icelandic cod for the purpose of comparative analysis. The research revealed that the Namibian hake fishing industry utilises about 70% of the whole hake, and that the hake fishery lacks some influencing factors which seem to support the full utilisation mechanism, such as fisheries management system, technology, clusters, research and development. The study, therefore, suggests that there is a need to get a "fuller" picture of current utilisation in the Namibian hake fishery. In addition, a need for enquiry from the fishing industry on whether they are aware of the value of byproduct, and if so, whether they are putting rest raw materials into the most valuable by-products.

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ACCRONYMS

MFMR	Ministry of Fisheries and Marine Resources
FMS	Fisheries Management System
ITQ	Individual Transferable Quota
IQ	Individual Quota
TAC	Total Allowable Catch
GDP	Gross Domestic Product
NSA	Namibian Statistics Agency
NPC	National Planning Commission
EEZ	Exclusive Economic Zone
ICSEAF	International Commission for Southeast Atlantic Fisheries
MCS	Monitoring Control Surveillance
IUU	Illegal Unreported Unregulated
FJS	Fisheries Judicial System
ICES	International Council for the Exploration of the Sea
MFRI	Marine Fresh Water Institute
MSC	Marine stewardship Council
ISK	Icelandic Krona
RRM	Rest Raw Materials
R&D	Research and Development
FAO	Food and Agriculture Organisation
FOB	Free on board

1. INTRODUCTION

The fisheries sector plays an important role in the socioeconomic wellness and development of Namibia. It is a major income and employment generator and also a rich source of nutritious food security. In addition, fisheries also contribute to the economic development of coastal towns. The hake fishery is one of the most valuable fisheries in Namibia. This fishery is the largest provider of employment in the fishing industry and generates a considerable amount of foreign currency. Considering the youth unemployment rate which is at 46% (NSA, 2018), it is important for Namibia to consider managing this fishery with management tools towards a more economically feasible full utilisation. A decline in the hake stock would seriously affect the industry, the level of employment and economic benefits to Namibians (MFMR, 2011-2014).

Hake is an industrial fishery with both onshore processing facilities and the TAC is spilt into 70% onshore and 30% offshore. The fishery uses two types of fishing methods to catch the quota: bottom trawling and long lining. Catches are landed as frozen or wet at the two ports, Walvis Bay and Lüderitz's (MFMR, 2015/16).

Since independence in 1990, significant developments have been made in the Namibian fishing industry, aimed at Namibianization, developing onshore processing, meeting international seafood safety standard requirements, ensuring access to major markets such as the European Union, investments and creating employment (MFMR, 2007). The industry has matured significantly in this time, and a present day visit to some of the factories, would reveal a variety of high-quality products being produced.

The Ministry of Fisheries and Marine Resources (MFMR) has put forward a criterion for value addition to promote further onshore processing in order to create employment and increase investments, with emphasis on the number of value-added products, volume and prices. There is, however, no strategy in place for "no waste" or to advocate fuller utilisation.

The main aim of the "Growth at Home Strategy" is to broaden Namibia's economic base and to reduce its economic dependence on a narrow range of products, as that is a vulnerability for the industry. A broader range of products should improve the competitiveness of companies and provide opportunity for the expansion of the fishing industry. (In developed markets, consumers more and more prefer partially prepared products and ready-to-eat meals, rather than raw products). Also, there has been an emphasis towards utilisation of all fish RRM to maximise value (MFMR, 2007). Namibia could take advantage of this opportunity and increase utilisation of all fish raw material, processing it into a wide range of valuable products to increase the industry's value addition and bring more benefits from ocean resources to Namibia (MITSMED, 2017).

The aim of the study is therefore to identify the potential possibilities of the underutilised and waste raw material and describe governance contexts that support economic gains from RRM. This project attempts to point to the resulting benefits, such as jobs creation and increased value of Namibian products, both of which will have a positive impact on economic growth. The study will also address the Namibian 5th National Development Goal on the blue economy (2017-2022) to maximise economic benefits from marine resources.

1.1 Purpose and objectives of the study

Current utilisation of hake, about 54% of the body mass is for human consumption, 16% fish meal and 30% discarded as waste. Primarily, the value-added products are hake fillets, steaks, and loins. Rest Raw Materials (RRMs) that goes for fish meal are fins, tails, bones, collars, and broken hake. The parts of the hake fish discarded as waste are, heads, livers, intestines, and stomach.

Since fish stocks are limited resources, it becomes important to maximise the value of the catch by producing higher-priced products from raw materials. This also results in additional economic, nutritional, and environmental value of the utilisation (Arason, 2003). The system of governance could provide appropriate measures, strategies, and technologies to create incentives for full utilisation of the whole fish body, this includes increased processing of valuable by-products from the rest raw materials that currently go to fish meal or waste.

The study focuses on possibilities for the Namibian hake fishery to fully utilise the catch. Future fisheries policy or hake management plans could then possibly be amended to encourage the full utilisation of the hake fishery resource in Namibia. The specific objectives of the study were to:

i) Analyse the current utilisation of hake RRM in Namibia

ii) Identify processing possibilities of hake RRM for better utilisation

iii) Describe management tools that support economic gains from full utilisation of the fish resource

In order to identify the possibilities for the Namibian fisheries for "full" utilisation of hake, the study presents an overview of the fisheries and fish industry in Iceland. Which is considered one of the leading fishing nations in the world with advanced fisheries technologies and fisheries management system that seems to have proven successful (Matis, 2016). Iceland and its fishing industry have adopted a policy with an aim of maximum utilisation of the fish catch and seems to have proven results. This is especially true for the Icelandic cod fishery, which is used as a benchmark for the study.

1.2 Methodology and structure of the project

A qualitative approach is adopted to describe and analyse the level of utilisation of rest raw material of the hake fishery in Namibia and discuss possible ways to fully utilise this species.

The study is carried out as a research-based project consisting of theoretical and empirical literature based on secondary and primary data to meet the stated objectives. Theoretical background was conducted as a literature study based on the problem statement and research objectives. Literature reviewed is from published and unpublished reports, journals, articles, books and government documents, data basis and statistical units of government bodies.

Secondary data from the Icelandic government statistics database (https://statice.is/) and technical reports were utilised to make a comparative analysis between the utilisation of RRMs for Icelandic cod. In addition, an influencing factor analysis that promoted the full utilisation in Iceland was compared to Namibia.

Primary data is collected to determine, analyse and asses the volumes of hake RRM utilisation in Namibia. These data were collected from three hake processing companies in Namibia.

The study is organised as follows: A brief introduction, objectives and methodology in chapter one followed by an overview, management system and catch performance of the hake fishery in chapter two. Chapter three provides a general overview on the utilisation of rest raw material. Chapter four expands on chapter three discussing the Icelandic level of utilisation with practical advances in utilisation of rest raw material as byproducts. Chapter five looks into the hake catch utilisation in Namibia. Chapter six discuses findings on the current hake level of utilisation and possibilities in increasing the utilisation. Chapter seven provides discussions of the main influencing factors for full utilisation. Followed by chapter eight with the conclusion then the acknowledgments in chapter nine and finally, references in chapter ten.

2. THE HAKE FISHERY

Two species hake, the Cape hake (*M. capensis*) and the deep-water hake (*M. paradoxus*) (figure 1) are assessed as a combined stock, as the commercial catch data does not distinguish the two species (Kathena, Nielsen, Thygesen & Berg, 2016). The two species are found on the continental shelf in Namibian waters. Cape hake is usually at depths of about 100 m to 350 m, overlapping with the shallow end of the distribution range of deep-water hake, which occurs mainly at depths of 300 m to 600 m. Both species are found in both Namibian and South African waters and the degree of stock separation, if any, is unclear (MFMR, 2014).

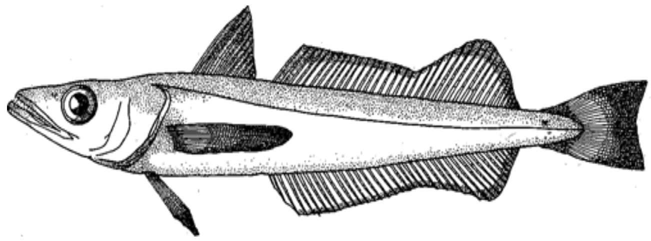

Figure 1. Namibian hake (*Merluccius capensis*) and (*Merluccius paradoxus)*

The main food items for hake, based on stomach content studies, are planktonic crustaceans (euphausiids and decapods), cephalopods and fishes (mainly myctophidae, gobidae, horse mackerel and, due to overlap in space, juvenile hake are also prey for *M. capensis*). The effects of predation on the hake stocks are largely unknown (MFMR, 2017/18).

Cape hake spawning occurs throughout the year, although the main spawning period is between July and October, the latter is declared a closure month (Kathena, Nielsen, Thygesen & Berg, 2016). Spawning takes place in demersal and mesopelagic zones, peaking offshore between 100 and 400 m depending on environmental conditions (cross-shelf circulation, low oxygen layers, mesoscale gyres) (Sundby, 2001).

Cape hake may grow to a maximum length of 113 cm and the deep-water hake is around 102 cm. These species grow at different rates and both species may live up to 12 years. Males mature earlier than females in both species and have a lower average maximum length and a higher growth rate. The hake fishing season is from September to November and harvesting is controlled by Total Allowable Catch (TAC) which is divided into freezer and a wet quota allocation (MFMR, 2017/18).

An important aspect of the current approach to stock assessment is that the two hake species are treated as a single stock since separate data for the two species has only been collected during research surveys since 1990. Catch, and hence the commercial catch rate data, is not differentiated between the two species, although the proportion of each species, and their length frequency, has been recorded from sampled catches by on-board fisheries observers since 1997. Given that growth and maturity rates are significantly different for the two species this is far from ideal (MFMR, 2017/18).

After Namibian independence in 1990, the implementation of the fisheries management regime was aimed at rebuilding the depleted fisheries stock. The TAC for hake was set at a low level of about 60,000 tonnes, to help rebuild the heavily depleted stocks. Since then the TAC allocation has been increasing gradually as shown in figure 3 below.

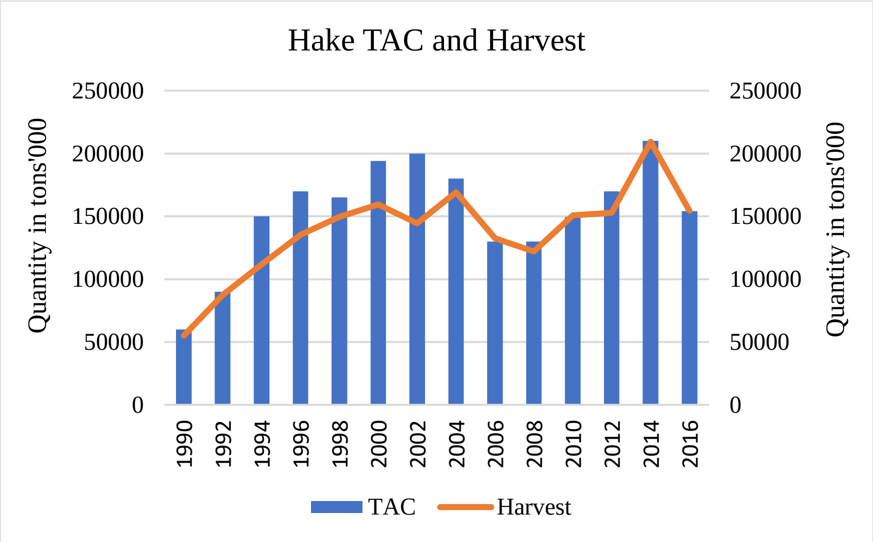

Figure 2. Hake TAC and Catches from 1990-2016 *(MFMR, 2014)*

It is evident from the figure that for more than a decade, the industry was not able to catch its total quota. This may have been due to a variety of factors such as environmental conditions or the limited hake stock as its one of the most valuable fish species in the Namibian EEZ.

2.1 Hake Management Regime

The hake fishery is subject to a total allowable catch (TAC) for each fishing year. The management of the hake fishery further consists of a combination of exploitation rights, individual quotas (IQs[1]), various fees, levies, technical measures, and an enforcement system of comprehensive monitoring, control, and surveillance (MCS system, see below). Rights are issued for different terms, ranging from seven to twenty years, depending on specific factors stipulated in the Marine Resources Act of 2000. There are currently 94 Namibian right holders in the fishery (MFMR, 2014).

[1] Individual non-transferable Quota system

Total Allowable Catch (TAC)
TACs are set at a level to ensure sustainability of the fishery. These are determined annually considering a comprehensive scientific assessment of the state of the stocks and the economic performance of the sub-sector. The Marine Resources Advisory Council as per the Marine Resources Act No. 27 of 2000 provides advice on the level of TAC to the Minister in this regard (MFMR, 2014).

Individua Quota (IQ)
Individual quotas are portions of the TAC allocated by MFMR to ensure economic viability of the fishing industry. Right holders are required to apply for these quotas on an annual basis and are thus allocated for the duration of the fishing season. To facilitate increased economies of scale, right holders enter into catch arrangements to utilise the quotas. It is important to note that the right holders to whom the quota is allocated remain liable for all fees and levies associated with the quota (MFMR, 2014).

Fees and Levies
Quota holders must pay quota fees, observer fees, fund levies and licences fees for the quota allocated which must be paid regardless of whether the fish that the quota allots is caught or not. This should encourage quota holders to make full use of their allocated quota (MFMR, 2014).

Monitoring Control and Surveillance
The government has invested considerable effort in this system, and it has proved effective and resulted in preventing illegal, unreported and unregulated (IUU) fishing activities in Namibian waters. The success of stopping illegal fishing is due to the capability of controlling its ports to prevent landing of illegally caught fish, but also in monitoring the transhipments of illegally caught fish through ports (Pramond & Pitcher, 2006). The Namibian MCS covers all four dimensions of the system: air, land, sea, and remote sensing.

2.2 Catch performance

The hake fishing fleet consists of three different type of vessels, freezer trawlers (24 – 73 m length) which have processing facilities onboard, wet-fish trawlers (23 – 70m length) land their catches for further processing on-shore and long-line vessels (19-42 m length) target larger fish which are exported fresh to European markets (MFMR, 2017/18).

On-shore processing in hake is encouraged through the 70:30 policy. This implies that 70% of the TAC is to be landed as wet for on-shore processing and 30% as freezer for off-shore processing. (MFMR, 2015/16). This has led to an increase in the number of white fish processing facilities. As of 2017, there is a total of 13, with 9 in Walvis Bay and 4 in Lüderitz. The hake fishery employs about 10,000 people that makes up almost 63% of the total fisheries sector employment (MFMR, 2017/18). Figure 2 shows the employment trend of the hake sub-sector of over a decade. The increase in employment on 2009/10 may have been as a result of a new land-based processing plants that opened at the time.

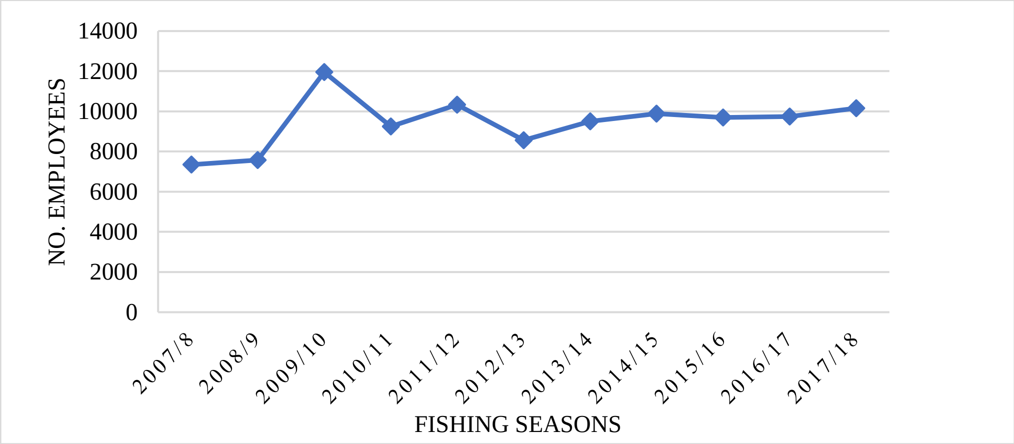

Figure 3. Employment in the hake sector 2007/8-2017/18

3. FULL UTILIZATION OF REST RAW MATERIAL

Post-harvest handling, processing, and transporting of fish is very important as the production of high-quality fresh fish depends on it. Post-harvest losses are mostly dominant in small-scale/artisanal fisheries of developing countries (Andrews, 2016). It is however a different case for the Namibian hake fishery as it is entirely industrial though the rest raw materials produced from the processing activities are not being utilised optimally, thus leading to the production of waste. Some of them contain organic substances that may cause environmental problems when not treated properly. When rest raw materials are not utilised to produce a product having economical value, they can be classified as waste. Moreover, it is essential for fishing industries to optimise their products and performance efficiency, for them to be able to compete in the global market (Irianto , Dewi , & Giya, 2014).

The fish processing industries worldwide generate significant amounts of rest raw material and waste, consisting of skin, viscera, heads and cut-offs. There is a difference between the terms rest raw material and waste. Rest raw material are products that are not regarded as ordinary saleable products (fillet, round, gutted or headed fish), but which can be recycled after processing. Waste is any product that cannot be used for feed or value-added products, and has to be buried, burned or destroyed (Rustad, 2003).

Historically, fish rest raw material (RRM) were considered low value and were disposed in the most convenient way. In many countries, importance is placed on the possibilities for further utilisation of RRM, from aquaculture as well as traditional fisheries (Kim, 2014)

In fish processing such as filleting, rest raw materials (RRMs), like heads, frames and off-cuts, may constitutes up to 70% of the catch (Olsen,Toppe & Karunasagar, 2014). In the past, these RRMs were often thrown away as waste or used as very low value products, such as feed for aquaculture, livestock, pets or used in silage and fertilisers where the value creation is relatively low. Apart from the traditional use of rest raw material, as feed ingredients like fishmeal, fish protein concentrates and fish oil, other uses have been gaining attention over the past two decades, as they represent a significant source of nutrition and can now be used more efficiently as a result of improved processing technologies (FAO, 2018). Many seafood producers welcome the increased focus on the rest raw material utilisation, recognising the possibilities for value added production and alternative use of rest raw material and waste. This will not only increase the economy of the sea food industry, but also strengthen the society and increase establishment of high-tech jobs (Jónsson & Viðarsson , 2016).

According to FAO, from an economic and nutritional point of view, rest raw material should not be wasted. For the reason that, they often have a higher nutritional value than fillets, in terms of essential fatty acids, vitamins and minerals, and can constitute an excellent means of combating micronutrient deficiencies in developing countries (FAO, 2014).

The need to use more of the rest raw materials for human consumption will demand that this raw material is treated as a potentially valuable by-product starting onboard the fishing boat or at the processing plant, resulting in rapid sorting and storage/preservation or processing into bulk products for later processing. There is also a need for national and international authorities to provide incentives or fines aimed at preventing this valuable raw material from being wasted (Rustad, 2007).

Fish RRM can be used for a wide range of purposes. Heads, frames and fillet cut-offs and skin may be used directly as food or processed into fish sausages, cakes, snacks (crispy snacks, nuggets, biscuits, pies), gelatin, sauces and other products for human consumption (FAO, 2018). Fish is a rich source of easily digestible protein that also provides polyunsaturated fatty acids, vitamins, and minerals for human nutrition. The amino acid composition and digestibility of fish proteins is excellent. It is a challenge both to increase the utilisation of the protein fractions from marine rest raw material and to use more of these valuable proteins as food ingredients (Venugopal & Shahidi, 1995).

4. FULL UTILISATION MODEL

4.2 Iceland Fisheries Management System

Management objectives and principles for Icelandic fisheries have been established under the legal framework of the Fisheries Management Act.[2] The main objective of fisheries management in Iceland is to promote conservation and efficient utilisation, thereby ensuring stable employment and settlement throughout the country (Icelandic Fisheries, 2006).

Quota systems were introduced in Icelandic fisheries in the 1970s and 80s following an increasing number of fishing vessels and declining fish stocks. Prior to implementing vessel quotas, Iceland tried out a wide range of alternative fisheries management systems. These included access licenses, fishing effort restrictions, investment controls and vessel buy-back programs, all of which were found to be unsatisfactory. After the extension of the exclusive 200-mile zone in the 1970s, an IQ (individual quota) system was firstly introduced in the herring fishery in 1975 and transformed into a fully-fledged ITQ system in 1979. Then an IQ system was further introduced in the capelin fishery in 1980 and turned into an ITQ system 1986. In 1984, an IQ system for larger vessels, was introduced in the demersal fisheries (small vessels under 10 GRT (gross registered tones) were exempted). In 1991, a complete ITQ system was adopted in all Icelandic fisheries that are subject to a TAC, applying to all vessels above a

[2] The current Fisheries Management Act was approved in parliament in 1990 and came into effect in 1991. The Act was rewritten to account for all amendments to it in 2006.

certain minimum size. Since 2004, the ITQ system was extended to cover all commercial fishing vessels (Arnason, 2008; Arnason , 1996).

The exploitation of commercial marine fish species is regulated under a system of tradable catch-quotas which are allocated to individual vessels (ITQs, Individual Transferable Quotas). These quotas assign a right to catch a specific proportion of the annual TAC of a specific species each year. The quotas can be bought and sold freely. Decision on the annual TAC levels are announced 2-3 months ahead of each fishing year, or once stock assessment has taken place. The Marine and Freshwater Research Institute carries out stock assessments. These are presented to the International Council for the Exploration of the Sea (ICES) for review before being issued as formal recommendations to the Icelandic government (FAO, 2004) .

The decline in the fish stocks in the 1980s and 1990s resulted in significant changes to the Icelandic fishing industry and that made the introduction and adaptation of an ITQ system easier. These changes led to a rapid consolidation in the fishing and processing sectors that caused a reduction in employment as the number of vessels and factories were decreased. Due to this companies became fully vertically integrated, thus maximising value and profitability. Introduction of fish auction markets also had an effect on the industry as it allows the companies to specialise and thus enhancing value and production quality (Gunnlaugsson & Saevaldsson, 2016; Knutsson , Kristofersson, & Gestsson , 2015).

4.3 Utilising RRM as byproducts in Iceland

Marine resources, especially fish, are the most important resources in Iceland. Opportunities for better utilisation of marine RRMs and product development are considerable. Their focus is on increasing the value of main and side products, utilising multiple value streams, reducing waste and minimising negative environmental impact (Tordarson, 2018).

In the Icelandic fishing industry, there is a clear focus on value added production where a “quantity mentality” has been replaced with a “value mentality”. The industry has adapted to more or less fixed total catches, the only way to increase value and reduce costs is to utilise as much of each kilogram of fish as possible into valuable products (Jónsson & Viðarsson , 2016). The living marine resources are limited, and it is important to utilise these resources in a sustainable way. It is also important to maximise their value by producing high-priced products from the raw material, which is used for fish meal or simply discarded (Arason, 2003).

RRMs such as fish livers and fish roes have been utilised to an economically sensible extent in recent times. Currently fish viscera, fish heads, frames from filleting, fish bones, swim-bladders and fish skin are all utilised to an increasing extent. Specialised products, such as fish enzymes, chitin (from shrimp shells), fish leather for fashion items as well as specialised omega fish oils are all part of this development (Tordarson, 2018).

As mentioned earlier, byproducts can range from being of relatively low value, such as fish meal and fish oil processed from silage, which are primarily used as a feed for animals, to extremely high value products used in pharmaceuticals, cosmetics and functional foods. The value-pyramid in (Figure 5) below, demonstrates how the value increases depending on final products. Not all rest raw materials are used for production of the most valuable products, but with better managed value chains it is possible to enhance the process so that utilisation can be focused on creating products that return the highest value addition (Tordarson, 2018; Jónsson & Viðarsson , 2016).

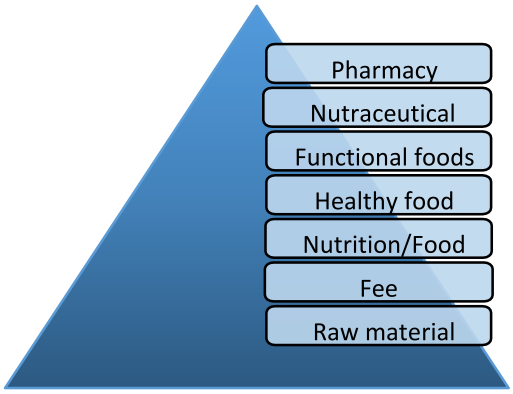

Figure 4. The value pyramid for byproducts *(Matis, 2016)*

4.4 Level of cod RRM utilisation

Atlantic cod (*Gadus morhua*) has always been the most important species in Iceland and has in recent years represented 35-40% of the total export value from seafood products (Statistics Iceland, 2016).

Figure 5 below shows how the export value of cod by-products has been increasing for over a decade however, there is been a slight decrease in the export value from 2012. This was due to a financial crisis in Nigeria that led to the closing of the Nigerian market for dried fish heads.

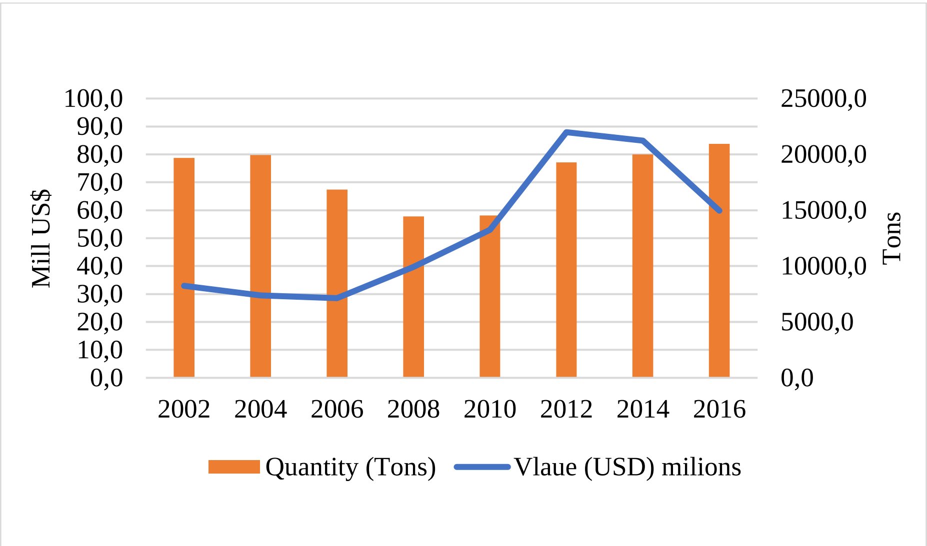

Figure 5. Export volumes and Values of cod byproducts (FOB) 2002-2016

Iceland utilises up to 80% of each cod while the average utilisation around the North Atlantic, is around 50% percent (Sigfusson, Cod Day, 2015). By increasing utilisation of each fish caught, it becomes possible to create more value from fewer resources. “Instead of focusing only on volume we should focus on creating more value from less” (Sigfusson, 2015).

Iceland has a very long history of utilising rest raw material, but only exported more recently. The average ratios of rest raw material of cod when processing both skinless and boneless fillets are described in Figure 6 below, and the characteristics of each rest raw material are described here below (Jónsson & Viðarsson , 2016). However, the same byproducts come from other demersal species, but the proportion differs slightly depending on species (Tordarson, 2018).

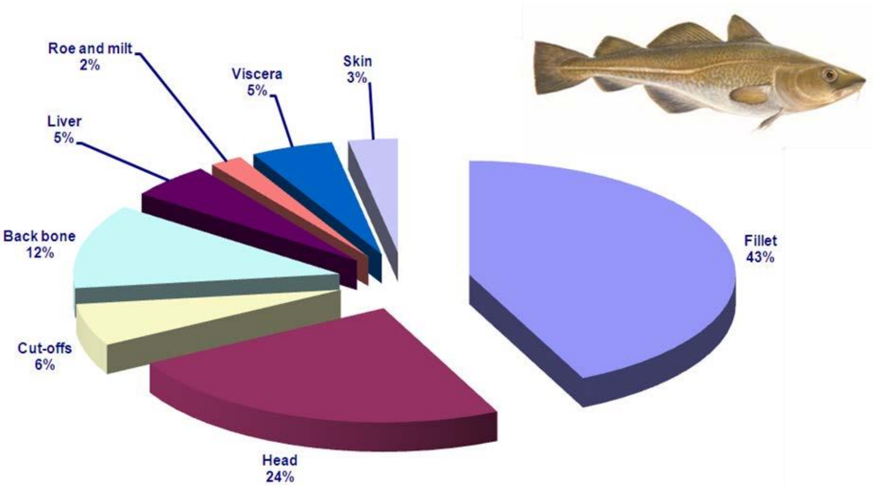

Figure 6. Ratio of the RRM when processing skinless and boneless fillets *(Jónsson & Viðarsson , 2016).*

The total cod catches in 2013 and 2015 amounted to 236 and 244 thousand tons in round weight, respectively. It is estimated that up to 72% of the 2013 biomass was utilised, which further increased to 77% in 2015. A wide range of different products were produced ranging from gutted whole fish, head and gutted fish, roes, fresh fillets, cuts and portions, mince, frozen fillets and portions, salted fillets and salted splinted fish, dried heads, dried heads with back bones, frozen heads, frozen fish faces, salted cheeks and tongues, canned liver and cod liver oil. The respective volumes as shown in figure 7 below.

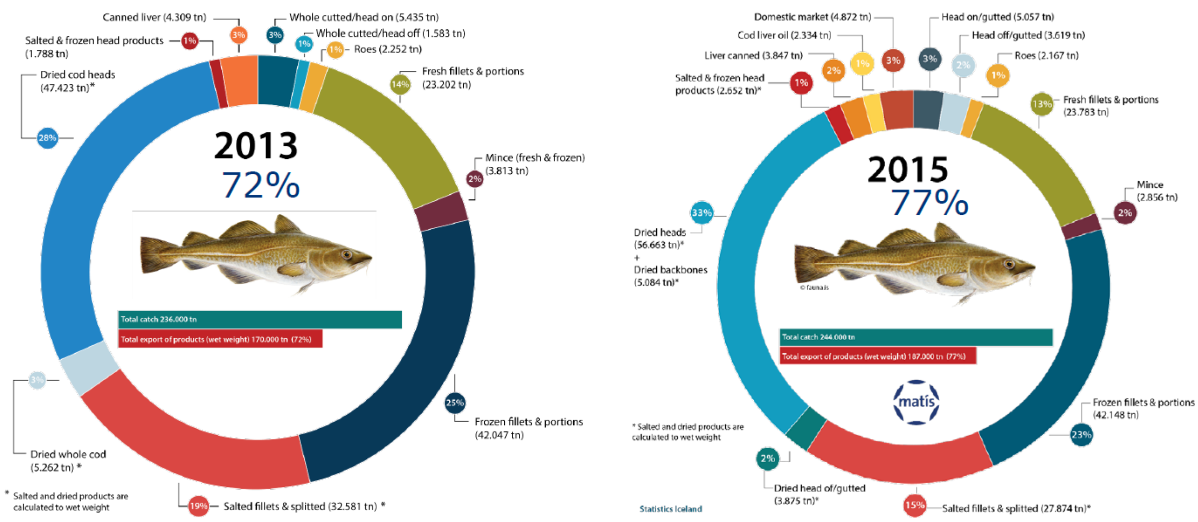

Figure 7. Total catch of cod in 2013 and 2015 (round-weight) and the total production of cod products *(Margeirsson, 2017)*

It is theoretically possible to utilise the whole cod. Assuming 100% utilisation and that the entire catch in 2015 is processed as skinless and boneless fillets, the rest raw materials could represent 57% and the fillets 43% of the catch volume as shown in table no 1 below.

Table no. 1 Proportion of fillets and RRMs in cod production *(Tordarson, 2018)*

Products/RRMs	Proportion of round weight	Theoretical volume (ton)
Fillets	43%	104.920
Cut-offs	6%	14.640
Heads	24%	58.560
Backbones	12%	29.280
Liver	5%	12.200
Roe and milt	2%	4.880
Skin	3%	7.320
Viscera	5%	12.200
Total	**100%**	**244.000**

Examples of all valuable products that can be made from previously discarded cod RRM (figure. 8). In his presentation at the Icelandic fisheries conference Sigfusson (2014), said if all the parts were utilised as shown in Figure 8, the average value of a 5kg cod could rise from $15 to $40-60. The utilisation of fish RRM can go even further, with full utilisation for human consumption. It should however be noted that the uses are not always for direct food but can also be used to produce fish protein hydrolysates that are commonly used as food additives, flavouring, and health promotors etc *(Losso, 2007)*.

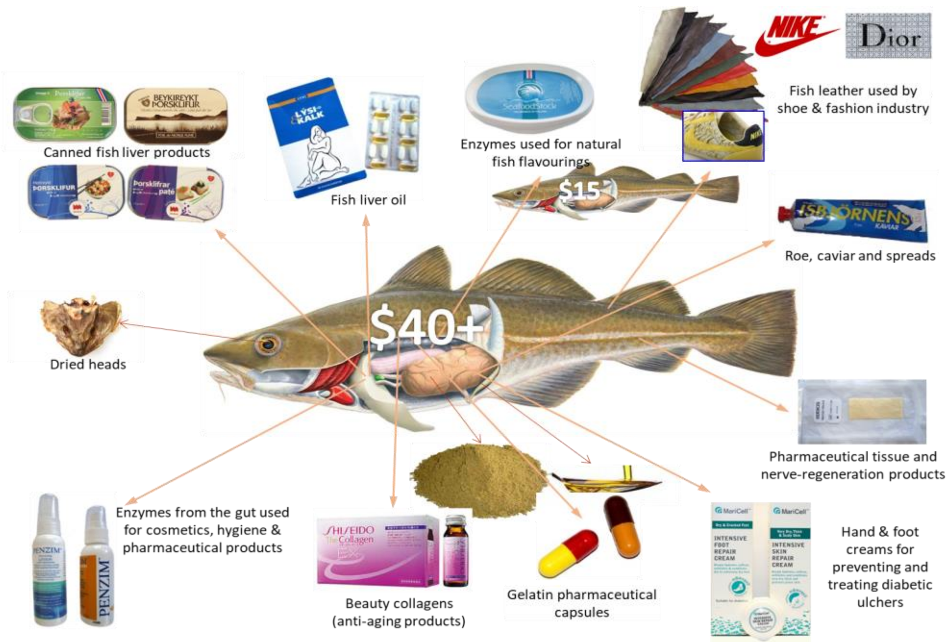

Figure 8. Products that can be made from cod *(Knutsson O. , 2018)*

Rest raw material utilisation of cod catches continues to increase in Iceland. These rest raw materials are processed as fresh, frozen, canned and dried food, fish oil, meal, ingredients, supplements, cosmetics and even medicinal products. There is therefore less 'waste' in the processing of cod. This does not only increase the value of the catch for the companies involved but may also demonstrate to the outside the world that the Icelandic marine sector is responsible for the utilisation of its resources (Tordarson, 2018; Jónsson & Viðarsson , 2016).

Matís (https://english.matis.is/company-profile/), a government owned company that focuses on research and development for the food and biotechnology industries, has worked closely with many companies in the fishing industry, both harvesting and processing firms. There has also been cooperation with related industries such as companies that produce equipment and technology for the fishing industry. This has assisted the Icelandic fishing industry in research and the discovery of new ways to further utilise rest raw materials. Hence, the knowledge, technology and understanding the importance of utilising rest raw materials are among the important factors that have driven Iceland to become a world leader in utilisation of rest raw material. This has also created significant value for the industry and the national economy (Jónsson & Viðarsson , 2016).

Figure 9 below shows the development of trade of RRMs in the Icelandic fishing industry from the cod catch over the last 25 years. The total volume was less than 700 tonnes in 1992 but was approaching 20,000 tonnes in 2017. The total value of these rest raw materials has also increased from less than 1 million US$ to more than 16 million. These numbers refer to the domestic market for cod RRMs, in other words, (these numbers show RRM transferred between firms). These are then turned into processed byproducts with added values and mostly exported as such (Statistics Iceland, 2016).

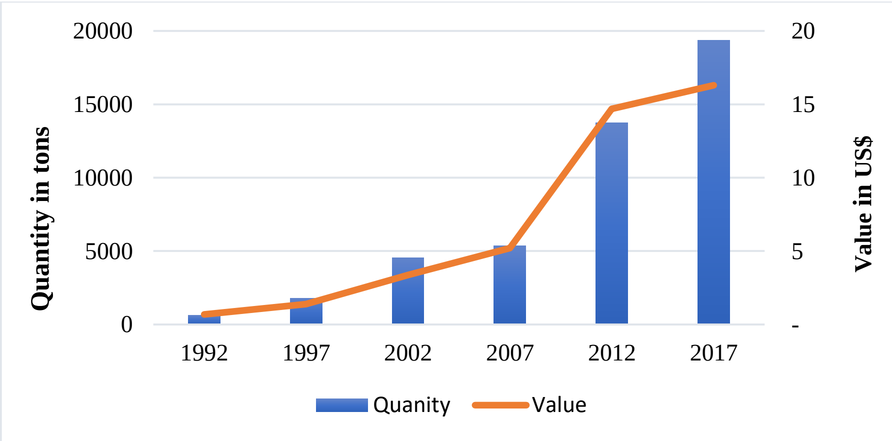

Figure 9. Volume and value of rest raw materials of cod 1992-2017

4.4.1 Fish heads

Codfish heads contain relatively little meat, but this fish part is a very much appreciated delicacy due to the taste and particularly its texture. Cod heads consist of about 23-24% of the body weight and are also processed in various parts such as tongues, cheeks, collar, and upper head meat (Arason, 2003). There has been a major obstacle in processing these products as the margin of labour cost was relatively high, however now an Icelandic company MESA has produced a machine that processes the heads. About 1500 tonnes of cheeks and tongues, mostly salted, are now exported each year.

Figure 10 below shows the increase in export volume and value of cod heads for over a decade. However, there was a decrease in 2015 due to the Nigerian market for dried cod heads that closed, because of a collapse in the world price of oil, which is Nigeria's main export product. The graph shows that the ratio of heads is sometimes 24% and in some years is higher than this 24% and the reason for this may be that some of the heads have backbones and tails attached (Jónsson & Viðarsson , 2016).

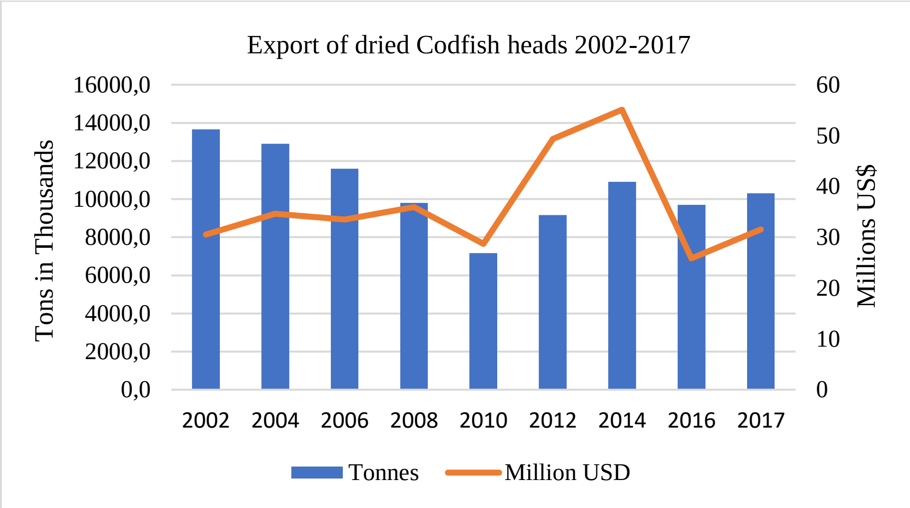

Figure 10. Export quantity and values of cod heads from 2002-2017

Traditionally, fish and fish heads used to be dried by hanging them on outdoor stocks racks. The utilisation of cod heads is significant in Iceland. Most of these products are exported to Nigeria. In 1978 indoor drying of cod heads began and today there are high tech factories using geothermal hot water as drying energy that do most of this production (Arason, 2003). Indoor drying is located where geothermal energy is found because the cost of oil or electricity used in the drying process is much higher than the cost of using geothermal energy (Jónsson & Viðarsson , 2016).

4.4.2 Fish liver

Fish livers contain considerable quantities of oil, between 40 and 75% depending on the species (Alonso, 2010). Utilisation of liver, especially cod liver to make fish oil, has a long history in Iceland, since at least 1728 (Jónsson & Viðarsson , 2016). The cod liver oil is a well-known product, which was previously recommended as a source of vitamin D and the actual recognition of the beneficial health effects of omega 3 fatty acids gave a new interest for its consumption. Since then there has been a major progress in the utilisation of liver (Batista, 2007). The export quantity and value of cod liver oil has increased significantly over the past decade, there was however a slight decrease in 2014-2016 as shown in figure 11.

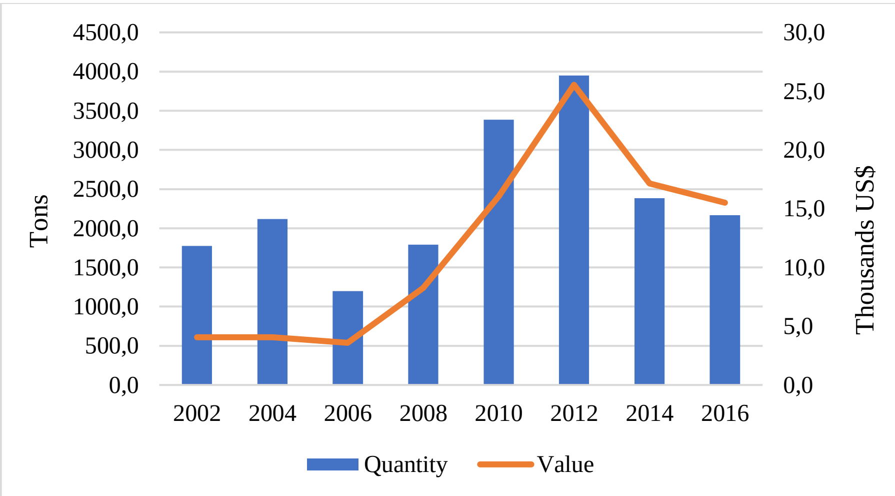

Figure 11. Export quantity and value of cod liver oil from 2002-2016

The processing of liver in Iceland is divided into two categories, production of oil and canning. Six major producers of canned liver are currently producing and exporting the product. Main export countries for Icelandic fish liver are Ukraine, Czech Republic, Russia, Lithuania, Germany, France, Poland, Denmark and Netherlands (Statistics Iceland, 2016).

4.4.3 Fish Roe

Fish roe and fish liver are and have been the best-known Icelandic fish byproducts for centuries. Roes are landed either fresh, frozen, or salted. In Iceland there is a high export demand for frozen and salted cod roe for canning, smoking and production of different kinds of caviar (Arason, 2003). Figure 12 shows the export volumes and values of cod frozen and salted roes have increased significantly over the last decade however, there has been a fluctuation from 2012 to 2016. If the utilisation rate of roes is on average 2% of the total fish body, and only half of the fish have roes, the females, then this amounts to almost 100% utilisation of cod roes in 2016. (Statistics Iceland, 2016).

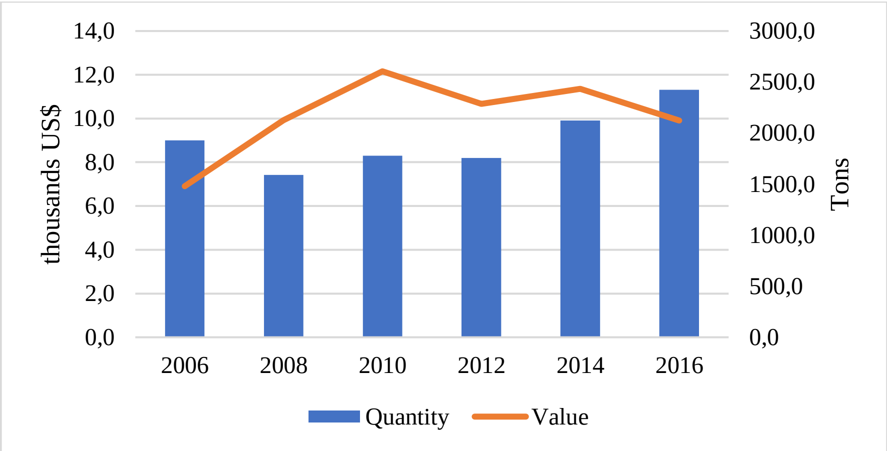

Figure 12. Export quantity and values of cod frozen and salted roes, from 2006-2016.

4.4.4 Fish Skin

Fish skins have been a challenge for the Icelandic seafood industry, as opportunities for utilisation have been rare in the past and it has been costly to dispose of them. However, this is changing, Codland (PTY) Ltd is working on setting up a processing plant in Grindavík that will process collagen and gelatine from fish skin. The collagen plant will be processing all the fish skins that the Icelandic seafood industry can supply. Fish skins are also used in production of textiles, clothes, shoes, handbags and other fashion products by a company called Atlantic Leather (Jónsson & Viðarsson , 2016). Research in Iceland indicates that fish skin can be stored refrigerated and frozen for a short period of time without a negative effect on the functional properties of the gelatine (Arason, 2003).

4.4.5 Fish backbone

When splitting the fish, the backbone is 8% of the weight of the fish (Arason S, 2009). In Iceland, this raw material is utilised as far as possible when processing on-land, where they are dried and sold to Nigeria. These by-raw materials are however not brought ashore from the freezing vessels, because of difficulties with freezing and storing the frames on-board (Jónsson & Viðarsson , 2016)

4.4.6 Viscera

Viscera (including liver and roe or milt) constitute between 10 and 25% of the net weight of fish depending on the maturity and season. In Iceland, most of the intestines are discarded at sea although they contain large quantities of digestive enzymes (Arason, 2003). These enzymes can be used in several industries, such as for detergent production, leather processing, chemical modifications, natural skin care products, cosmetics, or food processing (Kristbergsson & Arason, 2007).

Production of fish silage in Iceland has been almost none-existent, but this could change with producers becoming more aware of potential value creation by utilising low value raw material into silage and further processing in the future for higher value products. Fish silage is a liquid product processed from RRM like viscera. By adding acid, such as formic acid into the viscera it is liquidated by enzyme actions and naturally broken down to the right conditions to limit the growth of spoilage bacteria. Here with the products (silage) shelf-life increases and can be used as raw material in fish meal and oil and used for producing aquaculture feed, animal feed and as a fertiliser (Jónsson & Viðarsson , 2016).

5. HAKE CATCH UTILISATION IN NAMIBIA

The hake fishing industry is generally vertically integrated, and owns a large proportion of the value chain, from harvesting, processing, and distribution. Over the years, the hake industry has made significant investment in vessels, processing plants and equipment in order to add value to their products that are either exported or consumed locally. However, it is worth noting that some products are exported as materials rather than fully processed. Spain, South Africa and other markets are importing inputs that are further reprocessed there for retail ready products. This suggests that there is still room to increase value addition in Namibia beyond the current stage, even with the notable progress that has been made.

Hake is caught by trawlers and long liners. Fish caught by freezer trawlers is processed on board immediately after harvest, the products are packaged and frozen on board and can be off-loaded onshore for direct distribution, repackaging or for further onshore processing. Fresh hake landed on ice for onshore processing is mainly filleted and portioned then packaged and frozen or further processed into frozen fillets and blocks by glazing, portioning, and packaging. (MFMR, 2015/16).

Longline vessels on the other hand, specialise in landing fresh gutted fish, the fish is chilled on ice and then exported in its prime form to the specific markets that demand fresh hake. Fish that is not fit for exporting as fresh chilled is processed into fillets and other products (MFMR, 2017/18).

Namibian hake is processed in products, ranging from headed and gutted fish, skin-on and skin-off fillets, pin bone in and pin bone out, steaks, medallions, cuts, lion, roes, mince sausage and calibrated portions in retail packs. Most fish heads and almost all backbones, tails, fins and skin from the filleting process is sold to a fish meal industry plant where they are processed into fish oil and fishmeal (MFMR, 2015/16).

The main product market for processed hake is Spain, making it rather dependent on this market. This represents a risk in the sense that one has all the eggs in one basket. More market diversification would be preferable, not only to reduce potential risk but also to provide incentives for value enhancement. Demand for eco-labelled products has impelled Namibia to obtain the Marine Stewardship Council (MSC) certification for hake and this process is at an advanced stage. Certification will enable the hake industry to enter its products into markets demanding eco-labelled products and thus broadening its market base (MFMR, 2017/18).

6. FINDINGS ON HAKE LEVEL OF UTILIZATION

Inferring from the data received from a hake processing company indicates that it processes about 25000 tons of whole hake. Assuming the catch is landed with or without heads and guts, then this is approximately 17000 tons, or 68-69% of the total weight of the live catch.

Onshore processing consists of three types of main products; fillets, in various portions which is about (41-43%), cut-offs and trimmings, processed as bits, pieces and minced fish (12-14%) and tails, skin and bones which are processed as fish meal (14-16%).

At sea, about 1% of the RRM is utilised, landed as fish heads (about 5% of the heads are landed onshore) as cocochas (fish tongues). Additionally, some volumes of roes are utilised (less than 1% of the catch).

This suggest that the current rate of hake utilisation of this company is about 70% of the whole catch. Is it being put into the most valuable products? Could the company utilise more? Are other companies utilising at the same rate? These are some questions the Namibian fish processing companies could try to answer in order to estimate the potential of full utilisation of fish rest raw material.

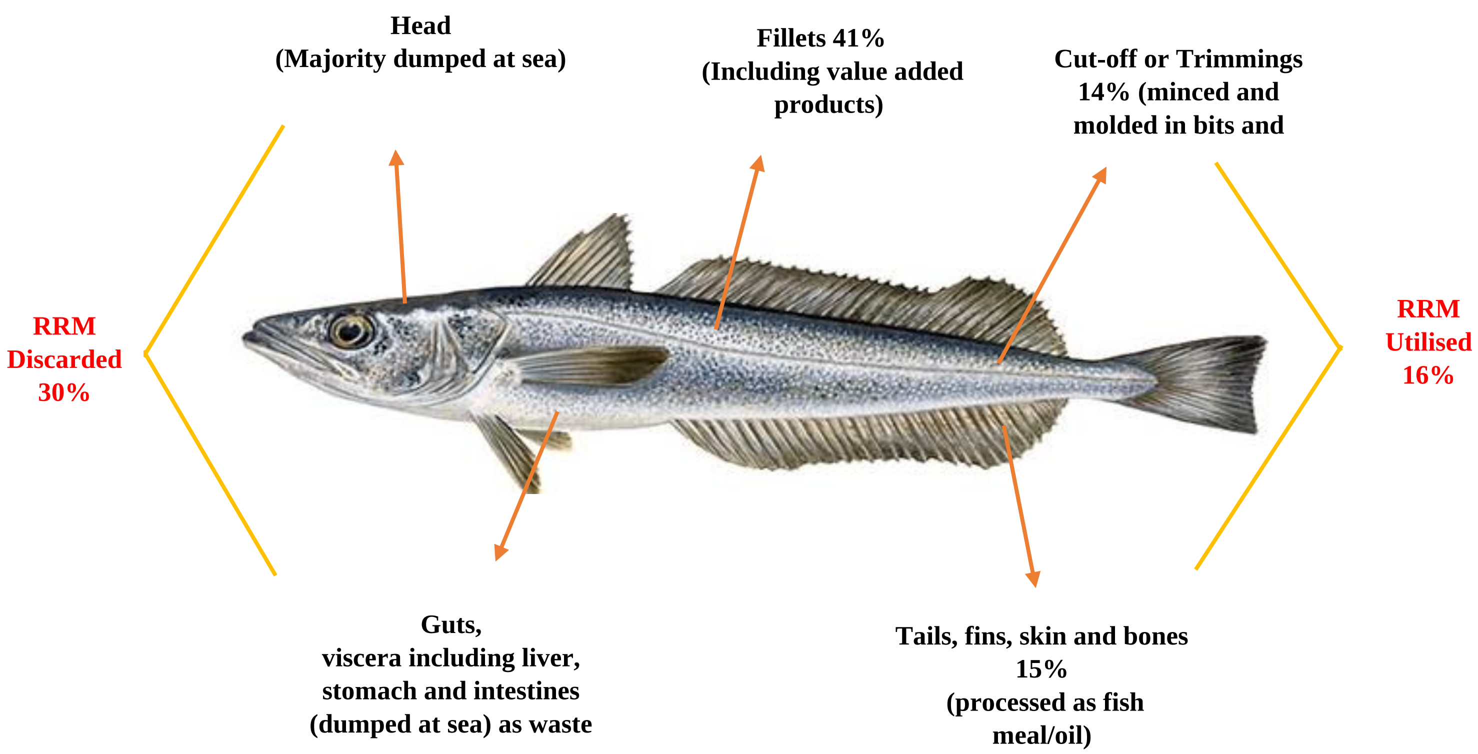

Figure 13: Current utilisation level of Namibian hake

What seems rather clear is that there is still a large element of waste. With RRM like liver and the majority of heads being dumped at sea and fish skin, backbones turn being processed as fishmeal/oil, when these raw materials could potentially be directed to other products of higher value. At the same time the negative environmental impact caused by the discard of organic waste would be minimised.

6.2 Possibilities to increase the level of utilisation

It is worth noting that as of 2018, the Namibian fishing industry has been exploring possibilities of extracting collagen and gelatin from the fish skin, in addition to the further processing of fish liver and developing a market for it. The processing of such rest raw materials very likely requires investment in intensive technology, as well as in research and marketing. New markets for byproducts are already opening up, it can be witnessed by a growing demand for fish heads in some Asian and African markets, while there is also potential use of fish heads and bones to meet a rising global demand for fish oil and mineral supplements (FAO, 2014).

6.2.1 Fish liver

Fish livers contain considerable quantities of oil, between 40 and 75% depending on the species (Alonso, 2010). In Namibia, hake liver is dumped at sea as waste, however fishing companies stated that they are exploring the possibility for value adding this RRM and developing a niche market for this product. Fish oil contains omega-3 fatty acids that play a significant role in the development of the human brain and have benefits to reduce the risk of degenerative diseases (Kim, 2014).

6.2.2 Fish skin and backbones

In Namibia fish skin together with bones, tails, fins, broken fish, and collars are processed into fish meal, but more can be done with fish skin and backbones. Fish skin is a good source for collagen and gelatin which are currently used in food, cosmetic and biomedical industries and fish bones contain 60-70% minerals including calcium, phosphorous and hydroxyapatite (Ghaly, Ramakrishnan,Brooks, Budge & Dave, 2013). In Iceland fish skin is also processed into leather for productions of shoes, handbags, and other fashion products.

6.2.3 Fish heads

The hake head constitutes approximately 15% of the body weight. Some of fish heads are packed and sold locally, commonly they are prepared into light meals, such as soup with added flavors or as fried. Also, majority of fish heads in Namibia are dumped at sea as waste. This is due to the limited storage capacity on the fishing vessels.

FAO recently called out the absurdity of this waste, suggesting it is time to get more fish heads on people's plates. “we must ensure that these raw materials are not wasted," Audun Lem, chief of FAO’s products, trade and marketing branch stated (FAO, 2018). As brains, cartilage and fat are nutritious and contain extra-high levels of vitamin A, omega-3 fatty acids, iron, zinc and calcium which is good for the human body and can also benefit the environment by reducing pollution (Bland, 2014). Fish RRMs may be “healthy” but uneconomical to produce byproducts from them. The Namibian fishing industry can only find out if they try. Therefore, Namibian hake fish heads landed onshore, could be dried and consumed locally, or exported as a source of protein, other than being discarded at sea.

7. DISCUSSION

Table 2 shows the comparison of rest raw material utilisation between Namibia and Iceland. As seen in the comparison, its clear that there is still an element of waste in the hake fishery as rest raw material such as heads, liver, and viscera are being discarded, while in Iceland these rest raw material are utilised in a more sensible way. There is an increasing rate of cod RRM utilisation in Iceland, which is currently at 80%. This results from the Icelandic cod industry suggests that a policy of "no waste" could be a yardstick for Namibia to explore.

Table no 2. Comparison of utilisation of RRM in Namibia and Iceland

RRM	**Hake (Namibia)**	**Cod (Iceland)**
	Applications	
Heads	Human consumption (sold locally, fresh) Majority dumped at sea	Human consumption (dried and exported)
Liver	Regarded as waste	Liver oil (Omega3, capsules, creams & canned products)
Roe	Human consumption (exported frozen)	Human consumption (exported frozen, salted, smoked & canned)
Skin	Goes to fish meal/oil production	Some used for collagen, gelatin, and fish leather
Backbones	Goes to fishmeal/oil production	Dried and exported, collagen
Viscera	Regarded as waste	Some used for enzymes for cosmetics /pharmaceutical

In order to utilise the fish rest raw materials and maximise the value creation in the future from fisheries, it is extremely important that the fishing industry and government cooperate in encouraging R&D and in the development and implementation of utilisation possibilities *(Jouvenot, 2015)*.

A specific management system in place may be a prerequisite for a nation's fishing industry to succeed in full utilisation, in setting objectives and levels at which the objectives are met. Table 3 below shows the influencing factors of full utilisation of fish rest raw materials compared between Iceland and Namibia, to measure the success and level of competitiveness to see where improvements are needed.

Table 3. Showing the main influencing factors for full utilisation of fish rest raw material in a comparative way between Iceland and Namibia.

Factors	Namibia	Iceland
Fisheries Management System	IQ system (not ITQ) that allows voluntary consolidation, which provides some incentives for increased efficiency	ITQ system that pushed for consolidation, which provides much incentive for increased efficiency
Fish species	Demersal hake (*Merluccius capensis* and *Merluccius paradoxus)*	Atlantic cod (*Gadus morhua*)
Industry structure	Vertical integration Smaller firms enter into operational agreements with larger firms.	Vertical integration, Market through auction markets/allows small specialised firms that larger firms may later swallow or copy.
Technology	Low automated processing in industry, limited utilisation, standardised products, better handling	Highly automated processing in industry/increased utilisation/standardised products/good handling/
Government Incentives to industry	Limited; (research and development institutes industry,)	Extensive; (Research and innovation institutes, industry, and firms)
Eco labeling	In process to get MSC	MSC certified
Policy	Policies and regulations in place, however, they do not advocate for full utilisation of rest raw materials	Supportive policies and regulations in place that promotes full utilisation of rest raw materials

Influencing factors which Namibia may lack are further described below.

Management systems

The Icelandic fishing industry is managed with ITQs that are permanent and they, therefore, provide incentives as property rights that allows for long term planning. This encourages the right holder to search for ways to increase profitability, which in turn seems to provide incentives for maximum utilisation of the catch. Due to competition amongst the companies/fisherman, the focus is more on using efficient fishing technologies, producing high quality fish products, good marketing, getting the best prices for their products and utilising every part of the fish landed, all in order to maximise their profits. This, results in increased economic efficiency in the fishing industry. Furthermore, the transferability and divisibility of the ITQs creates a market mechanism that can work well in generating better economic results for the industry. In addition, the less profitable companies that exit the industry may lease or sell their quota share and while they get financial rewards for it, they also help to increase efficiency and profitability in the industry. This contrasts with the IQs in Namibia, which are temporary and therefore provide lesser incentives than permanent and tradable quotas; they do not have the same essence as property rights and are not transferable.

Government incentives and policies

In Iceland there are both policies and incentives in place towards utilisation of rest raw materials. Regulations of minimal landing ratios of selected rest raw materials from both wet fish vessels and processing vessels have been issued. The government works hand in hand with the fishing industry to make sure rules and decisions taken are economically sensible and are in line with progress in the fishing industry before implementation. Also, considerable efforts and funds from different sources (industry, local and foreign companies, and government) are invested into R&D, both for product and byproduct development, technique and equipment. Matis, the government owned R&D firm, caries out research in all food production sectors in Iceland. In recent years it has operated on an income budget of about 16 million USD per year, half of which comes from government /public funds of Iceland. Whereas in Namibia, policies/ regulations in place are not explicit on the utilisation of fish rest raw material. Also, there are no government funding schemes, local or foreign companies' funding to the fishing industry for investments in research, product development, equipment and markets for byproducts.

Technology
The Namibian fishing industry is not fully automated due to its responsibility with regards to employment creation and fully automating it, could be quite challenge for the country at large. However, the utilisation of rest raw material could require more automated equipment to make value added products from the rest raw material. As well, locating lucrative niche markets for these byproducts. The Icelandic fishing industry is successful in full utilisation of rest raw material because of the highly automated equipment used and the location of lucrative markets for its byproducts.

Present Clusters
A cluster is a form of local cooperation and a primary means by which different nations compete in the global market. Icelandic companies in the fishing industry work together, that is harvest/process with research institutes, such as Matis and with equipment makers, such as Marel, to improve handling and processing of fish and RRM and make better or new equipment.

There are few limitations connected to data collection and literature for this study. Firstly, the core of this project is a comparison of RRM utilisation of two fish species which are geographically located at opposite ends of the planet. Secondly, the data collected from the hake industry was insufficient particularly, the volumes of rest raw materials utilised, therefore the utilisation rate of RRM from the hake industry and economic efficiency could not be determined. Thirdly, there is not much literature on utilisation of rest raw material in the Namibian fishing industry.

8. CONCLUSION

The aim of this study was to identify potential possibilities of the underutilised and wasted raw material by looking at methods and incentives used by other countries such as Iceland that utilises rest raw material to develop more fish products and maximise the overall value from the country's fisheries. This transition may not happen now or might even seem impossible due to factors that need to be in place for such a transition to be successful, which are currently not available. However, it is the responsibility of the Namibian government to take the opportunity and learn from the Icelandic fishing industry's new utilisation movement experience of limiting waste and maximising value of each part of the fish.

Iceland has history of utilising RRM such as heads, liver, roe and bones etc. and with declining fish stocks especially cod, forces surviving firms to create more value from less by increasing value added from fillets and creating or maximising value from rest raw material. This was made easier by the ITQs as it provides incentives to increase value of total quota catch, (main products and rest raw material). Also, pushing firms to compete in creating value and not in catching more volume. Iceland has diverse markets that demand export of fresh fillets, special cuts which are transported by air and more onshore processing. More rest raw material onshore leads to more byproducts with a decrease in offshore processing leading to less RRM thrown away at sea. Industry invested in new processor vessels equipped with the storage and utilisation capacity of RRM. In Icelandic, “nýtin” is a positive word that describes a person who uses things to their fullest (Sigfusson, 2016).

There are differences between the fisheries management system in Iceland and Namibia, although, both systems build on a framework of responsible and sustainable utilisation of their respective marine resources.

There is a need to get a “fuller” picture of the current utilisation in Namibia. Therefore, the MFMR should consider gathering more data on utilisation of rest raw material. Also, enquire whether the industry is aware of the value of byproduct, and if so, address the question of whether they are putting rest raw materials into the most valuable byproducts. Furthermore, the MFMR together with the fishing industry should invest in training, research & development, and in possibilities of utilising RRM and markets for the valued added products.

The government and industry could cooperate on putting rules in place, to encourage fuller utilisation. The Namibian hake fishery already has a policy that promotes onshore processing in place, this can be an advantage as more rest raw material can be are brought onshore and less would be dumped at sea. Also, the value addition criterion in place may be amended to advocate for full utilisation of RRM as it only emphases the number of value-added products, volume and prices. This may also encourage the fishing companies to produce more value from the fishery. It is therefore sensible for the hake industry to explore the utilisation of rest raw material.

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10. REFERENCES

Andrews, S. (2016, January 11). *The Fish Site*. Retrieved from thefishsite.com: https://thefishsite.com/articles/the-problem-of-postharvest-losses

Alonso, , A. A. (2010). Contributing to fisheries sustainability by making the best possible use of their resources: the BEFAIR initiative. In *Trends in Food Science & Technology* (pp. 569-578). Elsevier.

Arason. (2003). *Utilization of Fish Byproducts in Iceland.* Reykjavik.

Arason S, M. K. (2009). *Maximum resource utilisation -Value added fish by-products.* Norway: Nordic Innovation Centre Stensberggata 25 NO-0170 Oslo.

Arnason , R. (1996). ITQ fisheries management system in Iceland. In *Reviews in fish Biology and Fisheries* (pp. pp 63–90). Kluwer Academic Publishers.

Arnason, R. (2008). Iceland's ITQ system creates new wealth. *The Electronic Journal of Sustainable Development*, 36-40.

Batista. (2007). By-catch, underutilized species and. In F. Shahidi, *Maximising the value of marine by-products* (pp. 171-191). Cambridge: Woodhead Publishing Limited,.

Bland, A. (2014, March 7). *www.npr.org*. Retrieved from The salt: what's on your plate: https://www.npr.org/sections/thesalt/2014/03/07/286881659/why-we-should-quit-tossing-fish-heads-and-eat-em-up-instead-yum

FAO. (2004). *INFORMATION ON FISHERIES MANAGEMENT IN THE REPUBLIC OF ICELAND.*

FAO. (2014). *Opportunities and challenges.* Rome: Food and Agriculture Organization of the United Nations.

FAO. (2018). *State of the word Fisheries and Aquaculture.* Rome: FAO.

Ghaly, Ramakrishnan,Brooks, Budge & Dave, A. E. (2013). Fish Processing Wastes as a Potential Source of Proteins, Amino Acids. *Microbial & Biochemical Technology 5*, 07-129.

Gunnlaugsson & Saevaldsson, S. B. (2016). The Icelandic fishing industry: Its development and financial performance under a uniform individual quota system. In *Marine Policy Volume 71* (pp. 73-81). Reykjavik: Elsevier.

Icelandic Fisheries. (2006). *DOCSBAY*. Retrieved from https://docsbay.net/the-fisheries-management-act.

Irianto , H., Dewi , A. E., & Giya, S. (2014). Prospective Utilization of Fishery. In *Seafood Processing* (pp. 21-31). New York: Springer Science+Business Media.

Jónsson & Viðarsson , Á. R. (2016). *By products from white fish processing.* Reykjavik: Matis.

Jouvenot, L. (2015). *Utilisation of Rest Raw Materials from.* Norwegian University of Science and Technology.

Kathena, Nielsen, Thygesen & Berg, J. N. (2016). Hake species (Merluccius capensis and M. paradoxus) assessment in the Benguela Current Large Marine Ecosystem. In *Environmental Development* (pp. 193-201).

Kim, S.-K. (2014). *Seafood Processing By-Products.* London: Springer New York Heidelberg Dordrecht.

Knutsson , O., Kristofersson, D. M., & Gestsson , H. (2015). The Effects of Fisheries Management on the Icelandic Dermersal Fish Value Chain. *Marine Policy*, 173-179.

Knutsson, O. (2018). *Value chain concept.*

Kristbergsson & Arason, K. (2007). In U. o.-P. Industry, *Utilization of By-Products and Treatment of Waste in the Food Industry* (pp. pp 233-258). Boston, MA : Springer.

Losso, J. (2007). Using marine by-products in. In F. Shahidi, *Maximising the value of marine by-products* (pp. 450-456). Cambridge: Woodhead Publishing Limited and CRC Press LLC.

Margeirsson, S. (2017). *The Bioeconomy.* Reykjavik: Matis

Matis. (2016). *By-products from whitefish processing.* Reykjavik: Matis.

MFMR. (2007). *Assessment of Opportunities for Increased Value Addition and Improved Marketing of Namibian Marine Fish Products.*

MFMR. (2011-2014). *Hake Management Plan.* Windhoek: MFMR.

MFMR. (2014). *Hake Management Plan.* Windhoek: Ministry Of Fisheries and Marine Resources.

MFMR. (2015/16). *Hake TAC Report.*

MFMR. (2017/18). *Hake MRAC Scientist repot.*

MFMR. (2017/18). *Socio-conomic TAC report.*

MITSMED. (2017). *Growth at Home.* Windhoek: Ministry of Industrialisation trade and SME Development.

NPC. (2017/18). *NDP5.* Windhoek: National Planning Commision.

NSA. (2018). *nsa.org.na*. Retrieved from https://nsa.org.na/.

Olsen,Toppe & Karunasagar, R. L. (2014). *Trends in Food Science & Technology.*

Pramond & Pitcher, G. J. (2006). *An estimation of compliance of the fisheries of namibia with article 7 (fisheries management) of the FAO (UN) code of conduct for responsible fishing.* Canada: University of British Columbia.

Rustad, T. (2003). Utilization of marine by products. *Electronic journal of environment, Agriculture and Food Chemistry*, [458-463.

Rustad, T. (2007). Maximising the value of marine by-products. In F. Shahidi, *Maximising the value of marine by-products* (pp. 1-516). Cambridge: Woodhead Publishing Limited, Abington Hall, Abington,.

Sigfusson, T. (2015, September 22). Cod Day. (S. javarklasinn, Interviewer)

Sigfusson, T. (2016). A new utilization movement. In *Nordic ways* (pp. 233-236).

Statistics Iceland. (2016). *www.tatice.is*. Retrieved from statice.is: https://statice.is/statistics/business-sectors/fisheries/

Sundby, S. (2001). Interaction between Cape hake spawning and the circulation in the northern Benguela upwelling ecosystem. *South African Journal of Marine Science 23:1*, P317-336.

Tordarson, P. &.-P. (2018). *Utilization of rest raw material.* Copenhagen: Nordic Council of Ministers.

Venugopal & Shahidi, V. a. (1995). `Value added products from underutilised fish. In *J Food Science and Nutrition 35,* (pp. 431-453).