MSc Urban and Regional Planning
Graduate School of Social Sciences
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August 2020

Factors influencing location choice and patterns of industrial clustering in Africa's fish reduction industry

Evidence from Mauritania and Kenya.

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Submitted: 10th August 2020

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Abstract

This study aims to identify the reasons behind patterns of agglomeration in the fish reduction industry in African contexts. The phenomenon of clustering in the reduction value chain, whereby plants process small pelagic fish into fishmeal and fish oil, is examined with reference to the respective environmental, social and economic impacts on the wider region. A qualitative dual case study design has been applied in order to answer three sub-research questions about existing clusters in Nouadhibou (Mauritania) and Nakuru (Kenya). This research has two levels of analysis in both cases; first investigating the catalysts for the growth of a reduction industry and then exploring the combination influential features of agglomeration as per an established theoretical framework. This analysis allows us to understand the factors significant to two contrasting types of cluster structures: one made up of mass-producing, export-based firms and another comprising of smaller-scale businesses.

The findings of the study show that clusters develop mainly due to access to plentiful natural stocks alongside a favourable regulatory environment. Favourable legislation pertains to that which actively encourages industrial growth and/or turns a blind eye to the unchecked and unplanned proliferation of industry. The findings of this study are expected to contribute to two fields. In the field of urban planning and regional development, it can provide a useful insight into the effective allocation of land and infrastructure to the reduction industry, recommending that adequate regulation and auditing is in place to ensure legitimate practices. Secondly, in the context of the food security debate, it offers further insight into the disruptive nature of the industry developing in Africa under the influence of powerful external actors, thus strengthening the case for the sustainable use of pelagic fish in combatting food security issues.

Key Words: Small pelagic fish, value chain, clustering, reduction, food security, urban and regional planning

Acknowledgements

Thank you, Maarten Bavinck, for all the guidance and positivity throughout a very unusual thesis - you helped me keep my calm in the face of a global pandemic! Thanks also to all participants in this research, as without you taking the time to Skype with me, I would have had nothing but a whole host of second-hand papers to read. You have broadened my understanding, enthused my interest and added a great deal of value to the quality of this paper. Finally, I would like to acknowledge the help of Horace Owiti of the KMFRI. It's a shame that we were not able to meet in Kenya, but without your help I would only have only been able to produce half a thesis!

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1. Introduction

The academic literature surrounding the phenomena of industrial clustering broadly accepts that businesses benefit from the grouping of enterprises into geographic and sectoral clusters. It is argued that proximity to other firms gives rise to a certain collective efficiency, enhancing competitiveness and furthering industrialisation. Location is therefore a crucial factor affecting the success of individual businesses as well as industries as a whole, and consequently the study of location choice represents a significant element of various academic fields including economic geography, urban and regional planning and development studies. In addition to considering the significance placed on proximity to other firms operating within the same or associated value chains, decision-makers must consider myriad significant factors such as access to raw materials, markets, labour and the nature of the regulatory environment in which they are operating. Identifying the combination of influential features key to the success of a particular industry is useful in guiding policy and effective and sustainable regional development plans.

As such, a key aim of this research project is to contribute to the discussion of the sustainable use of small pelagic fish in the reduction sector in various African contexts. This study explores patterns of industrial agglomeration within the industry, which is concerned with the production of fishmeal and fish oil (FMFO). FMFO are materials most commonly produced from small pelagic fish, which are ground down and subsequently used to service the animal and aquaculture feeds industries. Although the reduction industry is well-established in some African countries, recent years exhibit varying degrees of increased activity in others across the continent. Observers of the situation highlight the benefits of a lucrative business opportunity, which brings value-addition into a country by establishing a strong domestic industry through capitalising on an apparent abundance of natural fish stocks and providing employment and income to many people. However, critics stress various damaging environmental, economic and social health concerns that arise as a result of increased activity, including foreign interference and corrupt dealings disrupting marine environments, degrading fish stocks and polluting local inhabited areas (Béné et al, 2015; Tacon and Metian, 2009). Perhaps most problematically, a significant proportion of the fish directed towards the reduction industry is food-grade (Cashion et al, 2017), and thus is disrupting to existing

commodity chains with far-reaching and negative implications for food security and employment across the wider region (Tacon and Metian, 2009).

With these observations in mind, this study examines two clusters of FMFO production plants located in Nouadhibou, Mauritania and Nakuru, Kenya. The two cases have contrasting empirical contexts and are an example of deviant case sampling, whereby the study of contrasting units makes it possible to gain a better understanding of the more regular patterns of behaviour and whether an unknown factor is exerting a common effect on the set of units (Seawright, 2016). Mauritania is an emergent producer of FMFO in the African market, having increased production rates from negligible amounts in 2005 to third highest in the continent in 2017 (FAO, 2019). Fish are not a large part of the diet in the country, therefore most FMFO is mass-produced for export. On the other hand, despite the crucial contribution to Kenyan food security that pelagics represent, particularly in western regions around the source of the fish in Lake Victoria, FMFO production levels in Kenya are comparatively low. The industry in Kenya is servicing increased livestock farming for a higher-income and domestic market, which is directing fish away from low-income consumers. As such, this research has two levels of analysis for both cases, first investigating the catalysts for the growth of a reduction industry and then exploring the combination of influential factors leading firms to invest in particular locations in close proximity to other reduction plants. This analysis allows us to understand the factors particularly significant to two types of cluster structures: one made up of mass-producing, export-based firms and another comprising of smaller-scale business structures.

The United Nation's Food and Agriculture Organisation (FAO, 1986) state that there are some particularly significant factors regarding location selection to consider at the planning stage of opening a reduction plant. Namely, ample and regular supply of raw material at an acceptable price, capacity of the size of the plant to house the specialised machinery for processing the amount of raw material in question and consideration of the location of the plant in relation to habitation and closed harbours. Using these factors as a starting point, this research uses the value chain framework considered alongside a dimension of cluster theory from the school of economic geography. These theories are used to look more closely at the manufacturing step of the FMFO value chain in the two clusters identified in Mauritania and

Kenya, in order to discern the influential combination of internal, external, locational and agglomeration factors which have led to development of the clusters. This can highlight potential opportunities for sustainable industry development, thus contributing to the debate on how fish value chains and food security could be improved in various African contexts.

Along this line, this research forms a part of the SmallFishFood[1] project, an initiative concerned with exploring the way in which fish value chains can be improved to ensure sustainable utilisation of small pelagic fish resources for Africa's low-income population (SmallFishFood, 2017). This area of study is both necessary and relevant as food and nutrition security is one of the greatest challenges facing the modern world (Béné et al, 2015; Tacon and Metian, 2018). The issue is only exacerbated by an ever-increasing population requiring more food for sustenance, thus increasing pressure on natural supplies and possibly leading to high levels of degradation, over-exploitation and accelerated decline in stocks (Corten et al, 2017; Béné et al, 2015; Kolding et al, 2019; LFFT in Changing Markets, 2020). With the geographic focus on Africa, the SmallFishFood project recognises that the debate on food security is particularly pertinent in low-income communities, which face additional geographic and monetary barriers to meeting their nutritional needs (Dimitri et al, 2014). Poverty is arguably the single most important cause of food security globally (Madeley, 2002). Moreover, the fish industry itself represents a central component in the debate on food security, as besides employing over half a billion people globally and providing vital employment and income opportunities in developing countries (Nomura, 2005; Allison, 2011), fish offer a fundamental nutritional source of protein (Béné et al, 2015). Fish provide approximately 4.5 billion people between 20-50% of their annual protein intake (WHO, 2019) and are particularly important to consumers in low-income communities as they provide a relatively affordable source of micronutrients, essential fatty acids, proteins and minerals. The small pelagic fish at the core of this study offer a particularly affordable way of combatting issues of hunger, micronutrient deficiency and non-communicable diseases, as consumption

[1]**SmallFishFood** is an interdisciplinary project working in Ghana, Kenya and Uganda, made up of a team from Norway, the Netherlands, Germany, Ghana, Kenya and Uganda. The work is funded by **LEAP-Agri**, a joint research and innovation initiative between Africa and Europe. The organisation is particularly interested in projects related to 'Food and Nutrition Security and Sustainable Agriculture' (LEAP-Agri, 2019). Projects are funded by the European Commission with a primary goal of creating a development partnership between the two continents.

of even small amounts demonstrate significant nutritional benefits (Bogard et al, 2015; Tran et al, 2019; SmallFishFood, 2017).

As such, the thesis is structured as follows. To begin, a succinct overview of the organisational and spatial structure of the African fish reduction industry is presented, setting this within the broader context of global fish value chains. The empirical context provided in this chapter is useful in contextualising the FAO's significant factors regarding location selection to consider at the planning stage of opening a reduction plant. In Chapter 3, a theoretical framework is established based upon a literature review of value chain and cluster theory. The structures and debates in economic geography are traced to cluster-focussed analysis of location selection in the context of global fish value chains. The intersectionality of the theories is used to establish a measurable framework through which to determine the combination of influential factors leading to industrial agglomeration of fish reduction factories in two African contexts. A methodology chapter describes and analyses the data collection methods used during this study, reflecting on the limitations of the chosen methods as well as the disruption caused by the COVID-19 pandemic. Chapters 6 and 7 are dedicated towards examining the cases of Mauritania and Kenya respectively, elaborating on empirical findings from research into the development of reduction industries in each country and better understanding the evident patterns of industrial agglomeration in two specific units of observation. These cases are compared and contrasted in the analysis that follows, informing knowledge of both domestic and export-based clusters. From this, it is possible to explore systemic opportunities and constraints of the industry, ultimately contributing to further research into ways in which fish can be used more effectively in feeding Africa's low-income population.

2. Empirical Context: Reduction Value Chains, Investment and Operations

This chapter provides empirical context in support of the FAO's three crucial factors to consider at the planning stage of opening a reduction plant, which have been specified in the introduction. Clarifying the functions and processes of steps of the value chain, as well as observing the key debates surrounding FMFO production is crucial to better understanding cluster-specific analysis that follows in later chapters of this thesis. Subsequently, international legislation pertaining to various stages of the value chain is mapped.

2.1 Fish Reduction: A Global Value Chain

It is commonly perceived that the landed catch of marine fisheries is destined for direct human consumption (DHC), however this fails to acknowledge the considerable proportion directed towards the reduction industry. According to the FAO, in 2018, 156 million tonnes of total fishery production was used for DHC, while the remaining 22.2 million tonnes was destined for non-food products (FAO SOFIA, 2020). This surplus has mainly been targeted towards the reduction industry for the manufacture of FMFO. The process of globalisation and the complex dynamics of the international trade in farmed food products result in complicated value chains as fishing, reduction into FMFO, animal and aquafeed production, livestock and aqua farming, distribution and, finally, consumption of the end product often occur in different countries (Changing Markets and CWF, 2019). *Figure 1* below visualises a simplified adaptation of the reduction value chain, outlining the main materials inputted and yielded, as well as the main activities of actors within each segment. As noted, each of these steps could occur in a different country, facilitated by linkages through various agents and brokers.

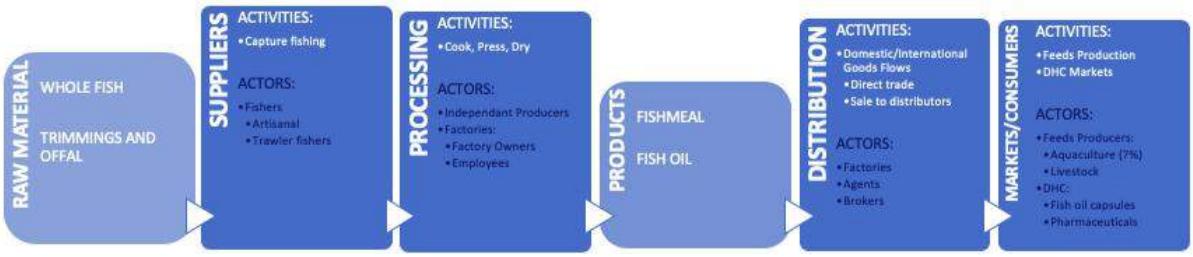

Figure 1: Simplified visualisation of fish reduction value chain (Source: author's own)

2.1.1 Raw Materials

FMFO is obtained from processing either fresh raw fish (est. 74% of global input) or trimmings and offal from the fishing industry (est. 26% of global input) (IFFO, 2020). The process of creating FMFO cooks, presses and dries the raw material into a brown powder or oil, which can then be utilised in its raw form or as a material to produce other goods. The industry is largely reliant on small pelagic forage fish species as they have a high oil content, are small in size (making them easy to reduce) and live in large biomass shoals (meaning they are easy to capture on a large scale) (Béné et al, 2015; Huntington and Hasan, 2009). Pelagics include two main types of fish; those with an affinity for temperate waters (such as chub mackerel and Atlantic horse mackerel) and those that prefer tropical waters (such as sardinella and Cunene horse mackerel). The species feed off plankton and have a considerably larger fat content than other fish, containing 60-72% protein, 5-12% fat and a high content of fatty acids EPA and DHA; more commonly known as long chain omega-3s (*ibid*). It is this unique amino acid profile and the high digestibility and oil content qualities that make them ideal for use in carnivorous fish diets, as well as in poultry, ruminant and pig farming.

Fluctuations in global FMFO output and production is naturally linked to the amount of fish landed in top producing countries. Large deviations are mostly linked to El Niño events impacting pelagic fish supply in top-producing countries in South America. The El Niño effect is a disruption of the ocean atmosphere in the tropical Pacific with influential consequences for weather and climate conditions across the globe. Consequences affect the FMFO industry as the weather conditions cause cold water to upswell along the coast of South America and push fish away from shorelines into harder to access waters, thus demonstrating the close relationship between the industry and unstable natural biosystems. However, research shows that some variation is also down to overfishing and unsustainable fisheries management. The unscrutinised proliferation of the fishmeal industry is leading pelagic fish in certain areas vulnerable to collapse according to marine experts the Lenfest Forage Fish Taskforce (LFFT), who observe that *"in many parts of the world where forage fisheries are most active, such as Peru, wider ecosystems are impoverished compared to their state prior to the onset of industrial reduction fisheries"* (LFFT in Changing Markets, 2020, p.16). The Taskforce has characterised pelagic fish as vulnerable to collapse even at low catch rates as they are a

primary source of food for many ocean predators, meaning that their health has major knock-on effects on larger ocean ecosystems.

2.1.2 The Producers

The production of FMFO is mostly concentrated to a few top producers in the Global South, with Peru, China, Thailand, Chile and Vietnam dominating fishmeal production (Seafish, 2018). The biggest players in the Global North are the United States (US), Japan, Denmark, Norway and Iceland (*ibid*). Much of global FMFO production has historically not been reported in country-specific detail and there is a more acute lack of information for the African continent (Hecht and Jones, 2009). At the time of writing this thesis, the most recently available information came from 2017, where the annual FMFO tonnage outputted by the top 31 producers of *'meals and similar animal feeding stuff, of aquatic animal origin'* was shared by the FAO (FAO YB, 2017). Just three African countries feature on the list - Morocco, Mauritania and South Africa – making it difficult to determine any spatial patterns of fishmeal production within the continent more broadly.

As figures pertaining to landed species from both capture and aquaculture fisheries becomes more robust, further information can be derived from the available data. FAO statistics detail the total fish and fishery production of each country globally and breaks this down into tonnage destined for food and non-food uses. Unfortunately, the data cannot be disaggregated specifically for reduction, however, it is reasonable to expect that much of the fish production for non-food uses is directed towards the reduction industry (FAO and World Bank, 2013; SOFIA, 2020). The below map (*Figure 2*) utilises the information from the FAO's latest Yearbook on Fishery and Aquaculture Statistics (2020) and visualises the spatial distribution of fishery production for non-food uses across the African continent. This map corroborates available FAO data, showing that Morocco, South Africa and Mauritania are main hubs of production. It also highlights production in the South-West African states of Namibia and Angola. Moreover, although faintly visible on the map and certainly with a significantly lesser output, a third hub of production can be seen in East Africa, in countries bordering Lake Victoria.

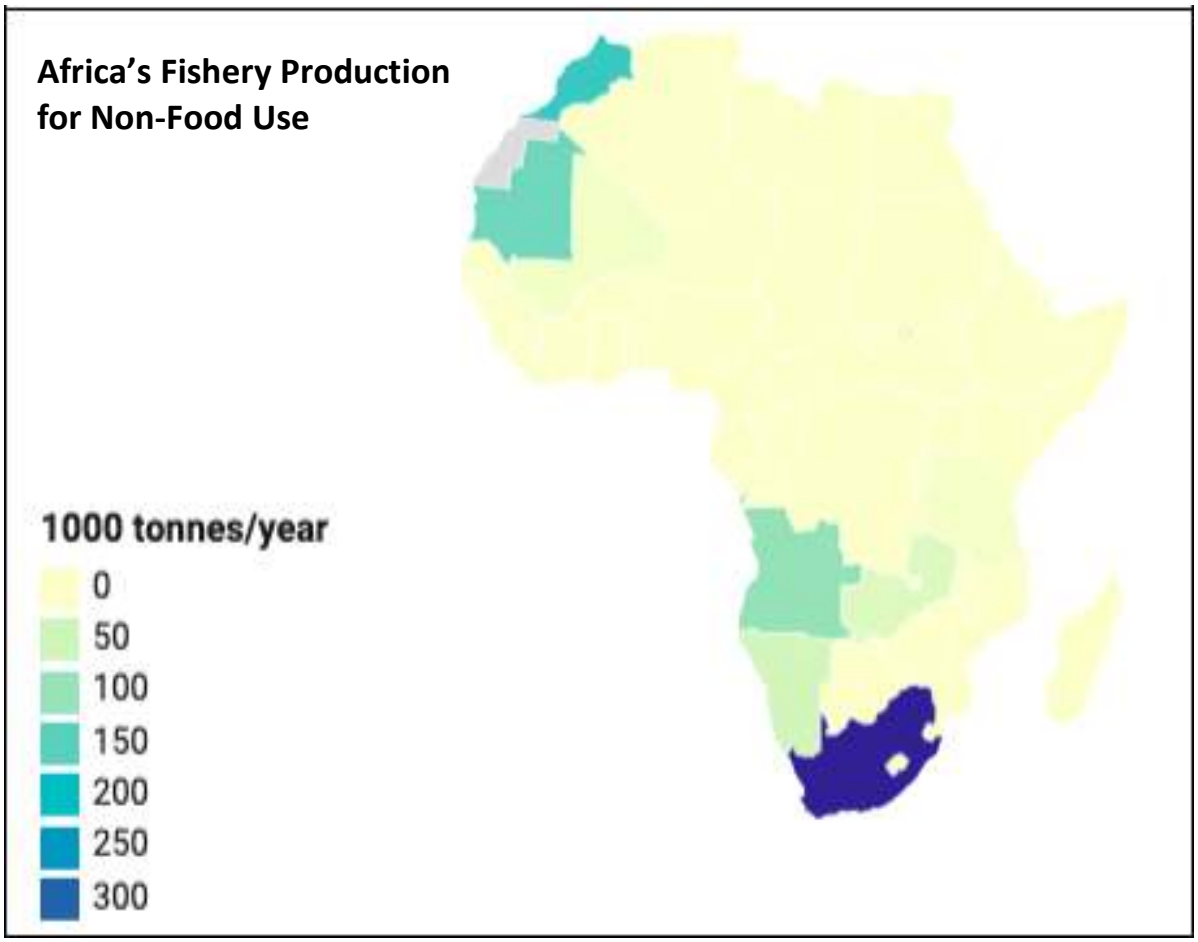

Figure 2: Map of fishery production for non-food uses adapted from FAO Yearbook on Fishery and Aquaculture Statistics (SOFIA) 2020 (Source: author's own using www.datawrapper.de)

2.1.3 The Process

The practice of fish reduction produces strong and putrid smells, both during the process and while the raw materials are stored, going some way to explain why the FAO warns plants must consider their proximity to habitation. Raw materials used in reduction are subject to lower quality standards compared with the fish destined for human consumption, and there is consequently less onus on fishermen or plants to store the fish in cool or hygienic conditions. The role of reduction plants is to reduce raw materials into usable products which can be sold on for further use. There are three main steps to this process. After receiving the raw materials, Step One is concerned with inspecting, cleaning and cooking the fish or offal at around 95^{o}C in order to separate the proteins and oils. During Step Two, the cooked fish is squeezed further to extract the remaining oil liquid. Step Three dries the material ready for sale as fishmeal (FAO, 1986). The main steps of this process are visualised in *Figure 3* below.

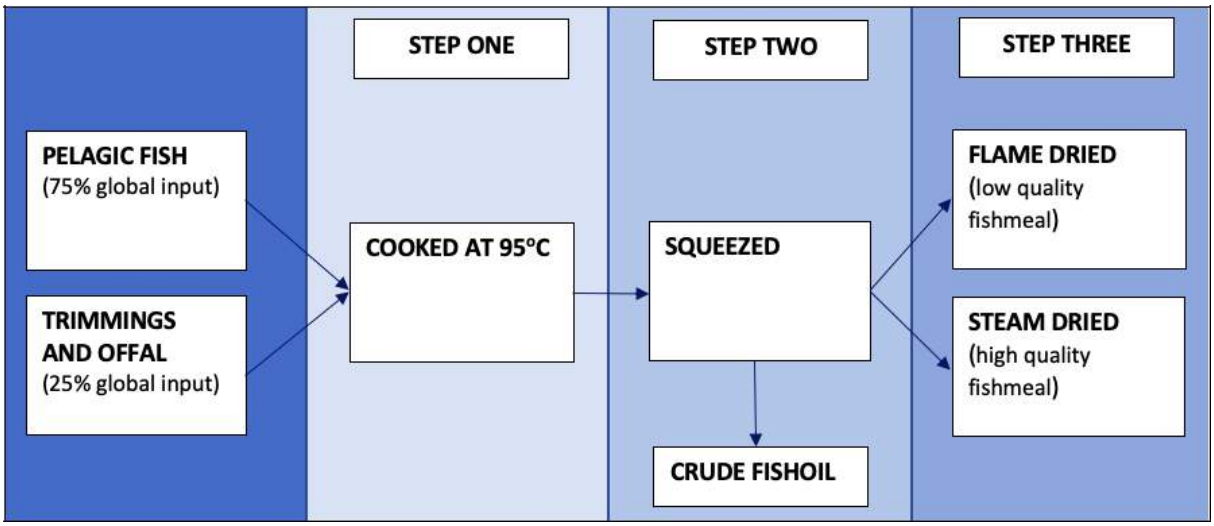

Figure 3: Process of fish reduction into FMFO (Source: author's own)

Naturally, this process requires specialised machinery and infrastructure, which varies depending on the scale of output. Most reduction plants will have grinders, cookers, pressers and some systems in place for storage, cooling, distribution and waste disposal (FAO, 1986). Moreover, some reduction plants also go on to make other products out of the FMFO, for example animal and aquaculture feeds. In this case, plants must make considerations for the extra raw materials that need to be stored and how the end products are to be manufactured (either into mash or pellets).

2.1.4 The Consumers

FMFO is most commonly used for supplying the animal and aquaculture feeds industries. As global demand for meat and fish for human consumption has increased, livestock and aquaculture farming has also proliferated, requiring vast amount of feeds to sustain the growth. Currently, the aquaculture sector takes an average of 70% of global output (SOFIA, 2020), making it the main consumer by a large margin. Aquaculture refers to interventions in the rearing process of aquatic organisms in order to enhance rates of production now accounting for approximately 50% of total fish production destined for both food and non-food use (*ibid*). The proliferation of the industry is reflected in the increased demand for fish; since 1961, annual global growth rates in fish consumption has been double that of population growth (*ibid*). Additionally, the growth of the industry is attributed to the increasing demand for specific fish species favoured by consumers in developed countries (FAO and World Bank, 2013). In 2016, 31% of the fishmeal destined for aquaculture was used

to feed crustaceans, 23% for salmon and trout and 15% to feed other marine fish (IFFO, 2020). In terms of consumer markets, China has consistently been the biggest importer of FMFO products due mostly to its large aquaculture industry. In 2018, Chinese imports totalled 1.47 million tonnes (FAO GlobeFish, 2019) despite the country being one of the biggest global producers of FMFO products itself. Following China comes the EU27, Russia and Scandinavian countries (SOFIA, 2020).

2.2 International Regulations

External scrutiny of FMFO value chains is challenging due to their complexity. There are many certification schemes available to be used by retailers and processors alike, though critics of these schemes assert that the certificates act as a smokescreen to illicit practice and perpetuate the lack of transparency and corporate accountability in the industry (Changing Markets, 2020). Firstly, schemes allow wild-caught fish to be directed towards reduction as long as they are 'sustainably sourced'. However, the definition of 'sustainable' in this case is highly problematic. The Marine Ingredients Organisation (IFFO) is the body which represents the reduction industry and its Responsible Supply (RS) standard currently certifies around half of global FMFO. The reliance on the IFFO standard creates a conflict of interest, as the organisation is responsible for both setting the standard as well as representing the interests of the lucrative global fishmeal industry. The organisation defends the use of small pelagics in the production of FMFO, maintaining that it is primarily produced from 'unwanted' fish, however this contradicts independent research showing that most fish directed towards the reduction industry is food-grade standard (Cashion et al, 2017).

2.3 Concluding Remarks

This chapter has given empirical context to the FAO recommendations regarding location selection to consider at the planning stage of opening a reduction plant. Namely, ample and regular supply of raw material at an acceptable price, capacity of the size of the plant to house the specialised machinery for processing the amount of raw material in question and consideration of the location of the plant in relation to habitation and harbours.

3. Literature Review and Theoretical Framework

This chapter begins by looking at the value chain framework, placing it within the context of global food systems encompassing procurement, processing and use of aquatic protein sources from capture fisheries for reduction. Following this, it elaborates on cluster theory, which is used to look more closely at the combination of factors which lead to geographical agglomeration of firms. These theories are used to better understand one another and contribute to a deeper level of analysis in this thesis; therefore, a section of this chapter explores how cluster theory can add value to value chain analysis. Examination of the theories and review of the relevant academic literature is used to build a theoretical framework through which research of three main hubs of Africa's fish reduction industry will be conducted. A conceptual model concludes the chapter, bringing together a way to visualise the discussed theories and how they intersect.

3.1 The Value Chain Framework:

A value chain refers to the "full range of activities that firms and workers perform to bring a product from its conception to end use and beyond" (Gereffi and Fernandez-Stark, 2016, p.7). This definition is useful as it shows that the framework encompasses the study of activities in a commodity chain and the often complex, relational linkages between all actors connecting producers with end consumers. Examining the actors in all steps of a commodity chain is also useful as it follows value-addition processes and can subsequently be used to maximise profits and other benefits for involved stakeholders (*ibid*). Identifying the roles and power dynamics between individuals, companies, agents, government and supranational organisations in a chain will distinguish more efficient activities at firm level, in broader regions and across different market scales (Gereffi and Kaplinsky, 2001; van Dijk and Trienekens, 2012).

Yet, there is an increasing academic focus on value chains that extends beyond assessment of economic efficiency and competitiveness. Rather, an emergent angle relates to social and environmental dimensions of commodity chains that examine industry structure, the functions of actors, the distribution of financial value (Béné et al, 2016) and the way in which global chains offer developing countries a way of integrating into the global economy (Bolwig et al, 2008; Gereffi and Fernandes-Stark, 2016; Kaplinsky and Morris, 2000; van Dijk

and Trienekens, 2012). The latter dimension sees value chain analysis exploring new areas such as employment and labour regulation, workforce development, gender issues and the greening of value chains (Gereffi and Fernandes-Stark, 2016). This new area of study arises from the four main dimensions of analysis in the value chain methodology defined by Gereffi and Fernandes-Stark (2016), which comprise of examinations of geographic scope, industry structure, governance within a chain, and the institutional context.

Firstly, looking at the geographic scope of value chain analysis is based on the increasingly common phenomena of global value chains, which see segments transcend state borders through improved transportation and telecommunication infrastructures. The process of globalisation has integrated more industries into the global economy as supply chains disperse. Increasingly, developing countries able to leverage low labour costs and a richness in raw materials to their own competitive advantage, tending to attract the segments of the chain requiring these assets, for example in production and processing stages. Consequently, firms and workers in separated locations are affecting each other more than previously and a shift towards regionalisation of steps of the chain can be observed. As highlighted in Chapter One, global reduction chains are interwoven and highly complex and the chain from fishery to form involves various stages: fishery, FMFO plant, animal/aquafeed producer, farms, processors, distributors, retailers and potentially many agents in between.

Secondly, industry structure refers to the identification and examination of the main segments of the chain being analysed. A value chain represents the entire input-output process from raw material and producers to the end product and consumer, with the different segments constituting different activities, processes and responsibilities. Most commonly these segments include design, production, processing, marketing and distribution, though naturally these are subject to variation depending on the context of the system within which the chain operates (Gereffi and Fernandes-Stark, 2016). Once the segments of a chain are identified, the characteristics of the activities and firms involved in them must be examined. This is important as different characteristics will alter the dynamics of the chain, for example if the chain is global or domestic or if firms are state or privately-owned. Identifying the typology of firms participating in steps of the chain shapes an understanding of its governance structure (*ibid*). With regards to the reduction industry,

some companies have a highly integrated value chain. Often within the aquaculture industry, one company and its subsidiaries control the operations of various activities including FMFO production, feed manufacturing, fish farming and distribution (Changing Markets and CWF, 2019). This creates complexities in the transparency of chains, hiding illicit and unsustainable practice within an industry.

Thirdly, another dimension of analysis is that of governance structures within value chains. This part of the value chain methodology distinguishes the "authority and power relationships that determine how financial, material and human resources are allocated and flow within a chain" (Gereffi, 1994, p. 97). The influence of governance comes from forces both internal and external of the value chain. As such, analysis begins with an identification of lead firms and focuses on their organisation and structure, examining the way in which they interact with actors they can exert power over and those which exert power over them (Gereffi and Fernandes-Stark, 2016). Globally, the value chain for fish and fish related products such as FMFO involve many intra-chain governance relationships (Gereffi et al, 2005) and contain numerous stakeholders ranging from fishers through to end consumers (Silva, 2016). Actors operating within the chain encompass a broad spectrum of typology, from independent fishermen to international trawling ships, subsistence FMFO producers to mass-producing factory operations. Relationships between these actors are complex and relational, reliant on interactions between individuals, multinational business, governments as well as a fragile and symbiotic connection to the natural environment. It is commonly accepted that any industry with a dependence on natural resources must incorporate an element of vulnerability within the business model (Anderies, et al, 2004; Gallopin, 2006). Moreover, interactions between stakeholders are not simply based on economic integration but also link to social networks, culture, technology and numerous other influences such as finite biological resources (Wang and Wei, 2007).

Internal governance looks at the interventions, strategic decisions and regulations imposed on an actor within the value chain by an actor also engaged in the value chain. Firms will often self-regulate in order to maintain standards, whether this is motivated by the goals of the business or external regulations imposed on the industry. Internally, governance in value chains occurs through formal and informal methods or 'instruments' (Boström et al,

2015). In a formal capacity these instruments refer to formal regulation and policy and relational networks, informal instruments are more related to the norms and unofficial practices that are characteristic of value chains in developing countries. On the other hand, external governance refers to the forces who are not directly engaged with the value chain but have the power to impose rules and regulations that impact activity within it. Common examples of these are government regulations, international standards and market forces that are highly influential in shaping internal business governance structures (Webber and Labaste, 2007). Also, in relation to governance factors is the idea of horizontal linkages within value chains, whereby actors enhance their position and competitiveness through mutually beneficial linkages with other firms (Gereffi and Fernandes-Stark, 2016). As well as knowledge sharing with other firms, horizontal linkages allow firms to share risks (Kaplinsky, 2004). This approach considers a broad range of factors in addition to formal and informal regulations, in particular the influence of culture and norms. Acknowledging the influence of horizontal linkages is crucial as it deepens the understanding of the way in which a chain can impact the local environment, society and economic system. Moreover, the idea of horizontal linkages and knowledge sharing is core to cluster theory, the importance of which is developed upon in the following section.

Finally, analysing the institutional context of a chain identifies how local, domestic and international conditions shape activities within each stage of the value chain (Gereffi, 1995). Conditions include the political and regulatory landscape which governs the cost and availability of labour, available infrastructure and access to other resources such as finance; the social context dictates the skill of available labour, and factors such as female participation and access to education (Gereffi and Fernandes-Stark, 2016). Related to external governance, institutional context also encompasses tax and labour regulation, subsidies, and education and innovation policy that can promote or hinder industry growth and development (*ibid*).

As a limitation to the value chain framework, it can be argued that the metaphor of a chain provides a simplistic way of viewing often complex and globally interrelated commodity chains, such as within the reduction industry. Problematically, terminology referring to value 'chains' and the 'links' within them connotates a vertical or linear relationship between producers and consumers (Bolwig et al, 2010). It is crucial to note that very few value chains follow this simplistic

pattern (Sturgeon, 2001), a consideration acknowledged in this thesis specifically, in the context of the fish reduction industry. In this particular commodity chain, referring to the production, distribution, and consumption of aquatic products for use in the manufacture of animal and aquafeeds, the raw materials, suppliers, manufacturers, distributers and consumers are linked both vertically and horizontally.

3.2 Cluster Theory

Cluster theory is related to the study of concentrations of specialised industries in particular localities. It exists as a theoretical framework for analysing the geospatial placement of businesses and associated institutions, as well as providing a useful tool for predicting suitable locations for industries to locate. Broadly, the theory states that concentrating industries in specific regions creates several economic and social advantages, which is widely accepted amongst academics, business owners and policy makers alike. A criticism related to the phenomenon of industrial agglomeration; is of its impact on the environment in which it occurs. The social environment is impacted as more industry is attracted to an area, with the emerging market bringing workers, customers, traders and other firms in related fields eager to capitalise on the opportunity. In industries reliant on raw materials, such as the reduction industry, the natural environment is impacted as animals are hunted, livestock reared, and organic material farmed. Nevertheless, industrial location selection and allocation can be central to communities seeking economic development and is useful in guiding sustainable development policy. While the topic of location selection is not necessarily related to the phenomenon of industrial clustering, it represents a central component in the field of economic geography. There is no single theory that can sufficiently explain the phenomena behind location selection and patterns of clustering as various behavioural, social and locational characteristics influence firm's location and decisions are often complex and context specific.

When discussing industrial clusters, the term can pertain to either some or all enterprises of a value chain agglomerating in one location, or firms operating within a particular segment of a chain clustering in close proximity to one another. Aside from this, in the literature, the term 'cluster' is used in two somewhat different ways. The first definition comes from Porter

(1990), who specifies that a cluster is a group of firms engaged in similar or related activities within an economy and that relationships between the firms benefit from being located near to one another. Notably, however, he does not consider geographic proximity to be a defining characteristic of clusters. On the other hand, Schmitz (1992) asserts that an industrial cluster is specifically characterised by the proximity of the firms within it, rooted in Marshall's (1890) analysis of the textile and metalworking districts of England, Germany, and France during the latter half of the nineteenth century. For the purpose of this study the second definition is adopted as, due to the geographic scope of this research focussing on the African continent, and as a result of poorer infrastructure systems there, weaker information sharing capacity and a culture that places a higher value on face-to-face communication, geographic proximity plays a more influential role than in other settings.

Due to the broad scope of cluster theory, and the contributions made from various fields of study, it can be used as a framework to help understand many topics at many different levels. At a microlevel of analysis, the primary point of reference is finance and is helpful in understanding the way in which geographical location can impact the financial performance of a firm (Lu et al, 2018). This thesis is primarily concerned with location selection as opposed to economic performance and therefore utilises mesolevel cluster theory. The mesolevel model refers to determining the factors influencing location choice and unpacking why geographic clustering occurs in the fish reduction industry (*ibid*). Notably, considering that policy is highly influential in land allocation and economic and industrial development, a significant portion of cluster theory analyses the importance of regulatory environments on industrial clustering (Brenner and Schlump, 2011), an element also considered in this thesis.

When considering the body of academic literature, four distinctive waves of cluster theory can be identified, which each offer contributions to the theoretical framework used in this thesis. The first strain, (Neo) Classical Economic Theory is focussed on decisions influenced by cost minimisation by the rational 'economic' man. In 1890, Marshall wrote *Principles of Economics,* the first ground-breaking piece of work in the field of clustering which has influenced classical 'agglomeration' theorists since. This wave assumes that entrepreneurs

act rationally on a cost-benefit analysis when decision-making related to all factors, including location selection. Marshall (1890) highlighted the concept of external economies of scale arising from a triad of influential factors, namely a pooled market for workers, availability of specialised inputs and services and technological spill overs. Furthermore, the neoclassical strain contributes to these assumptions with consideration of the other influential qualities including market competition, revenue, internal economies of scale and effects of varying combinations of production factors that focus on profit maximisation (Hoover, 1948).

Secondly, Behavioural Theory is a strand that considers industrial location choice as a part of a decision influenced by more than cost and profit. It is assumed that businesses tend to be rational and will therefore 'suffice', rather than constantly seek maximisation (Rahman and Kabir, 2019). In this case, it is understood that individual entrepreneurs will consider factors such as growth, risk minimisation and self-survival as a priority when making (location) decisions (Pred, 1967). Moreover, effecting change in spatially rooted industries is a slow process, and therefore 'path dependence' pertaining to historical factors matters when analysing geographic concentration, which also attracts sector-specific knowledge and innovation to particular locations (Malmberg and Maskell, 2002). Behavioural theorists would therefore be particularly concerned with historical analysis, observing how industries become rooted in particular localities over time.

Thirdly, New Economic Geography (NEG) emerges out of early agglomeration theory, focussing more closely on external spatial factors influencing the geographic clustering of industries. The main focus of NEG theorists is consideration of opposing centripetal (agglomerating) and centrifugal (dispersion) forces. While the centripetal forces refer to Marshall's (1980) externalities which lead to clustering, Krugman's (1992) 'Core-Peripheral Model' in *Geography and Trade* adds the dimension of dispersion forces including immobility of labour, increasing land rents and environmental problems arising from increased industrial concentration. This wave also acknowledges that patterns of clustering can occur as a result of an "accident of history" rather than active and conscious decision-making, linking to the ideas of 'path dependence' recognised by behavioural theorists. It is noted that, once

established, industries become “locked in” to geographical clusters and re-agglomeration occurs as a result of forward and backward linkages (*ibid*).

A fourth paradigm refers to the idea of ‘knowledge spillovers’. The knowledge-based economy has come to represent most modern industry, though knowledge-sharing and collective learning is also relevant in non-technical industries (Malmberg and Maskell, 2002). The central idea is that the key areas for competitiveness the modern globalised economy are knowledge creation, sharing, innovation, and learning arising out of localised industrial agglomeration. In the context of developing economies, there is a distinct emphasis on ‘tacit’ as opposed to ‘codified’ knowledge, ‘codified’ knowledge sharing is more closely linked with standardised mass production (Martin and Sunley, 2003). By contrast, ‘tacit’ knowledge refers to the understanding that shared cultural, linguistic and social norms are most efficient and vibrant when actors meet face-to-face (Storper, 1995). Hence, this approach understands that proximity of firms is beneficial in order to reduce the costs of transmitting knowledge across large distances (Audretsch and Feldman, 1996). As individual firms may be specialised in a particular aspect of the production process in a value chain, another may trade in inputs or final products. By fostering communication, enabling information sharing and facilitating technological upgrading, clusters enhance industrial capacity better than dispersed industries. In short, clustering appears to have the potential to enable African countries to overcome some of the barriers to industrial development (McCormick, 1998). As well as information-sharing, another way of measuring collective action is through what Schmitz (1999) coins ‘Joint Action’. This type of 'consciously pursued action' underscores the importance of inter-firm linkages and networking. There are four identifiable categories of joint action in industrial clusters; including bilateral, multilateral, horizontal or vertical arrangements. In bilateral cooperation, two firms work together to share some equipment such as a fishing boat or team of fishermen. Within a multilateral arrangement, a larger group of firms join together in a lobby, union or other association with a common purpose. Vertical cooperation occurs when firms involved in different stages of a value chain work collectively and horizontal action refers to collaboration between competitors within a chain or segment of a chain (*ibid*).

Related to these waves of cluster theory, authors have made various distinctions of the way in which influential features affecting location decision can be classified. Useful classifications include van Noort and Reijmer's (1999) distinction between 'pull', 'push' and 'keep' factors, which refer to features driving industries toward a location (e.g. market access), those which drive industries to relocate to a new location (e.g. unfavourable legislation) and those which influence firms to remain in their current location (e.g. an unwillingness to waste human resources), respectively. Martyniuk-Peczek et al (2017) refer to hard or 'measurable' factors such as a proximity to markets, labour, resources, production space and transport, and soft or 'immeasurable' factors such as quality of life and community ties, which are relative to subjective judgement. For the purpose of this thesis, I will be referring to the work of Dicken and Lloyd (1990), who acknowledge an interrelated trio of 'internal', 'location' and 'external' factors. This categorisation builds a theoretical framework for this thesis, as it classifies the most influential factors and allows them to be analysed against one another. This is expanded upon in *Section 3.5*. There are some factors imbedded in these classifications which occur more frequently as influential elements, arguably suggesting that they are more significant in the debate on industrial clustering. These influential factors vary from one industry to another, as the literature tends to focus on one particular industry and therefore the subjective judgments of entrepreneurs become markedly more important factors in the location selection analysis (Rahman and Kabir, 2019). In modern economies the significance of some physical location factors, such as access to raw materials, transportation, industrial energy are becoming less important as technology, infrastructure and economic systems improve.

Naturally, as with any theoretical framework, there are limitations to cluster theory. It must be noted that clusters are 'fuzzily' and 'chaotically' defined (Malmberg and Maskell, 2002; Martin and Sunley, 2003). As Krugman (1992) pointed out, when defining his field of economy geography, it is not worth trying to define the subject as more than "the location of production in space" (p.1). Arguably, such chaotic definitions are useful, as they root the "evolutionary nature of the cluster" (Lazzeretti et al, 2014, p.22). The broad definition integrates theories from a variety of different fields of study such as economics, management, regional studies and urban planning amongst others. The broad definition also enables policy makers to apply cluster strategy to various different socioeconomic contexts, useful when

studying developing economies, which may not have been considered in other theoretical analysis.

3.3 How does cluster theory add significance to value chain analysis?

Cluster theory and value chain analysis both offer theories that can be applied to cases independently, even though they are closely interrelated. While each can be utilised separately in relation to the study area, for the purpose of this research they are used together in a way that is useful in adding value to the depth of analysis. GVC theory offers a conceptual framework within which the dynamics of the economic geography of industries can be better analysed. In complex value chains, academic focus is often broad in scope and considers the chain as a whole entity rather than assigning focus to the co-ordination of actors within a particular segment. Within the reduction value chain. focus is most commonly placed on exploring power dynamics, distribution of financial authority (Fabinyi et al, 2018) and barriers to access in the chain (Bolwig et al, 2010). On the other hand, cluster theory allows academics to zoom in to look at what relationships are in place within a particular segment of the chain. In the case of this research project, focus is centred on the manufacturing segment of the chain concerned with the reduction of small pelagics in FMFO. This facilitates exploration of the various factors impact activity within this segment and provides the opportunity to study relationships between reduction plants and the potential implications of these relationships on location selection.

3.4 Conceptual Model

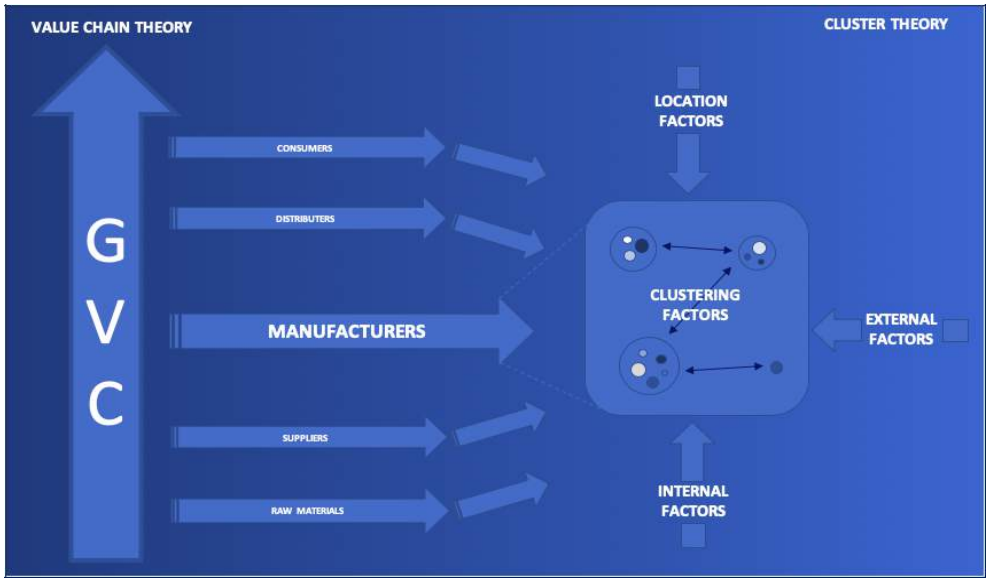

Figure 4: Conceptual model (Source: author's own)

This conceptual model visualises the intersection of value chain and cluster theory described in *Section 3.3*. The model demonstrates that influential features from both inside and outside the chain lead firms to situate in geographic proximity to one another.

3.5 Theoretical Framework

Based on the relevant literature and the empirical case offered by expert bodies in the reduction industry, the following theoretical framework has been established. The factors influential to industrial clustering of FMFO plants have been categorised using Dicken and Lloyd's (1990) 'internal', 'external' and 'location' labels. A fourth category entitled 'clustering' factors has also been included. The addition of this fourth category is key to this research, as it relates to the core premise of the study in identifying the potentially beneficial effects of geographic proximity in the reduction industry. These features are deeply interconnected and relational; this study takes the stance that the most logical starting point for analysis is to establish 'internal' features of a cluster and understand the others in relation. The framework is designed to guide the operationalisation of this research, providing measurable and tangible points of investigation that will ultimately help to answer the main research question.

Internal Factors:

Factor	Justification	Indicators and Research Points
Business Structure	Knowing the typology of businesses operating within a cluster is crucial to analysis and impacts most other influential features. The structure of a business, for example whether it is export-based or domestic, mass-producing or small-scale will impact its requirements for location selection.	• Typology of businesses: o Export /domestic o Production rates o End consumers o Integrated value chain?
Ownership and Finance Structure	Knowing the ownership structure of a business and how it is funded is crucial to cluster analysis. Conclusions on influential factors cannot be drawn without understanding these nuances.	• Who owns the company? o Independent? o Conglomerate? • Government-funding?

Figure 5: Internal factors of investigation and justification (Source: author's own)

Location Factors:

Factor	Justification	Indicators and Research Points
Access to raw materials	As highlighted by the FAO Fisheries Department (1986), this is one of the most influential factors guiding location selection in the reduction industry, as plants are reliant on a steady supply of bulky raw materials. When processing perishable materials, manufacturing plants should be situated near the source of these materials, particularly when their cost is a significant portion of the total value of the end product (Renner, 1947). Related to this, firms must consider price of the raw materials, length of the season (meaning how many days the plant can be in operation) and the influence of other variables on the supply of pelagic fish such as climate change.	• Do plants have adequate access to raw materials? • What is the cost of raw materials? • Are natural stocks depleting? • Is climate change or environmental degradation affecting stock levels?
Size of plot available	It is crucial to consider the amount of land available when making a choice on location, a factor closely related to expected yield or output of a plant. Factories must be able to accommodate the bulky cooking and pressing machinery necessary for the fish reduction process (FAO, 1986).	• How much land is available or allocated? • Is there adequate space to store raw materials or the end products?
Transportation infrastructure	Reliability of transportation infrastructure must be considered by plants in order to ensure constant supply of raw materials and shipment of end products. Reliability should be prioritised over cost minimisation (Jones and Woods, 2002).	• What transportation is available nearby? • What services are utilised by the plants operating in the area?
Access to market	This factor considers 'markets' referring both to consumer and industrial markets; it is crucial to distinguish the difference between	• How do plants access raw materials?

	the two (Jones and Woods, 2002). Businesses manufacturing products for consumers tend to locate in urban areas, whereas industrial goods producers will locate in regions nearer to the industries that represent the end users of those products. Naturally, export-based companies will need to consider proximity to trading hubs, linking 'access to market' closely with the factor of 'transportation infrastructure' and demonstrates the interconnectedness of all features.	• How do businesses access end users? • Do plants use agents or separate suppliers? • Do companies have monopolies on different steps of the chain?
Labour	Adequate access to a (skilled and productive) workforce is necessary for businesses though it represents a complicated location feature as it is closely linked with 'external' factors influenced by government legislation such as trade union authority, minimum wage rates and other labour laws (Djwa, 1960).	• Who constitutes the main workforce? • What skills are necessary for different jobs?
Industrial energy	While the accessibility to industrial energy has become less important in modern economies, it remains influential in some developing countries. Adequate access to industrial energy such as water and electrical power sources will attract industries to a particular location.	• How do firms ensure adequate and reliable energy?

Figure 6: Locational factors of investigation and justification (Source: author's own)

External Factors:

Factor	Justification	Indicators and Research Points
Regulatory Environment	External factors are inextricably linked to the attitude of government and other influential regulatory bodies (Yamawaki, 2002). Regulations can often represent bottlenecks or additional costs for businesses; therefore, a positive attitude of the government will	• Free Trade Zone? • Sympathetic labour or environmental legislation? • What is the taxation policy for the industry?

	draw further investment to an area. Benefits are reflected through sympathetic legislation and taxation policy, as well as the provision of infrastructures and services to a location. Free Trade Zones are manifestations of this, representing designated areas which do not need to apply to regular domestic labour or environmental policies.	• Specific infrastructure provisions?

Figure 7: External factors of investigation and justification (Source: author's own)

Clustering Factors:

Factor	Justification	Indicators
Information and Resource Sharing	This is related to knowledge spillover enhancing capabilities of businesses operating within a cluster.	• Technology or knowledge spillover?
Joint Action	The importance placed on proximity to other firms is deserving of its own category, concerned with exploring patterns of and potential benefits related to knowledge and resource sharing amongst firms within a cluster or chain.	• Is there an industry union? • Evidence of resource sharing? • Vertical or horizontal action?

Figure 8: Cluster-related factors of investigation and justification (Source: author's own)

4. Methodology

This chapter describes and analyses the data collection methods used during this study, setting out a distinct research design and methodology. For each case study, the research was conducted in two phases. The preliminary phase was concerned with identifying reduction plants operating within the observation areas and in the second phase, the explanations behind the development of a reduction industry and the apparent patterns of industrial clustering were investigated. Information collected through both phases was recorded as per the theoretical framework set out in Chapter Three, which ultimately facilitated the interpretation and analysis of results. Various exploratory research methods have been used to uncover the influential combination of factors motivating location choice, the benefits and limitations of which are elaborated on in this chapter. In addition to establishing a research design and operationalisation plan, this chapter begins with a discussion on the challenges faced due to the unfortunate timing of the global COVID-19 pandemic.

4.1 Challenges of COVID-19

During the planning stage of this research project, the intention was to explore the intricacies of the FMFO production industry within a solely national setting. The original research design, operationalisation plan and preliminary research into empirical context was centred on industrial clustering evident in Kenya. Much of this work had already taken place in preparation for a two-month period of fieldwork from March – May 2020. The research intended to build on the findings of the 2019 Master's student having identified three key FMFO production clusters around Lake Victoria, Nakuru and Nairobi, whilst conducting her own fieldwork in the country. Utilising this existing research and new connections made on the ground, the outcome of the original research design was anticipated to be a comprehensive map of all Kenya's reduction clusters, establishing the typologies of factories within said clusters and power dynamics between them. From this, it was expected that a robust interpretation of influential features of agglomeration in the face of competing demands for affordable sources of raw materials could be made. The previous working title was; "*What factors influence location selection and patterns of industrial clustering in Kenya's fish reduction industry?*". However, due to the proliferation of the global COVID-19 pandemic and subsequent closure of borders across the globe in March 2020, it was necessary for this existing plan to be drastically altered as fieldwork could no longer be carried out. As such, the

scope of the academic study was broadened, as well as the geographical focus expanded. As established in previous chapters, this research project is now concerned with uncovering the combination of influential forces at play in two contrasting African contexts, requiring a desk study model to get results. The study has become a partly socio-economic analysis of the two case studies, reliant on a stronger understanding of historical accounts of the industry in each country and the observations of interviewees and key informants.

4.2 Units of Observation

The two units of observation in this study are industrial clusters identified in Mauritania and Kenya. The two areas, representing clear agglomerations of fish reduction factories, have been selected through 'purposive' or 'judgement' sampling methods, meaning that the judgement of the researcher has been used to select the unit of analysis using their own 'expertise' in the field (Black, 2010). In this instance, these units are examples of deviant case sampling, whereby contrasting cases are used to provide a more nuanced way of understanding and analysing the patterns that emerge during research. By studying contrasting units, it is possible to gain a better understanding of the more regular patterns of behaviour and whether an unknown factor is exerting a common effect on a set of units (Seawright, 2016).

4.3 Research Questions

The main research question of this paper is: "*How does the industrial clustering of fish reduction plants occur in African contexts?"*. In order to answer this, the study will address some sub-research questions in relation to each case study and compare, contrast and discuss the findings in the final chapter. The sub research questions are:

1. W*hat has led to the development of a reduction industry in [Mauritania/Kenya]?*
2. W*hat features of the industrial cluster in [Nouadhibou/Nakuru] have encouraged location selection for entrepreneurs?*
3. *What are the perceived benefits of proximity to other firms in the industrial cluster in [Nouadhibou/Nakuru]?*

4.4 Operationalisation

A mixed-methods approach to this research has been necessary owing to the nature of the project, which explores intricacies of industrial development, infrastructure, business structure and decision-making within a value chain reliant on complex relationships between invested stakeholders, often serving their own interests, and a fragile biological system. As such, a parallel data collection design has been used, whereby both qualitative and quantitative data has been utilised and triangulated to enhance legitimacy in the findings and analysis. The theoretical framework set out in *Section 3.5* of Chapter Three is the most useful resource to this operationalisation plan, as it offers a tangible and measurable reference point that helps to build a picture of the most influential clustering factors relative to each unit of observation. Quantitative data was used to understand measurable features of the framework, for example the size of land and transportation links available, and qualitative data was adopted in order to explore others, such as the perceptions of entrepreneurs in relation to this data, the regulatory environment and political involvements in the industry. Qualitative data garnered from interviews with key informants was used to assist the explanation and interpretation of these findings (Creswell, 2003). The timescales, research methods and outcomes of the two phases of this study are set out below in *Figure 9*.

Phase	Time	Activities	Outcomes
Phase One	March – May 2020	**Analysis of secondary data sources**, including existing reports and academic literature on chosen FMFO production clusters. Using **mapping tools** (Google Earth, Google Maps) to corroborate findings from secondary sources. **Online platforms** (Google, LinkedIn, social media) and **preliminary discussions with key informants** to build a more robust contact database.	Established **empirical context** of both research areas. **Maps** of FMFO production clusters with locations of factories clearly marked on them. Substantive **database of fishmeal factories** in each cluster including location co-ordinates and any available contact details. **Database of useful contacts**, industry experts and key informants. **Theoretical framework database** (Excel) populated with initial research and findings.

Phase Two	Jun – Aug 2020	Survey questions developed (and translated where necessary) according to available information to be sent to factory owners in each cluster. **Surveys** administered to contact database of factory owners and managers. **Semi-structured interviews** with key informants and experts, snowballing techniques used to identify further contacts. Further reading of **academic literature and reports** relevant to ongoing interviews/research. Results of interviews, surveys and further reading recorded into theoretical framework.	**Theoretical framework database** populated with more substantive findings from various research techniques. Finalised **maps** created with any updated information found through 'snowballing' techniques. Up-to-date **databases of fishmeal factories** and **useful contacts** for both case studies.

Figure 9: Operationalisation timeline including main activities and outcomes (Source: author's own)

4.4.1 Phase One

Phase One mapped the spatial distribution of Mauritania and Kenya's reduction industries, the results of which were used to establish a sound context of the specific units of observation in Nouadhibou and Nakuru. This began the process of building useful contact databases that were integral to Phase Two of the research. This part of the research design utilised contact with key informants, online search engines, mapping software, existing reports and data resources, as well as related academic literature. While resources pertaining specifically to this topic are generally scare, there have been some official registries and previous reports on industrial FMFO processing facilities that have helped to inform this study including:

- European Commission: list of establishments approved for export to the EU (2020)
- Nouadhibou, Mauritania:
    - Greenpeace: A Waste of Fish Report (2019)
- Nakuru, Kenya
    - Kenya Market Trust: Feed Millers Addresses and Physical Location in Kenya (2019)

These relatively up-to-date resources have been invaluable as a starting point to identifying the facilities operating in each area and the knowledge garnered from them have helped to inform preliminary discussions with contacts. Without being able to visit sites to corroborate and cross-check the information, creative and exploratory research methods were necessary in order to build more accurate pictures of the areas. Online searches using Google and the affiliated resources of *Google Maps Street View* and *Google Earth Time Capsule* were used to verify information, identify further facilities in operation and establish in what order plants were opened. Without these useful tools it would have been near-impossible to gather this data using a desk study model, due to the scarcity of information about the reduction industry in these countries. The location of plants was stored in an Excel database named 'Active Factories', which also contained contact information and any further information on their typology.

In addition to this database, another two databases were developed as tools that would be necessary during Phase Two of the study and for the data interpretation and analysis to follow. Each Excel database was split into two separate sheets, with each sheet relating to either Mauritania or Kenya, thus allowing the collated data to be easily accessed and compared at a later time.

Database	Data Included	Purpose
Active Factories	This database corresponded with the maps generated for each cluster, including the names and co-ordinates of the identified facilities. Any other relevant information identified such as ownership structures, date opened, capacity, type of raw material used, websites and contact details were also included into this spreadsheet.	This corroborates the information in maps of research areas. Facilitated interviews with factory owners and affirmed knowledge when speaking to other key informants. Useful in guiding analysis of 'internal' factors as per theoretical framework.
Useful Contacts	A database of contact information for key informants on the ground in each unit of	As this study has relied on a snowballing method of accessing

	analysis and other useful contacts in related fields of academia or areas of expertise.	information, this database was necessary in order to keep track of conversations and interviews with informants. This database is also a useful resource for future studies into the industry by UvA students or other researchers for the SmallFishFood project.
Theoretical Framework	For each unit of analysis, a spreadsheet corresponding to the theoretical framework was generated and populated with relevant information as it was uncovered.	This method of storing data is useful in such a comparative study in order to organise the argument and draw comparisons and conclusions.

Figure 10: Operationalisation databases created for the purpose of this research project (Source: author's own)

4.4.2 Phase Two

This phase was concerned with uncovering the reasons behind the development of a reduction industry and the specific factors leading to agglomeration in each unit of observation. This phase employed qualitative multiple case study design in order to identify why the clustered location pattern of FMFO factories in each unit of observation had evolved. This method was necessary as the study was addressing sub-research questions for which 'why' and 'how' questions were necessary. This is when the researcher has limited or no control over events and the study is focussed on a contemporary phenomenon within real-life context (Yin, 2014). Due to the distance study, interactions with entrepreneurs were limited to electronic means, which drastically lessened the probability that targets would respond to calls for an interview or answer a survey.

Surveys (Online/Telephone):

Initially, all entrepreneurs whose details were identified during Phase One were contacted using the available communication information and sent a simple online survey about their

reduction plant, their views on why the particular location was selected and what the effects of geographic proximity meant for them. It was chosen to send a survey as they could be accessed in any location and could be answered to a desired extent by the respondent. In many cases the information requested could be sensitive and respondents may be wary of sharing this in an interview and surveys provide a way of anonymising results, should the participant wish. Secondly, the written aspect of a survey allows for less error in the interpretation of spoken interview responses in which the interviewer uses their own judgement in interpreting answers. Furthermore, due to language barriers, surveys with simple and direct questions could be easily translated, which was necessary in the Mauritanian case where working languages in the industry are Arabic, English, French and Chinese. Unfortunately, of the eleven surveys sent in Mauritania, none were returned, meaning that a different approach to accessing information from entrepreneurs was necessary.

Due to the low response from the email surveys in the Mauritanian case, interactions occurred using non-probability convenience sampling with informants involved in the operations of reduction factories who had key insights into strategic location selection. This was based on the ability to find a useable contact, their willingness to take part in an interview or respond to written questions and their availability. It was possible to gain responses through carefully building relationships with other contacts in the country, explaining the purpose of the research and seeking their assistance in making a connection. Using this technique, two WhatsApp interviews were conducted with contacts involved in plant operations, one a Mauritanian ex-employee of a factory in Nouadhibou and a Dutch agent connecting plants with international buyers of FMFO. In Kenya, the research design was presented to a researcher at the KMFRI, who facilitated the outsourcing of a junior researcher to contact reduction plants in Nakuru and interview available participants using the previously prepared survey questions. Using a budget set aside by the SmallFishFood Project, this field research was conducted in July 2020, the results of which have been presented in this paper. There were 4 online surveys completed by managers and owners of reduction plants and telephone interviews took place with a further 5 participants. The telephone interview questions posed to all individuals involved in plant operations followed the same format as open-ended queries based on the questions originally created for the online survey. Putting

the same questions to all respondents is crucial as when each respondent answers the same set of questions, a generalisable overview can be provided with the opportunity to identify more definitive arguments.

Semi-Structured Interviews:

Alongside the search for entrepreneurs to contact about their opinions on location decision, key informants and industry experts were interviewed in order to gain a more rounded impression of the development of a reduction industry in both countries. Participants outside the chain were selected following a purposive sampling technique, using various contacts and connections made available through UvA and other sources. These informants were asked about their views on the proliferation of a reduction industry the phenomena of industrial clustering. All interviews took place over Skype and WhatsApp call using an informal style with semi-structured questions prepared, this interview style was employed as it allows the interviewer to answer unscripted follow-up questions to the other predetermined questions (Bryman, 2016). For each case study, three industry experts were interviewed, including academics, government partners and actors working for industry-related international organisations. All of the interviews were recorded with the permission of the interviewee, which meant that the notes written up after the discussion gave more accurate and reliable data.

4.5 Research Limitations

Language and cultural barriers have occurred throughout this research in the same way that they would have done with the original research plan to go to Kenya. These barriers will occur with any investigation conducted in a country that is not your own. Though English is widely spoken across Africa, there are many tribal languages spoken in rural areas which creates difficulties when making contact with smaller reduction factories and independent traders. In Kenya, English is broadly spoken and did not pose too many issues in the research process with contacting key informants on the ground. However, when making contact with informants in Mauritania for interviews it was difficult to find English-speaking contacts as French and Arabic are the most widely spoken languages there. Additionally, as around 50% of the factories in the identified cluster in Nouadhibou were Chinese owned and managed, it was limiting to the number of entrepreneurs that could be contacted for interview. One

WhatApp interview with a Mauritanian contact was conducted in French using Google Translate, and therefore some of the interpretation of responses might be affected.

Secondly, using a desk study model for research posed challenges in getting the most accurate account of the make-up of the industrial clusters being examined in each case study. In normal times, assessing the number of operating FMFO facilities is complex due to fluctuations in raw fish supply, seasonality of fishing activity, factory capacity and ongoing litigations with authorities and local populations (Greenpeace, 2019). Using the new research model, it was pointedly more difficult to build a comprehensive picture on the definite structure and make-up of the clusters without the opportunity to make in-person observations, walking tours of the areas and personal interviews with factory workers and managers. In both research areas, the industry lacks transparency on ownership structures, inputs and outputs of operations, trade data and environmental impact assessments, making information gathering from a distance a difficult task. Contact was limited primarily to email and video calls, which added considerable barriers to accessing informants working in factories, who often do not have the time to give interviews and are likely not easily accessible through electronic means. While it was possible to contact one ex-manager of a plant in Mauritania, the distanced communication between the United Kingdom and African state may have perpetuated a feeling of distrust of the interviewer, meaning that the interviewee was unwilling to give specific details on intricacies of management structures or goals of businesses so as not to jeopardise the business interest.

A final limitation regarding data collection came as a result of outsourcing researchers in the Kenyan case, as follow-up questions could not easily be carried out within the given timeframe. Had the surveys been carried out personally, either in person or by telephone/Skype call, then further necessary information could have been gathered from participants. Interpretation of the results could not be as accurate as if the information has been gathered and written up personally.

4.6 Ethical Considerations

The nature of this research into various business structures, ranging from small-scale producers to multi-national partnerships with governmental ties requires some serious

ethical considerations. All key informant interviews taking place over Skype and WhatsApp Call were recorded after participants gave oral consent. To reaffirm this, all participants were contacted in follow-up emails to ensure that confidential and sensitive information could be included in this paper. Moreover, when discussing more sensitive information, this paper has ensured anonymity of the contact.

4.7 Concluding Remarks

This project's original research design was highly disrupted at a formative stage of its development, however through adaptability and resilience the challenges have been overcome. There have been problems with accessing certain pieces of data and evidence, however this could have occurred even with field research due to my age, gender and the nature of project. Owing to the complexity of the topic, a mixed methods approach has been used to source relevant information from various actors and this, combined with use of secondary data, increases the validity of the information. Empirical findings pertaining to Mauritania and Kenya are presented in Chapters 5 and 6, respectively.

5. Exploring the catalysts behind Mauritania's fish reduction industry

This chapter sets out the combination of factors influencing industrial agglomeration of FMFO production plants in Mauritania. The focus of this particular study is on the northern port town of Nouadhibou, where an industrial cluster has formed on a single stretch of land over the last 15 years, with only a handful of plants located at other sites in the town. The chapter discusses two aspects of the significant features of reduction plant clustering in Mauritania. The first aspect refers to those factors that have drawn the industry to proliferate from a negligible part of the economy to a key contributor to national GDP in a significantly short period of time. The second aspect covers more specific features of the case of Nouadhibou, which have led to the formation of the highly productive cluster in the town. The empirical findings in this chapter are supported by interviews with several industry experts based in the EU and Mauritania, as well as contact with two informants working within the reduction chain itself. It is demonstrated that there are persuasive powers keeping levels of fishmeal production booming despite damaging ecological and socio-political side-effects evident domestically and the west African region more broadly.

5.1 Country Profile

Mauritania is a large and sparsely populated state bridging the area between the Arab Maghreb and Western sub-Sahara. To the south, the country shares a border with Senegal, to the east with Mali and to the north with Western Sahara, the contested territory partially occupied by Morocco. Mauritania is located in a constraining physical environment, which is reflected in its many major social, political and economic challenges. It is classed a lower-middle-income country, with Gross National Income at $1,660 in 2019 (World Bank, 2020). While Mauritania's GNI rankings were boosted from low to low-middle, the recent data shows that development indicators trail far behind Sustainable Development Goal (SDG) targets. In 2018 infant and child mortality remained high at 75.7/1,000, versus a target of 45/1,000 (UNICEF, 2020). Access to electricity is only 20 percent compared with the 32 percent Sub-Saharan Africa (SSA) average, and only 50 percent of the population have access to improved water sources (World Bank, 2016). Thus, the Human Development Index (HDI) unsurprisingly lists Mauritania as "Low Human Development", ranking it 159th in the world (HDR, 2019). Moreover, discussions with Mauritanian contacts further highlight the lack of social security

for the largely nomadic population, it is often the responsibility of NGO's, international aid packages and individual Mauritanians working in the small formal sector to provide support for tribes of up to many thousands of people.

In 2018 the population was estimated at 4.4 million (World Bank, 2020), though exact figures related to this and other demographic indicators are hard to project due to the nomadic nature of the population. In 2014 the urban population only marginally overtook the rural, with urban life densely condensed into a few populous areas while rural dwellers remain largely and sparsely dispersed. A further issue affecting reliability of official demographic data is the ongoing discussion on who is defined as Mauritanian. There are three main ethnic groups within these discussions, the White Moors (or Bidhâns) are the ruling group with monopolies on strategic positions in the state apparatus and who are inextricably linked to the strong military presence in political life. The Black Moors (or Haratin) are a marginalised group despite being Arabic-speaking and some having loose affiliations to the White Moors, while the "Black Africans" (Haalpulaaren, Wolof, Sooninko and Bamana) mostly live along Mauritania's borders with Mali and Senegal and are almost exclusively left out of political life (BTI, 2020). The politicisation of identity and strong military role in the country since independence in 1960 have naturally shaped the socioeconomic problems evident today.

The current President Ould Ghazouani is a close friend of his predecessor, Ould Abdel Aziz, who had ruled the country since 1978. The autocratic nature of Mauritania's regime has led to widespread corruption in political life which has also translated into the business realm. This corruption is undisputed by observers of the situation, a World Bank report illustrates that *"large firms with political connections continue to dominate state procurement contracts and import markets, even in the presence of cheaper local producers"* (2013, p.13). The World Bank (2016) further highlights the oligopolistic tendency of the economy to have a small number of Bidhân businessmen and their families controlling most key product markets through conglomerate structures including fisheries, mining, construction, hotels and even credit provision by banks. A source interviewed for this research framed it well, stating *"we are a population of 4.2 million, you could take 500,000 out of that and that would be the economically active population – if you cut the intellectuals and consultants then you end up with a very small group of people who have*

power – conflict of interest is a very foreign concept here" (Sidatt, May 2020). This high-level involvement also pervades the fisheries sector and is closely linked to the many reduction plants opening in the country, the relevance and repercussions of this are expanded upon in later sections of this chapter.

The majority of Mauritania's land mass is covered by the vast Saharan desert (78%), while the western border is formed of a 720km long Atlantic coastline with a continental shelf of 32 366 km^2 holding an exclusive 200-mile economic zone covering an area of 162 166 km^2 (FAO Mauritania, 2020). It is these two juxtaposed environments that home Mauritania's valuable natural stocks, iron-ore and fish, which constitute the two main pillars of the country's economy. A report by the World Bank (2016) maintains that the economy is likely to remain dominated by export of its extractive industries, which can be attributed to two main reasons. First, the location of Mauritania on Africa's West Coast places it close to Spain's Canary Islands, where goods can easily enter EU and global trade markets. Historically, Mauritania was considered Africa's gateway to the world for this very reason. Secondly, industry is export-based as Mauritanian's will not be easily able to exhaust their wealth of mineral and hydrocarbon resources domestically due to the pointedly low population size. Exports of the extensive deposits of iron ore in the desert account for almost 50% of GDP (*ibid*) and while official statistics are hard to come by, the FAO estimates that fisheries contribution to GDP varies between 4-10% (FAO Mauritania, 2020). Problematically, though the mining and fishery sectors represent around 60% of the country's revenues, they make very little contribution in terms of employment (World Bank, 2016). For example, the fisheries sector currently employs an estimated 180,400 people, of which a substantial amount are migrant workers (FAO Mauritania, 2020).

The region's waters have always been a rich fishing area with the so-called Canary Current home to almost 600 inventoried fish species of which 200 are subject of commercial exploitation (*ibid*). The main commercial resources are: Cephalopods (octopus, cuttlefish, squid); Demersal fish (bream, soles, rays and sharks, red mullet, hake etc); Crustaceans (coastal and deep sea shrimp, lobsters, crabs); tuna species (albacore, yellowfin, skipjack) and, of course, small pelagics (sardinella, sardines, horse mackerels, mackerel, anchovies). The small pelagic genus thrives in the conditions present in the Canary Current, which occupies

the ocean between the namesake Canary Islands and along the west African coast from Senegal and the Gambia, past Mauritania and up to Morocco. The upswelling tendency of the current replaces surface water with deeper cold and nutrient-rich water, which in turn stimulates primary productivity crucial for feeding pelagic fish. As such, three species of small pelagic fish have consistently made up a majority proportion of the landed catch in the region; the round sardinella (*Sardinella aurita*), flat sardinella (*Sardinella maderensis*) and the bonga (*Ethmalosa fimbriata*) (*ibid*).

Figure 11: Canary Current in relation to Mauritania (source: onesharedocean.org)

Crucial to note, national demand for fish for human consumption in Mauritania has always remained at a low level and has not been considered important to food security. Average consumption is estimated at 8-10kg/year per capita, reaching up to 20kg/year in coastal regions around the capital city of Nouakchott and northern fishing town of Nouadhibou (FAO Mauritania, 2020). To the south in Senegal, pelagic fish make up a part of the national dish (*Thiéboudienne*) and the Senegalese are reputably talented artisanal fishermen. Per capita fish consumption is 29.9 kg/year (providing 70% of all animal proteins), with small pelagic fish as a main component of this (Greenpeace, 2019). Even in the case of Mali, the landlocked country highly dependent on import of fish to ensure food security, consumption levels were similar to Mauritania with an average of 9.3kg per person in 2017 (FAO Mali, 2019). The low demand for fish for consumption in Mauritania has meant that aquaculture production is non-existent, and the population is not typically skilled in fishing or fish farming, as they have historically been more focused on pastoral farming, agriculture and mining.

Consequently, the recent development of a fishmeal industry based on catching and reducing small pelagics into FMFO represents an interesting area of study. There are now more than 30 reduction factories operating in Mauritania, overtaking the number in neighbouring Morocco, which has historically always been one of the leading producers of FMFO in Africa. An estimated 60% of the more than 1 million tonnes of fish caught off the coast of Mauritania are now changed into fishmeal, where previously that percentage was virtually zero (FAO Mauritania, 2020). This transformation brings the country into lucrative international fish

value chains, albeit in a step of the chain which represents a low-cost and low-skill segment. However, while the redirection of fish into the reduction chain is not necessarily impacting food security in Mauritania, damaging effects on neighbouring countries with less access to the abundant natural stocks have been observed (Corten et al, 2017; Corten, 2020a; Greenpeace, 2019).

5.1.1 How is Mauritania's fish reduction industry spatially distributed?

Currently, Mauritania's FMFO manufacture industry is concentrated in the northern port town of Nouadhibou, and to a lesser extent around the more southerly capital city of Nouakchott. Both hubs of production lie strategically on the country's vast coastline with direct access to the rich fishing waters. Reports on the reduction factories present and actively operating in Mauritania fast become outdated as new plants are being built near-continuously alongside others temporarily suspending production or closing permanently. The most recent official report on the reduction industry in the West African region was conducted by Greenpeace in March 2019, finding 27 factories actively operating in Nouadhibou, compared with 12 in Nouakchott with a theoretical processing capacity of about 1 million tonnes. Taking this information to be the most accurate, the map below visualises the spatial distribution of the industry in Mauritania.

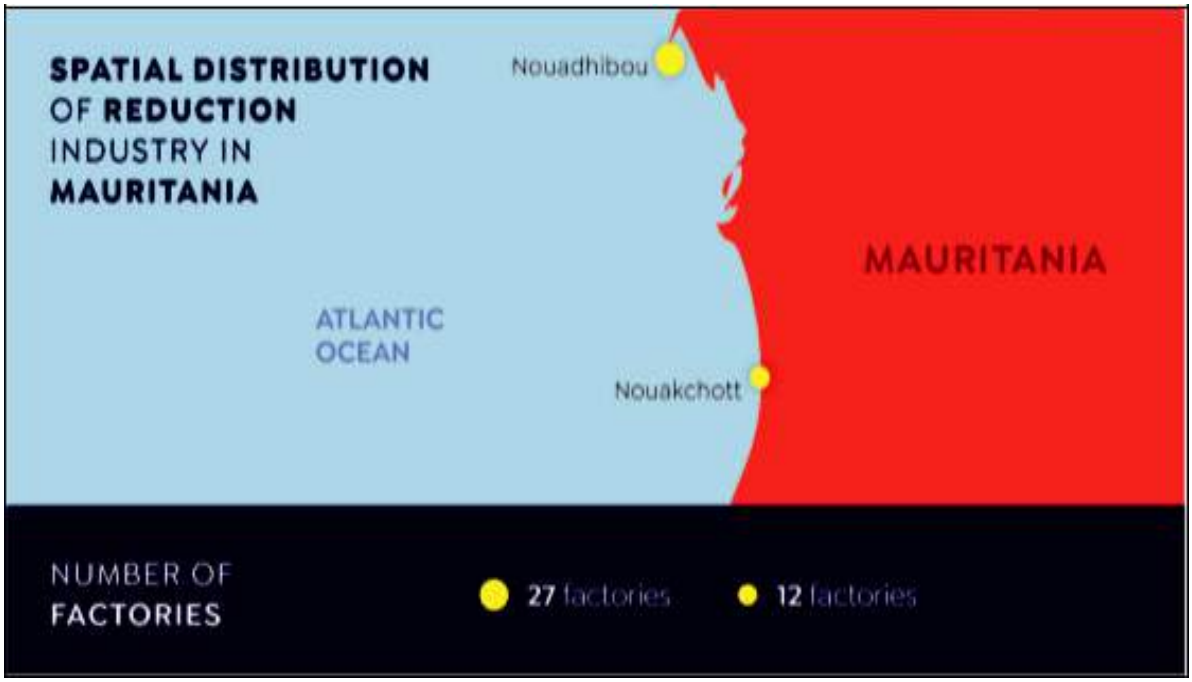

Figure 12: Map of spatial distribution of Mauritanian fishmeal industry (Source: author's own adapted from data by Greenpeace, 2019)

5.1.2 What has led to the development of a fish reduction industry in Mauritania?

Historically, there have been numerous attempts to use small pelagics for fishmeal in Mauritania dating as far back as the 1960's (Corten et al, 2017). According to the Mauritanian Institute of Oceanography and Fisheries Research (IMROP), in 1965, the first shore-based fishmeal plant was opened in Nouadhibou, though the plant was closed less than 10 years later citing high production costs and low fishmeal prices. Another attempt to capitalise upon the abundant natural resources came in the 1970's, with a handful of other FMFO plants opening, however all had ceased production again by the end of the decade (*ibid*). In 2005, after a 25-year gap, the reduction industry returned to Nouadhibou with the construction of RIM Fish's fishmeal production plant. RIM is a company jointly owned by two Mauritanian and Syrian investors which began with using offal from a local sardinella-processing factory that produced goods for human consumption (Evin, 2020). The opening of RIM's plant was welcomed by inhabitants as, previously, the offal was dumped in the desert outside Nouadhibou, leaving behind a putrid smell and contaminating the local environment. After a slow start between 2005 and 2010, and when it was becoming apparent that the first plant was generating profits, other international investors began to come to the area. Due to an increase in demand for raw material, the offal by-product from the sardinella-processing plant was no longer sufficient in supplying the factories and in 2012 a fleet of artisanal fishermen from Senegal were contracted to catch fish from the local waters as Mauritanians did not possess the relevant skills (Corten et al, 2017).

Previous to the planned influx of Senegalese fishermen servicing the FMFO industry, the small pelagics in Mauritania's waters were predominantly exploited by EU trawlers (Corten, 2014; Corten et al, 2017). The EU trawling ships made use of the rich fishing area strategically located in close proximity to the Spanish Canary Islands, catching and processing pelagics and other abundant fish for human consumption on-board technologically sophisticated vessels. This arrangement with international trawling companies brought revenue in the form of licensing fees for the Mauritanian government, however it did little to contribute to the domestic economy or generate employment in the country. In an interview with Ad Corten

(23rd April 2020), an expert in the Mauritanian case[2], it was highlighted that this was a major annoyance for the government and fisheries ministry. It was at this point that the trawlers were asked to invest on shore but didn't for two main reasons. Firstly, an onshore facility is not as logistically efficient as a factory vessel because it cannot follow the seasonal migrations of fish north and south along the coastline. Secondly, the country had a reputation as a corrupt place to invest due to past negotiations with the Spanish in the mussel industry, in which the EU partner almost always lost out to the Mauritanian. Corten et al (2017) highlight that the industry surged after decisive government policy on the "domestification" of the pelagic sector, with the intention that the development of a shore-based industry would direct a larger part of the wealth from pelagic resources to the Mauritanian people. At an international event hosted by IMROP in 2011, it was stated that only a small portion of the potential annual catch of small pelagics in Mauritania's waters was necessary for domestic human consumption and therefore the utilisation of pelagic species for fishmeal could be justified as it did not impact domestic food security. Moreover, the relatively low-technology, low-skill process of reducing fish into FMFO presented a viable option to establish a domestic industry for a population not well established as practised or skilful fishermen. As such, even if domestic consumption was increased to a target level of 15kg/year per capita, Mauritanian's would only require 45,000tonnes/year while the surplus of the over 1 million tonnes could be used in the production of fishmeal and offer value addition and employment to the wider population (*ibid*). Consequently, an agreement was reached in 2012 between Mauritania and the EU which forbid the foreign trawlers from coming within 20km of the country's coastal area (previously it was 13km), where the pelagics are most highly concentrated.

The vacuum left by foreign trawlers meant that the Mauritanian government was required to contract local artisanal fisherman in order to supply the existing fishmeal plants. At this time, satellite data suggests that around 8 reduction plants were in operation in Nouadhibou, which could be sufficiently serviced through the use of offal from other companies and contracts with Senegalese fisherman. Though in the period between 2005 – 2014 the number of canoes

[2] *Corten was head of pelagic research in The Netherlands between 1971 - 1996 and coordinator of the Dutch-Mauritanian cooperation in fisheries research from 1998 to present. He is a member of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa and of the EU-Mauritanian Joint Scientific Committee.*

brought over from Senegal to fish for fishmeal plants rose from 10 to 136 (5 to 122 in Nouadhibou and 5 to 14 in Nouakchott) (Corten et al, 2017). The situation in Mauritania is complex and ever-changing and, in the years following the introduction of Senegalese fishers, the number of reduction plants spiked again with evidence of significant foreign direct investment. Since 2015, a fleet of Turkish purse-seines were brought to the waters following an agreement reached between the two governments and began servicing 3 plants owned by Turkish companies (Standing, 2019). There are now 50 - 60 industrial Turkish vessels operating in the coastal zone, supplying other factories as well as being subcontracted by some Chinese companies (*ibid*). A third fleet now operating in the waters is that of privately-owned Chinese vessels working directly for Chinese-owned plants, however the exact number of these remains unclear.

Trawler

- This type of ship drags a large net for a long time, eventually hauling the catch up.
- These are technologically advanced vessels with the capacity to process catch instantly on board.
- Trawlers were mostly used by EU and other foreign fishers in Mauritania's waters before the 2012 agreement to limit their access to not within 20km of the shoreline.

Pirogues

- These vessels are operated by Senegalese fisherman and have fished small pelagics in Mauritania's waters to supply Mauritanian FMFO plants since 2012.
- In 2016, Mauritania suspended its agreement, claiming fish were being landed in Senegal rather than in Mauritania, thus leaving many fishermen without fishing grounds.
- In 2018, Mauritania and Senegal signed an agreement granting 400 licences with a total allowable catch (TAC) of 50,000t/year, to be landed in Mauritania.
- An additional 120 pirogues were allowed to operate under charter agreements as long as the catch was landed in Mauritania.

Purse Seine

- Large ships where a curtain-like net is dropped over a fish shoal and closed like a purse below – useful in catching small pelagic fish due to their tendency to travel in shoals.
- The boats cannot process fish but for the reduction of fish into fishmeal this is not necessary as the raw materials do not need to be frozen or preserved.
- In 2016, a fleet of 40 Turkish purse seines were contracted to fish pelagics in Mauritania's waters through a government deal between both states.

Figure 13: Types of fishing vessels operating in Mauritania's waters (Source: author's own using data from Corten, 2020a; Greenpeace, 2019)

As well as this intervention into the fisheries sector, the Mauritanian government has also introduced official policy for the "domestification" of pelagic fish due to their apparent abundance in stocks (Corten et al, 2017). As established in *Section 5.1*, the waters off the coast of West Africa have always been a rich fishing area, however studies show that pelagics are migrating more to Mauritanian waters due to the effects of climate change. Studies have shown that *"the waters off northern Senegal and Mauritania are warming faster than any other part of the equator-girdling belt called the tropical convergence zone"* (Green, 2018, no pagination). Since 1995, rising temperatures have pushed sardinella an average of 200 miles north according to researchers for the Marseille-based institute IRD-France (*ibid*). This migration, more significant than anything witnessed on land, is favourable towards the reduction industry and therefore encouraged the utilisation of this apparent abundant natural stocks for the chance to bring value-addition into a country. The Mauritanian government has implemented a number of trade reforms through this "domestification" policy. One of these measures was the creation of a Free Trade Zone (FTZ) in the northern port city of Nouadhibou, a port integral to the shipping of iron ore and fish to international markets, which has had a significant impact on the country's reduction industry.

While on the surface the intervention by Mauritanian authorities appears an example of favourable external intervention into the industry, encouraging economic growth and valuable industrial development, there is also a separate underlying motivation. It is "*no secret"* according to key informants in Mauritania that the executive, government and other high-ranking officials have substantial investments in the fishmeal industry, as well as a host of other powerful international players. This information is difficult to corroborate through online resources as contracts for the allocation of land are shrouded in secrecy, however in interviews with key informants with knowledge of the industry in Mauritania it is highlighted that on the ground the high-level investment is common knowledge. Sources also highlight that the President Ghazouani had shares in a company (though they could not reveal which one) and that prominent players from China, Russia and Turkey create strong lobbies interested in facilitating the continued growth of the industry. Notably, a key informant described the businessmen operating within the country as *"not the guys that you want to go and get coffee with"*, expressing that one partnership between a Mauritanian and Russian saw an international arrest warrant issued after the Mauritanian shareholder stole some

fishing boats; they are *"not like your [average] bad guy, it's your bad guy that is having problems with other bad guys"*. Naturally this information is anecdotal, however it is reflective the broader landscape of corruption evident across the African continent, which is essentially hands the license to exploit finite natural stocks to the highest bidder.

5.2 Case Study: Nouadhibou

The focus of this research is on Nouadhibou, a city located at the northern-most tip of Mauritania on a spit of land straddling the coastline and the border with Western Sahara. The unique geographic formation of the spit 'Cap Blanc' almost exactly emulates the well-established fishing town of Dakhlat in Morocco located further north along the West African coast. The latest available data shows that 24 reduction plants are located in 'El Bountiya', the industrial zone situated directly on the coast to the east of the city. Away from this cluster, there is one plant located in the centre of the town and two on the coastline out of the western side of the town.

	Factory Name		Factory Name
A	Africa PROTEINE	N	MMOA Peche Farine Et Huile
B	Alfa Service Ltd	O	Mouhit Al Baraka
C	Atlantic Peche	P	Ocean Proteine
D	Atlantic Proteine	2	OLVEA ATLANTIC
E	ATLANTIC YUFEN (ATYFEN SARL)	Q	Omaurci SA
F	Aussie Group	R	RIM Fish
G	Cofrima Proteine Sarl	S	SF HP Sarl
H	Comapeche	T	SICOP Industries SA
I	Continental Seafood SA	U	Sino-RIM
1	HONGDONG INTERNATIONAL FISHERY DEVELOPMENT FARINE ET HUILE	V	SMPC Sarl
J	Lem Seafood	W	Somaesp S.A.R.L
K	M.C.F Sarl	3	SUNRISE OCEANIC RESOURCES EXPLOITATION COMPANY (SOREC) SA
L	MAH EL TURK Sarl	X	Xiangheshun-Mauritanie SA
M	Mauritania FISHMEAL SARL		

Figure 14: Map and list of reduction plants operating in Nouadhibou (Source: Google Earth with author's own additions)

The following sub-sections explore the various features that have led to the agglomeration of these FMFO plants as per the theoretical framework established in Chapter Three. It must be noted that the discussed features are by no means exhaustive of the 'pull' factors and they are closely interrelated to one another. It is difficult to discuss one without referring to others, so to begin it seems appropriate to look at the typology of factories operating in the town, understood in this study as the 'internal' features of agglomeration.

5.2.1 Internal Factors

Information on active plants is difficult to come by without being able to participate in field and gaps in this information come as a result of this. An interview was conducted with an ex-employee of RIM Fish, the first reduction plant to operate in Nouadhibou, while other data and observations have come from interviews with industry experts and secondary resources.

Ownership and Finance Structure	- Considerable foreign investment, mainly: Chinese, Turkish, Russian - 50% of plants are Chinese owned
Business Structure	- Large-scale, mass production - Export-based business structure - At least one example of fully integrated value chain

Figure 15: Internal factors influencing industrial agglomeration, Nouadhibou (Source: author's own)

Ownership and Finance Structure

When researching Mauritania's reduction industry, it is immediately apparent that there is vast foreign investment in the sector, which is further reflected in the ownership structures of Nouadhibou's reduction cluster. Recent reports by Greenpeace (2019) and an in-depth

investigation by media outlets such as Reuters (Green, 2018) and de Volkskrant (Vos, 2018) also highlight the extent of the Chinese influence on the industry in Nouadhibou. 50% of reduction plants in Nouadhibou are either completely or part owned by a Chinese partner (Greenpeace, 2019). At least 3 plants are owned by Turkish partners (Standing, 2019) and investments from at least 6 other nationalities can be made out from visiting the websites of companies based in the town. *Figure 16* below visualises the significance of foreign investment in relation to how many plants are operating in the area. However, it must be noted that many of these plants are owned as partnerships with a Mauritanian shareholder (often with majority shares). The 'unknown' plants are likely to be owned by all Mauritanian investors or potentially other international partnerships.

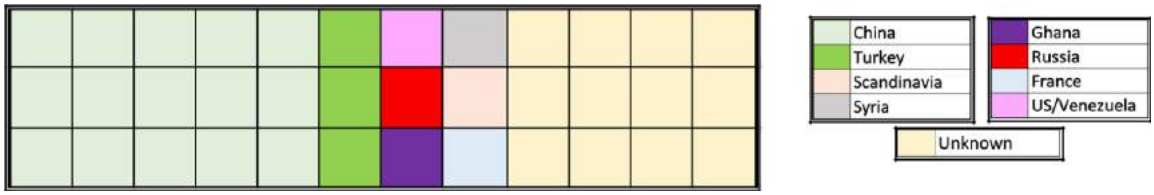

Figure 16: Visualisation of the known nationalities of full or part-owners of Nouadhibou reduction plants (Source: author's own adapted from primary data and Greenpeace, 2019; Standing, 2019)

Business Structure:

The processing capacity of plants in Nouadhibou is about 1 million tonnes (Greenpeace, 2019). In 2017, figures show that plants operating within the cluster exported from 119 tonnes (Ocean Peche) up to 30,710 tonnes (Xiangheshun-Mauritanie SA) (ONISPA, 2018). Undeniably, the cluster is classifiable as a highly productive, mass-producing zone.

Moreover, a discussion with a Dutch agent, working between Mauritanian plants and various international buyers of FMFO such as Köster Marine, 999 and Skretting, confirmed that most plants in Nouadhibou export their goods to foreign markets. This is reflected in the available trade figures as exports of FMFO from Mauritania doubled between 2014 and 2018, making the country the largest exporter of the goods in the region, followed by Morocco. Official statistics vary depending on the source, however, according to the Mauritanian government, in 2017 the total catch of all pelagic species was to 780,662 tonnes, with 128,870t fishmeal and 39,600t of fish oil exported (ONISPA, 2018). According to data made available through the International Trade Centre (ITC)'s Trade Map, in the same year Mauritania exported 119,745t of fishmeal and 34,482t of fish oil (UN Comtrade, 2017). This demonstrates a

doubling in the amount of exported fishmeal since 2014, when 66,783t of fishmeal and 19,752t tonnes of fish oil were traded. China has consistently been the largest importer of fishmeal from Mauritania, taking over 40% of fishmeal exports in 2016 and 2017. This is not surprising considering that 50% of the plants in Nouadhibou are at least partly owned by Chinese investors.

	2014	2015	2016	2017	2018
World	**66,783**	**66,346**	**74,516**	**119,745**	**127,940**
China	0	244	11,467	49,638	53,066
EU	38,319	12,418	23,683	10,966	29,196
Turkey	4,265	4,323	12,433	20,429	20,381
Vietnam	4,757	16,802	8,830	22,333	14,800
Japan	1,323	3,918	3,421	3,344	3,325

Figure 17: Top 5 importers of fishmeal from Mauritania 2014 – 2018 (tonnes) (source: author's own adapted from data by UN Comrade/ITC Trade Map)

While many plants in Nouadhibou rely on agents to sell the FMFO goods on to international feeds producers, at least one plant identified in the town is part of a vertically integrated value chain. Sunrise Oceanic Resources Exploitation Company (SOREC) is a joint venture between a Chinese company named Guangxi Crown Fisheries (GCF) and a Mauritanian partner. GCF is one of China's biggest aquaculture producers, which requires a constant supply of FMFO to feed its tilapia farms (Harkell, 2018). The US$150 million plant in Nouadhibou opened in 2017 and is the largest in the country, supplied by 20 new and purposely built 40-metre fishing vessels delivering catch directly to Chinese ports (*ibid*). The company claims to provide employment opportunities for up to 1,500 locals with an annual fishmeal production capacity of 50,000t and storage space for 8,000t of product. Linked to GCF is Baiyang Investment Group, China's largest tilapia exporter and third-largest market-listed Chinese seafood company, though SOREC, the West African business venture, is kept off Baiyang's market-listed public accounts and is therefore exposed to less scrutiny. The two types of value chain structures described are visualised below in *Figure 18,* including the actors involved in each set-up.

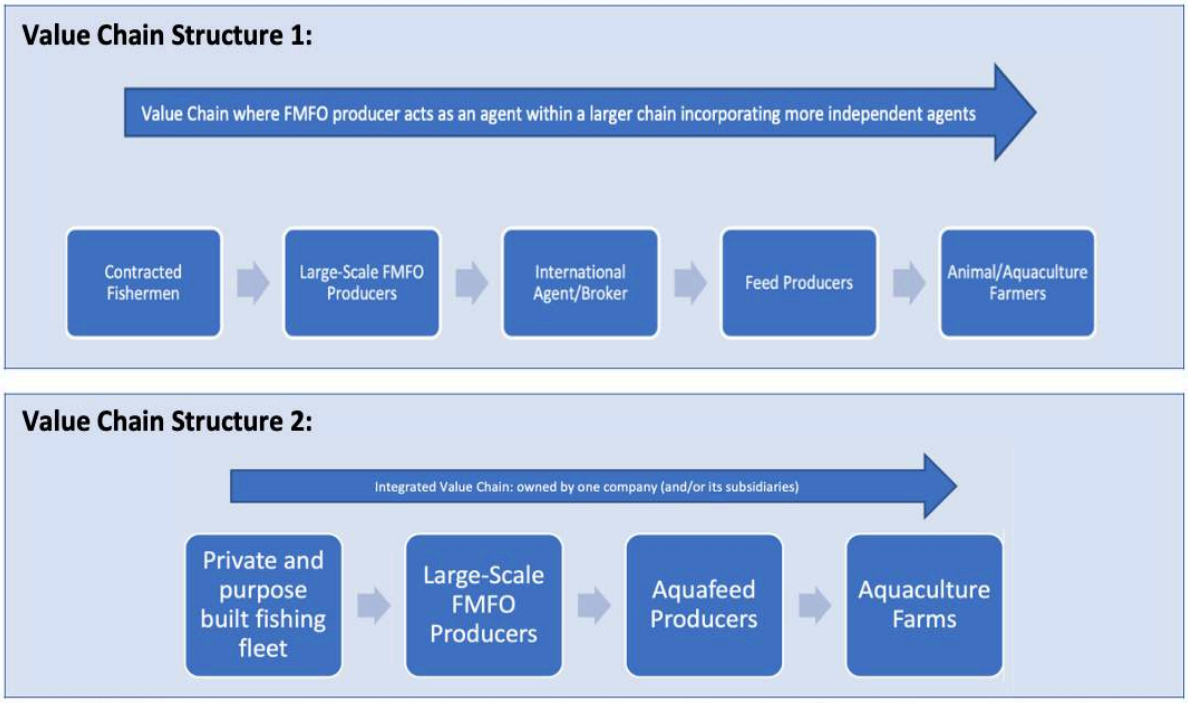

Figure 18: Visualisation of value chain structures found operating out of Nouadhibou reduction cluster (Source: author's own)

A point highlighted by a key informant is that reduction plants in Mauritania are effectively operating as 'agents' in a production line, whereby they produce a product that is sold on to another company (mostly outside of the region), which is then the one that turns it into a product for the market (into animal or aquaculture feed). Consequently, the fishmeal product does not have to apply to any type of rigorous quality auditing, checks and controls and the Mauritanian officials have consequently been flexible with regulation of the plants in Nouadhibou (Sidatt, 2020).

5.2.2 Locational Factors

Geographic qualities of Nouadhibou are conducive to the predominantly export-based FMFO industry in Mauritania – *"in addition to its natural deep seaport, which facilitates landing for fishing boats, Nouadhibou is ideally located for external trade"* (World Bank, 2019, p.2). This section explores the features unique to Nouadhibou's location, which both facilitate and hinder this particular typology of industry.

Access to raw materials	- Rich fishing area for small pelagics in Canary Current - Nouadhibou's waters are home to a third small pelagic fish species – the *bonga*
Size of plots available	- Area 'El Bountiya' designated in FTZ for fish processing (which has almost exclusively become fishmeal production) - Abundance of land along coastline around Nouadhibou
Labour	- Cheap labour force in Mauritania, though they are unskilled in the sector; private companies and government have contracted workforce when Mauritanians could not meet the needs of the industry
Industrial energy	- Plants previously required to generate their own energy - New FTZ plan to provide infrastructure moving forward (although with preference for higher value products)
Access to market	- Access to EU trading partners through Spanish Canary Islands through international trading port (harbour)
Transportation infrastructure	- Old port unable working over capacity, new deep-sea port being built by Chinese actors

Figure 19: Locational factors influencing industrial agglomeration, Nouadhibou (Source: author's own)

Access to Raw Materials

The waters off the coast of Mauritania have always been a rich fishing region due to the many different fish species present in the Canary Current. Specific to the fishmeal industry, the small pelagic fish are in abundance in these waters. Aside from the tropical waters home to the round and flat sardinella, another factor likely attracting investment specifically to Nouadhibou - as opposed to Nouakchott further south - is the presence the *bonga* (Ethmalosa fimbriata), a third pelagic fish species found in the northern waters. Research conducted by Corten et al in 2017 tracked landings of pelagic species between 2012 and 2014 in the two fishing ports. The below graphs (*Figure 20*) show a comparison of the species composition by landing size in these years, making clear that the *bonga* fish constitute a significant proportion of landed catch at the northern site - often more, or at least equal to, the amount of flat sardinella landed.

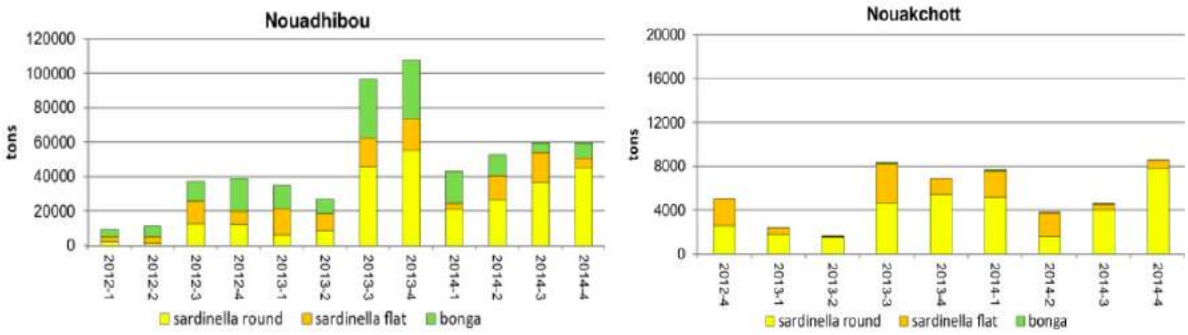

Figure 20: Landings of small pelagic species by quarter and species in Nouadhibou and Nouakchott in 2012-2014 – note the difference in scale for both locations, no data available for Nouakchott in first three quarters of 2012 (Source: Corten et al, 2017)

Size of plots available

The size of land necessary for a reduction plant depends on the expected output of the factory. Mauritania is very sparsely populated meaning that there is plenty of land available to be developed upon. The peninsula on which Nouadhibou is situated is a largely untouched coastline, presenting prime real estate for development opportunities in the fisheries sector. As well as land being largely available at a low cost, there is also ample space for expansion if necessary. The area of land in Nouadhibou made available for the development of an onshore fisheries industry, 'El Bountiya' is roughly 416,000m^2 (calculated using Google Maps measuring tool). Currently 24 fishmeal plants are operating in this area meaning that an average plot size is 17,333m^2. All of the plants have been purpose built so will have the necessary facilities installed. Evidence from satellite images of the area show there is little more room in the El Bountiya zone, though larger plants are beginning to open further down the coast away from the original cluster (See: *Figure 14*).

Labour

Adequate access to a skilled and productive workforce is necessary for businesses to operate effectively and therefore key to location selection. Mauritania has a cheap labour force, a feature of Noudhibou boasted by proponents of the 'El Bountiya' FTZ in promotional materials (Bouh, 2016). Operating machinery in reduction plants is low-skill and therefore has attracted many Mauritanian's to the industry as a way to earn relatively fast and easy money (Sidatt, 2020). However, there are some roles within plants that Mauritanian's are unable to fill due to a lack of skills in the fisheries sector. For example, the fishermen servicing Nouadhibou's

reduction plants that are generally outsourced to either Senegalese, Turkish or Chinese workforces. Moreover, in Chinese-owned businesses it is evident that a Chinese workforce is employed for technical and managerial matters. Nevertheless, these factories employ local workers for the manual labour jobs, claiming to pay higher than average wages (this information is presented on private company websites and has not been corroborated by other sources).

As highlighted in the previous section, the Nouadhibou industry is highly productive, with most plants having a significant production capacity. The SOREC plant claims to provide employment opportunities for up to 1,500 locals, though these claims are contested by a key informant in Mauritania. Regardless of capacity, purpose-built and technologically advanced fish mills such as the ones in Nouadhibou can give the illusion of being big employers, but most do not go beyond around 50 employees. Contracts are generally given for around 250 employees, however the unwillingness for the government to audit the industry has resulted in significantly lower levels of direct employment in the plants. The informant highlights that plants are open about the low levels of employment but have expressed justification in that, even with fewer employees, you can be responsible for 20 or 30 families within a tribe receiving money from workers. Therefore, they argue that reduction plants indirectly offer a way of compensating for a gap in social security, and it is arguably in the interests of those in the know to avoid speaking out against the issue.

Industrial Energy

The El Bountiya zone did not come with any pre-existing industrial energy infrastructure installed. Plants operating within the area are responsible for connecting to mains electricity and waste disposal systems. The infrastructure is *"lacking even it there is a road"* and the availability of water and electricity infrastructure *"leaves something to be desired"* (Evin, 2020).

Access to Market

As the nature of business structures in Nouadhibou's fishmeal cluster is predominantly, if not entirely, export-based, a location in a place with strategic global transport links is optimum for efficient trade. Historically, the town of Nouadhibou has been an important trading port

for Mauritania, but also for West Africa as a whole. The location of the town in close proximity to the Spanish Canary Islands has been crucial for trade with Europe and consequently the rest of the world. ITC Trade Flow tables in *Figure 17* in *Section 5.2.1* show China, Russia and the EU as key consumers of Mauritanian FMFO and therefore, despite the large distances to these countries, the location of Nouadhibou offers a strategic base for investment into internationally exporting FMFO plants. Existing and planned infrastructure projects in Nouadhibou also help to facilitate this trade, the impact of which is explained in the following sub-section.

Transportation infrastructure

Firstly, and important in ensuring stable and continuous access to a supply of raw materials, Nouadhibou has an already established open port. This is not only useful in bringing in the supply of raw materials, but also in the eventual distribution of the products. From information gathered from the websites of plants operating in Nouadhibou, goods are distributed using container ships from the port, which can now no longer handle the volume of exports taking place. Mark Assaf, the head of the port management team for the UN's Conference for Trade and Development (UNCTAD) stated that *"Mauritania's fishing industry could boost exports and create jobs, but its ports will need to become more competitive"* (UNCTAD, 2016, no pagination). In 2018, the start of construction on a deep-sea port on the western side of Nouadhibou was announced. According to materials obtained on the Nouadhibou FTZ, the proposal for upgrading the existing port infrastructure was designed to:

1. *Reinforce Nouadhibou's geostrategic positioning*
2. *Catalyze the development of the free zone by facilitating the different activities of the fishery sector, mining projects, trade and hydrocarbons.*

(Bouh, 2016)

The new complex will have an 18m deep commercial wharf and include a container terminal (equipped with gantry cranes), a heavy goods berth, a service port and will have the potential for future expansion (Global Construction Review, 2018; Kapital Afrik, 2018). This is evidence of a massive investment into furthering the facilitation of an export-based industry in

Nouadhibou. This significant investment of US$350 million is being made by a Chinese investor who has thus far not been named (Sidatt, 2020).

5.2.3 External Factors

Development of industrial clusters and their internal dynamics are largely influenced by the nature of government regulation related to the location and the industry. As established in the previous section, ownership structures of plants in Nouadhibou reflect some domestic political influence in the industry, which arguably leads to corrupt practice in the industry.

Regulatory Environment	- Establishment of 'El Bountiya' FTZ by governmental authorities - Contracts for plots of land awarded to Chinese investors involved in local infrastructure projects - Contracts passed through government without public scrutiny, resulting in lack of transparency and inability to audit businesses on a range of different factors

Figure 21: External factors influencing industrial agglomeration, Nouadhibou (Source: author's own)

Regulatory Environment

The town of Nouadhibou was declared a Free Trade Zone (FTZ) in 2013. Two contacts interviewed for this research worked with the World Bank team that advised the government on the declaration on the best way to encourage the development of a domestic fish processing industry. The creation of the FTZ was intended to bring value addition into the country by focussing on the transformation of fish in order to better impact the local population. In this plan, an area to the east of Nouadhibou named 'El Bountiya' was designated as a site for the construction of processing facilities, due to its proximity to the harbour, workforce and spatial capacity for future development. After the creation of the FTZ, a rush of investment could be witnessed in the area, with some 20 new authorisations for the construction of fishmeal plants issued (Corten et al, 2017). The area of El Bountiya is now home to the most significant reduction cluster in Mauritania. The World Bank interviewees expressed frustration at the influx of investment into FMFO plants as it has given a *"bad press"* to the FTZ project, which had initially encouraged the attraction of more technologically advanced industries. The tendency to continue investment into reduction is attributed to the boom in the price of fishmeal with the relatively small cost of setting up a plant. It is estimated

by one of the contacts that the companies are operating at a rate that allows a 50 – 80% profit margin, a significant return for any product.

Free Trade Zone Agreement 2013

- Industrial area of 'El Bountiya' designated for specialised fishery activity.
- Main Aims:
  - Encourage the development of an industry that would bring value-addition to the country, impacting the population through revenues and employment creation.
  - Bring transformation of fish on land by attracting investors to build plants and encourage those who already had small plants to upskill from just packaging to fileting, cutting, cleaning or cooking fish.
  - Enhance economic standing on the international stage through attracting the investment of high-tech companies.
- Compensation and incentives:
  - 15-year pack for tax incentives, whereby businesses pay no tax for the first 8 years (just their fishing license fee). Following this, tax is increased incrementally every 2-3 years still at a rate lower than typical taxation levels in the country.
  - All imported equipment and consumables are custom free.
  - *Incentives for international trade include a seven-year zero tax policy and a 0% custom fees on imports and exports in the FTZ.*

Figure 22: Terms of the FTZ Agreement (Sources: Bouh, 2016; Corten, 2020a; Rougiers, 2020; Sidatt, 2020)

In addition to this, the construction of a deep seaport by an unspecified foreign investor is problematic in terms of transparency and scrutiny. This project is reflective of numerous Chinese investments in African countries as a part of Xi Jinpeng's *One Belt One Road* initiative, which provides credit or infrastructure contracts in exchange for rights to exploit natural resources. Arguably, this could be classified as evidence of a use of 'coercive capital' by the Chinese. The location of the US$350 million 'gift' port is on the western side of town, further from the El Bountiya reduction cluster, but closer to two outlying reduction plants owned by Chinese companies. SOREC is a plant mentioned in *Section 5.2.1* due to its integrated value chain business structure and the second is one named Hong Dong International (Mauritania) Fishery Development Co Ltd. This plant also has its own jetty, a fleet of 169 vessels and had an investment of nearly US$100 million to build a fishing base, wharf, cold room, processing plant, training centre and staff housing covering an area of 90,000m^2 (Harkell, 2018) – considerably larger than the average size of a plant in the El Bountiya zone. The contract awarded to Hong Dong International (Mauritania) Fishery Development Co Ltd for the construction of its plant was passed through a parliament vote without any information

shared in the public realm. According to a key informant, the parliamentarians from the opposition said they would refuse the deal because they were only given a title and did not see any annexes (while most of the work was referenced as part of these annexes). As such, it is hard to say if Chinese or Mauritanian partners are fulfilling a deal because there is no way to access the details of the deal and actors cannot be monitored for compliancy. The Hongdong plant will be the closest to the future deep seaport that is being built and is therefore positioned in a very strategic location. This is indicative of high-level involvement between reduction plant business owners, decision makers and political actors. The ability to coerce decision-makers through the use of capital naturally attracts investment into Nouadhibou though perhaps from an undesirable type of investor.

5.2.4 Clustering Factors

It is argued that proximity gives rise to a certain collective efficiency within value chains. This thesis is exploring the benefits of geographic proximity in the reduction industry, therefore looking at instances of joint action evident amongst firms in Nouadhibou.

Information and Resource Sharing	- Sharing of resources for the supply of small pelagics
Joint Action	- Strong union of fisheries, despite not much obvious information sharing between companies

Figure 23: Clustering factors influencing industrial agglomeration, Nouadhibou (Source: author's own)

Information and Resource Sharing

Though contacts interviewed for this project said that there was no obvious information sharing between plants, it is clear from analysis of the situation in Nouadhibou that resources for the supply of aquatic protein are shared amongst plants. The pattern seems to be that plants of the same national origin are likely to share their resources for fishermen with one another. Turkish purse seiners mainly service the Turkish plants (Standing, 2019), the Chinese fleet of fishing ships services the Chinese plants and the Senegalese catch is shared amongst the rest.

Joint Action

The fisheries union in Mauritania remains strong despite several ongoing lawsuits and complaints by local populations. It can be said that there is a certain benefit of 'safety in numbers' within the cluster in Nouadhibou. The Environmental Justice Atlas (EJA, 2018) details protests by Nouadhibou's inhabitants complaining of the putrid smell, discharge of waste into local waterways and contamination of local habitation. On 12th January 2017, close to 1,000 protesters gathered at the Hotel Eljazira, and marched through the centre of Nouadhibou with signs reading "*Stop Pollution Nouadhibou!*" in English. The EJA also highlights that local doctors reported increases in cases of asthma, allergies and respiratory problems since the opening of the plants, particularly amongst children. In light of this, the authorities were forced to temporarily suspend production for inspection, though all have since restarted operations (*ibid*). Amongst other things, this can be attributed to a joint political clout – 'safety in numbers' - ensuring continued protection of the lucrative group of plants in the city.

5.3 Regional Issues and Criticisms:

The significant increase in FMFO production in Mauritania is having serious socio-economic and environmental impacts in the broader West African region. After being relatively under-the-radar during the proliferation period of the industry, these issues are becoming increasingly obvious and the need for action is difficult to avoid. Though Mauritania has a low population and has not historically been a large consumer of aquatic protein, estimates suggest that around 40 million African consumers could be impacted by its reduction industry (Greenpeace, 2019).

The pattern in Mauritania and neighbouring Senegal and the Gambia has been that fish catches for DHC have decreased in favour landings directed towards the FMFO industry, which contradicts the global trend (SOFIA, 2020). Coastal communities in these countries are largely dependent on fisheries as a source of protein as well as for employment and livelihoods. In Senegal, fisheries provide over 600,000 jobs with indirect employment in the sector bringing this up to 825,000 (Harper and Sumaila, 2019), and in the Gambia, the World Bank (2018) estimates that 200,000 people are 'critically dependent' on fisheries for their livelihoods. Global trade data and a closer examination of the Nouadhibou reduction cluster

confirms that virtually all of the products are exported to international markets, mostly outside of Africa to China and the EU. This is highly problematic as extremely large quantities of fish fit for human consumption are leaving areas with food insecurity issues in order to service higher-income consumers.

Moreover, the shift from an artisanal to commercial industry replaces experienced workers with lower-skilled jobs. In terms of fishermen, navigating the Senegalese pirogues is a trade often passed down through families, however the capacity of the small boats is unable to compete with the amount of catch produced by trawlers or purse seiners. Secondly, small-scale fishmeal producers using offal as raw material (a more sustainable use of resources) will be unable to keep pricing competitive with large-scale producers and are likely to subsequently lose business or be absorbed as an employee of one of the larger plants. Finally, many women in the region are involved in fisheries as processors of fish that are smoked and marinated and sold on the local beaches. In 2019, the women of the Confederation of African Artisanal Fishing Organisations (CAOPA) published a declaration stating that *"women in the sector are directly affected by poor resource management. We also have to face unfair competition from other actors, such as fish meal processing plants, which deprive us of our fish and prevent us from contributing to the food and nutritional security of populations"* (p.2). Women are already a vulnerable group in this region and taking away even a small source of income from them will certainly have wide-ranging effects on their family lives as well as their communities.

With regards to environmental damage, aside from the complaints of inhabitants about their local environment, there has also been high-profile criticism brought against reduction plants due to the high-volume business models. The FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa (FAO WG, 2019) asserts that, based on the different indicators available, stocks of sardinella and bonga are considered as overexploited and it is the pressure from the fishmeal industry that has led to the regional increase in fishing effort on these species. Problematically, the recurrent issue of transparency in Mauritania's fisheries industry also affects stock reporting (*ibid*). While the government has introduced measures restricting the use of endangered stocks, there was no limit on the amount of other species used for fishmeal production. Consequently, the measure has had little effect since

the IMROP has taken minimal samples (19 of the 600,000t landed for fishmeal plants, and no samples from the 500,000t caught by pelagic trawlers) and there has been no monitoring of the species composition of catches used for fishmeal (Corten, 2020b).

5.6 Concluding Remarks

This research has shown that the government in Mauritania is willing and able to implement decisive policy to stimulate the growth of a domestic industry, encourage competitive international trade and attract investment of significant amounts of capital. Problematically, the political action in the reduction industry no doubt comes as a result of ulterior motives linked to the personal investments of a select group of powerful individuals both internationally and within Mauritania itself. Arguably, it is the agreement to ban fishing for international trawlers and the creation of the FTZ, which mark significant catalysts for the development of the fishmeal industry in Nouadhibou. The actions proceeded to attract a windfall of domestic and foreign investment to the area, in return for license to exploit the natural fish stocks and bring 'value-addition' into the country. Locational features of Nouadhibou include geographically fortunate accidents of nature such as the plentiful access to raw materials, but also carefully designed infrastructural and regulatory interventions facilitating the attraction of investment into the industry.

With regards to the benefits of proximity, the agglomeration of plants in El Bountiya serves as a way for businesses to hide behind one another, with most being able to avoid any significant public scrutiny. This evidences a type of vertical, multilateral joint action as different levels of the production chain, including both internal and external actors, are involved in the continuation of FMFO production in Nouadhibou. This in the face of the many damaging environmental and social side-effects related to the reduction cluster demonstrates that it is inherent corruption that is the most pervasive issue acting as a bottleneck to positive institutional change and sustainable development of the pelagic fisheries industry in Mauritania.

6. Understanding the clustering in Kenya's fish reduction industry

This chapter is intended to better understand the operations of the fish reduction industry in Kenya. This industry is reliant on small pelagic fish species sourced from Lake Victoria, most notably the silver cyprinid *Rastrineobola Argentea* (locally known as *'dagaa'* in Tanzania, *'omena'* in Kenya and *'mukene'* in Uganda). The study will use the Swahili name *dagaa* when referring to the fish, which are central to food security and nutrition, employment, income and foreign exchange earnings in Kenya and the wider East African region. There is a lack of information on the dynamics and development of the reduction industry, which is comprised of many unregistered, small-scale producers and a handful of larger multi-national firms based in the bigger cities. Following a country profile and detailing of the way the industry is spatially distributed, an account of why the industry developed is given. This is in response to the first sub-research question and has been informed through interviews with industry experts and related academic literature. Later sections examine a cluster of plants in the town of Nakuru and utilises the theoretical framework in order to explore the combination factors influencing patterns of agglomeration in the area. These two levels of analysis are used to identify domestic and regional issues of the trade and draw conclusions on the potential barriers to sustainable industrial development.

6.1 Country Profile

Situated on the East African coast and bisected by the equator, the Republic of Kenya has a rich and biodiverse physical environment. The country is bordered by South Sudan and Ethiopia to the north, Somalia and 536km of the Indian Ocean to the east, Tanzania to the south and Uganda to the west. At the southwestern corner, 206km of Lake Victoria's shoreline straddles the border between Tanzania and Uganda. The altitude in Kenya varies from sea level at the Indian Ocean up to the glaciated peak of Mount Kenya, standing at 5,199 metres tall. By landmass, Kenya is the world's 47th largest country, covering a total area of 580,370km^2. Of this area, an estimated 274 000km^2 are made up of cultivatable land and over 11,000km^2 are inland water bodies, including the famous Lakes Victoria and Turkana (FAO Kenya, 2015).

Kenya's coastal and inland fisheries play a significant role in the health and wellbeing of its people. The marine fisheries can be classified into two subsectors: the coastal artisanal

fishery, which is largely subsistence and artisanal and the Exclusive Economic Zone (EEZ) fishery, which is dominated by distant-water purse-seine and long-line vessels exploiting target species (*ibid*). Inland, Lake Victoria is the most important fishery, accounting for over 80% of the total national landings in the country (Nyamweya et al, 2016). Notably, Kenya's portion of the lake's basin has around 307 fish landing sites compared with 141 on the marine shores (FAO Kenya, 2015). Although Kenya occupies the smallest portion of the lake (6%), sharing it with neighbouring Uganda (43%) and Tanzania (51%), 35% of the total catch is landed on Kenyan beaches (*ibid*). Additionally, the lake provides a vital source of employment for people living near to its shores. Specifically, to the dagaa fish, there are over 3,000 fishing boats most commonly operated by men, while processors of the landed fish are usually women (Kolding et al, 2019). Notably, females made up 64% of processors in Kenya, indicating opportunities in the trade of dagaa fish for the often-vulnerable group (LVFO, 2016). The processors will either sell on fresh fish or sun-dry (most common), deep fry or salt them in order to bring value-addition (Legros and Luomba, 2011). Problematically, the processes are often unhygienic and can lead to contamination and spoilage (*ibid*; Holford, 2019), which is a route through which the fish are directed towards reduction in order to service animal and aquafeeds manufacturers (Kolding et al, 2019).

Despite the equator creating tropical coastal climates and arid and semi-arid land (ASAL) to the north and northeast of the country, the ASAL areas are covered by permanent pastures and nature reserves, hosting 80% of the country's livestock and 65% of its wildlife (FAO Kenya, 2015). The remainder of the cultivatable land falls along the Gregory Rift, which is an intra-continental ridge system running west of the capital Nairobi, through the country from north to south. Kenya's Great Rift Valley is forged along this ridge and is one of the main geographically characterising features of the country, as well as being the backbone of the robust agriculture sector.

Figure 24: Great Rift Valley, Kenya (freeworldmaps.net, 2020)

Agriculture is the mainstay of the Kenyan economy. The most recent World Bank data shows that the agricultural sector constitutes 34.15% of national GDP (value added: agriculture, forestry and fishing) (World Bank, 2020) and accounts for 65% of total exports (FAO Kenya, 2015). Industrial crops and horticulture are the two main exported goods, though other major agricultural sub-sectors are food crops, livestock and fisheries (World Bank Kenya, 2020). As a result of this, agriculture is crucial for ensuring stable employment and livelihoods in the country. About 69% of the total economically active population is employed in agriculture (FAO Kenya, 2015) and a significant 75% of the population of approximately 48.5 million people is either directly or indirectly employed at least part-time in the sector (CIA Factbook, 2020). Smallholder farms of around 0.2-0.3 hectares make up a considerable 75% of the industry, while larger-scale operations, on farms of 50 ha average, mainly produce industrial crops such as tea, coffee, maize and wheat. In the ASALs, pastoralists raise livestock such as beef, dairy cattle, sheep, goats, camels, pigs and poultry on farms up to 30 000ha (*ibid*). Aside from this, commercial farming represents a reasonably new industry in Kenya, as keeping livestock was traditionally a strategy used in cultural practices and to protect against drought (MLD, 2008). In fact, the Kenya Market Trust (2017) has highlighted that there is now an increased need for commercial farming linked to general population increase, particularly within the urban middle-class populations, who have access to increasing wealth and represent changing consumer habits demanding higher value products (USDA, 2014).

Notably, in 2020, Kenya was listed as the third largest economy in sub-Saharan Africa (after Nigeria and South Africa), with the latest value for GNI at US$1,620 per capita in 2018 (Atlas method) (World Bank Kenya, 2020). Despite this ranking and a growing middle class, the Human Development Index (HDI) ranked Kenya 147 among 177 countries (HDR, 2019). This is likely linked to low human development indicators in the country - life expectancy remains low at 66 years and the under-five mortality is 33.6 per 1,000 births (*ibid*). Though these figures have improved since independence from colonial rule in the 1980's, poverty affects almost 50% of the population and is more prevalent and widespread in rural areas. Furthermore, there are over 10 million people in Kenya currently suffering from chronic food insecurity and poor nutritional levels (FAO Kenya, 2015). In the mid-2010s, approximately a third of Kenyans lived below the 'food poverty' line, meaning that they had a lack of financial capacity to maintain adequate daily calorie consumption (KBNS, 2018). Related to fish

consumption, in 2013 per capita annual consumption was estimated at 4kg/year per capita by the FAO, pointedly low compared to the world average of 18.6kg/year (Obiero et al, 2019).

The Nyanza region in Western Kenya around Lake Victoria is particularly characterised by entrenched poverty. Social and economic challenges linked to malnutrition, poverty and HIV are especially prevalent in this region, whose population relies heavily on the health of the lake fishery (Abila, 2003). The communities are trapped in a vicious cycle of food insecurity – *"paradoxically, many of the local communities living around the Lake Victoria fishery - the unique and vast natural food resource - are among the poorest and most food insecure"* (*ibid*, no pagination). These problems can be linked to environmental factors such as declining land productivity, recurrent droughts leading to soil degradation and desertification, loss of biodiversity, livestock and crop diseases, as well as political factors related to poor investment, development and trade policies for the region.

Regional investment is largely influenced by the state of government and tribal politics. The political system in Kenya is fragile as the former president Daniel arap Moi's executive appeared to increasingly meddle with the affairs of the judiciary (World Bank Kenya, 2020). Therefore, Kenya has consistently ranked low on Transparency International's Corruption Perception Index (CPI) - in 2019, the nation placed 137th out of 180 countries, with a score of 28/100 (CPI, 2020). In recent years there have been significant periods of unrest and violence during which over 1,000 people have died and over 300,000 have been displaced (Roberts, 2009). This violence has risen out of contentious elections and have deeply impacted the Kenyan society. The most recent post-election violence in 2017 was concentrated around Lake Victoria in the town of Kisumu, which is the strong hold and tribal home of the opposition leader Raila Odinga. As such, this western region is considered more dangerous and volatile, subsequently suffering as a result of uneven allocation of resources in many different sectors.

6.1.1 How is Kenya's fish reduction industry clustered?

There is a distinct lack of information available on the spatial distribution of the reduction industry in Kenya, which can be attributed to two main reasons. Firstly, many plants do not have fixed physical addresses as approximately 90% of the industry is made up of small and medium sized millers operating outside of the formal sector (KMT, 2017; USDA, 2014).

Secondly, there is a distinct lack of transparency in the sector with little regulation regarding operations and registration of reduction plants and millers. The most recent reports into the industry were conducted by the Kenya Market Trust (KMT) in 2017 and 2019, compiling a substantive list of the plants in operation at the time, with a recommendation that a more formal census should be made and maintained in order to improve transparency. Aside from these reports, research conducted through the University of Amsterdam and the SmallFishFood Project in 2019 found that many additional plants had sprung up in areas across the country, which were not included in the previous list.

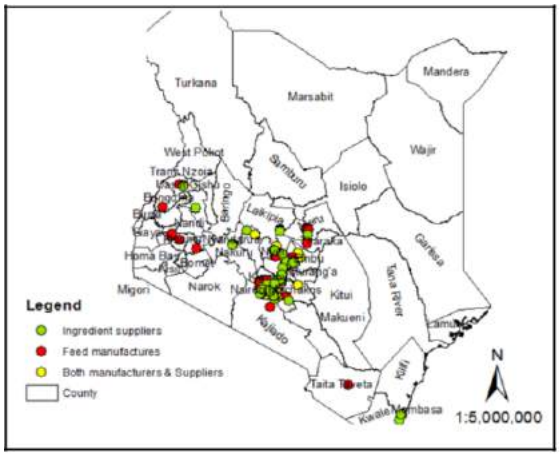

Figure 25 (above): Kenya's feed suppliers and manufacturers (Source: Kenya Market Trust, 2019)

Figure 26 (right): Map of spatial distribution of Kenyan fishmeal industry. Exact figures on the number of plants in each 'cluster' cannot be given, therefore the size of the dots indicates an estimate on the proportion of mills in each area using the KMT (2019) report as a guideline (Source: author's own)

Taking the data from the KMT's map (*Figure 25*) on board, this project recognises four main hubs of production in Kenya, which are identified in *Figure 26*. The majority of the plants are concentrated in and around Nairobi, Thika (a town around 50 km north of Nairobi) and in the central regions of the country in the Rift Valley. A more dispersed group of plants are located in the west of the country and nearer to the sources of raw aquatic protein in Lake Victoria. There are over 100 active reduction plants and millers operating across the country servicing the animal and aquaculture feeds industries, making Kenya's reduction industry internationally competitive and the largest in the East African region (USDA, 2014).

6.1.2 What has led to the development of a reduction industry in Kenya?

In the East African region around Lake Victoria, only about 30% of landed *dagaa* is used for human consumption with the remainder transported to industrial feed mills to be reduced into raw material in the production of feeds for poultry, fish and livestock farming (Isaacs, 2016; LVFO, 2016). In Kenya, the reduction industry mainly services the manufacture of animal and aquaculture feeds, though some is directed towards pharmaceuticals and food supplements selling at both domestic and regional markets (Kolding et al, 2019). Initially the feeds industry started using dagaa as the main source of crude protein in the early 1990s, when there were six major feeds manufacturing companies using the small pelagics in 1996 though this figure has proliferated to the 100+ now evident across the country.

Dagaa is the main source of crude protein in the feeds industry although manufacturers are also found to use a mixture of different ingredients (including limestone, soy, maize, wheat and other cereals) (USDA, 2014). Dagaa fish appear plentiful in Lake Victoria, with exploitation levels at only at 10% (Kolding, 2020). A recent study by Nyamweya et al (2020) demonstrates that catch and effort dynamics show that dagaa remain abundant and the catch composition of the lake is now dominated by small pelagic species. This is while tilapia and other fish catches are in decline, indicating that they are over-fished. The species has attracted a particular level of academic attention due to this apparent abundance as well as a resilience to ecosystem variation and use as a sustainable and nutritious food source (Abila, 2003; Isaacs, 2016; Kolding et al, 2019). Exploitation levels are set at 70% (LVFO, 2014) as the fish are able to reproduce and mature at a very face rate. Consequently, many fisheries experts and government officials do not see an increase in catch for the feeds industries and non-human consumption as a challenge (Holford, 2019).

The feeds industry can be categorised into two main groups; animal feeds producers and aquaculture feeds manufacturers, of which the animal feeds industry is still relatively more established. As touched upon in *Section 6.1.1*, the commercial livestock sector in Kenya has grown significantly, linked to growing demand from middle-class consumers and facilitated by market liberalisation in the 1980s (KMT, 2017). In the past, global strategies focussed on increasing agricultural production at household and national levels and ensuring that a portion of the food was stored for the next harvest (Brown and Kane, 1994). However, these

strategies did not successfully alleviate issues of food security due to declining land size, outdated farming technology, poor infrastructure, the demand for cash money and increasing population size. Now there is a shift from self-sufficiency to a focus on trade as a tool of tackling food insecurity alongside bringing developing economies into global value systems (Abila, 2000). As such, the growth of the feeds industry to service this increase agriculture has been encouraged by the Kenyan authorities through legislation and the formation of manufacturing groups to share knowledge and skills (USDA, 2014).

However, it is broadly accepted among industry experts interviewed for this research that the expansion of the reduction industry in Kenya comes a result of a political push to increase aquaculture production, which requires large amounts of feeds to sustain growth. A specific catalyst is the initiation of the Economic Stimulus Project (ESP) by the Kenyan government in 2009 (Obiero et al, 2019; Ogello, 2020). This project allocated US$34 million to build up a vibrant aquaculture industry through the Fish Farming Enterprise Productivity Program, which was aimed at injecting commercial thinking into aquaculture initiatives. This program triggered a massive increase in the construction of ponds in inland areas; about 200 fishponds were constructed in every one of the 140 constituencies totalling approximately 27,000 ponds (Obiero et al, 2019). Subsequently, there was an immediate boost in short-term demand for formulated fish feeds (over 14,000MT) and about 28 million certified tilapia and catfish fingerlings, which could not be supplied, even by the private sector (Munguti et al, 2014). Naturally, this gap in the market motivated a huge interest in the reduction industry in Kenya, prompting an almost ‘gold-rush’ mentality in setting up plants and resulting in the proliferation of the small-scale, ‘cottage’ style industry evident today. While funding for the aquaculture program has stopped, leading to an overall decrease in Kenyan fish farming since 2014 (Opiyo et al, 2018), there has been a recent trend in entrepreneurs setting up cages in Lake Victoria (Munguti et al, 2014). Today, the Kenyan aquaculture sector produces about 30,000 tonnes of fish annually, which requires consistent supply of processed fish feeds (Opiyo et al, 2018). According to the Kenya Market Trust (2017), the demand from the aquaculture and animal feeds industry from the commercial farming sector has not yet been met.

Though farm fishing has gained momentum in Kenya the commercial aquaculture sector has not yet reached its full potential as most fish farmers are still operating at subsistence levels that do not require large quantities of feeds. The potential for aquaculture production stands at 1.14 million hectares of farming area with a capacity to produce 11 million tonnes of fish annually (FAO Kenya, 2015). As such, it is understandable that larger animal feeds producers based in Nairobi, Thika and Nakuru are expanding their range of aquaculture feeds, as the businesses see potential in the growth of the aquaculture industry (Holford, 2019).

Alongside the push for greater aquaculture production has been a large movement to boost nutrition and food security through government 'Eat More Fish' and 'Fish for Wealth and Health' campaigns. These socio-cultural evolutions are targeted at changing consumer habits of Kenyan people that have previously not eaten fish due to cultural and or religious reasons. The government has enlisted the help of domestic celebrities to support the campaigns through television and radio channels (See *Figures 27* and *28*). These campaigns are supported through strong international lobbying groups; the UN's FAO and the EU-funded Indian Ocean Commission SmartFish Programme helped the Kenyan government fund and implement the campaigns.

Figure 27 and 28: Materials from the 'Eat More Fish' campaigns, involving Kenyan celebrities Avril, Baha and Paul Were (Source: FAO Blue Growth Blog, no date)

6.2 Case Study: Nakuru

Nakuru is the fourth-largest city in Kenya with approximately 570,000 inhabitants according to the latest census in 2019. This population makes it the largest urban area in the agricultural mid-west region of Kenya. It is the capital of Nakuru County and former capital of the Rift Valley Province, making it an important hub within the region. Consequently, agriculture and

manufacturing companies servicing this sector are the backbones of the economy in Nakuru. The town is situated 150km north-west of Nairobi and just under 200km from Lake Victoria. There is a hub of reduction companies based in an industrial zone in the town, with at least 9 plants contacted during this research operating in an area less than 1km in length.

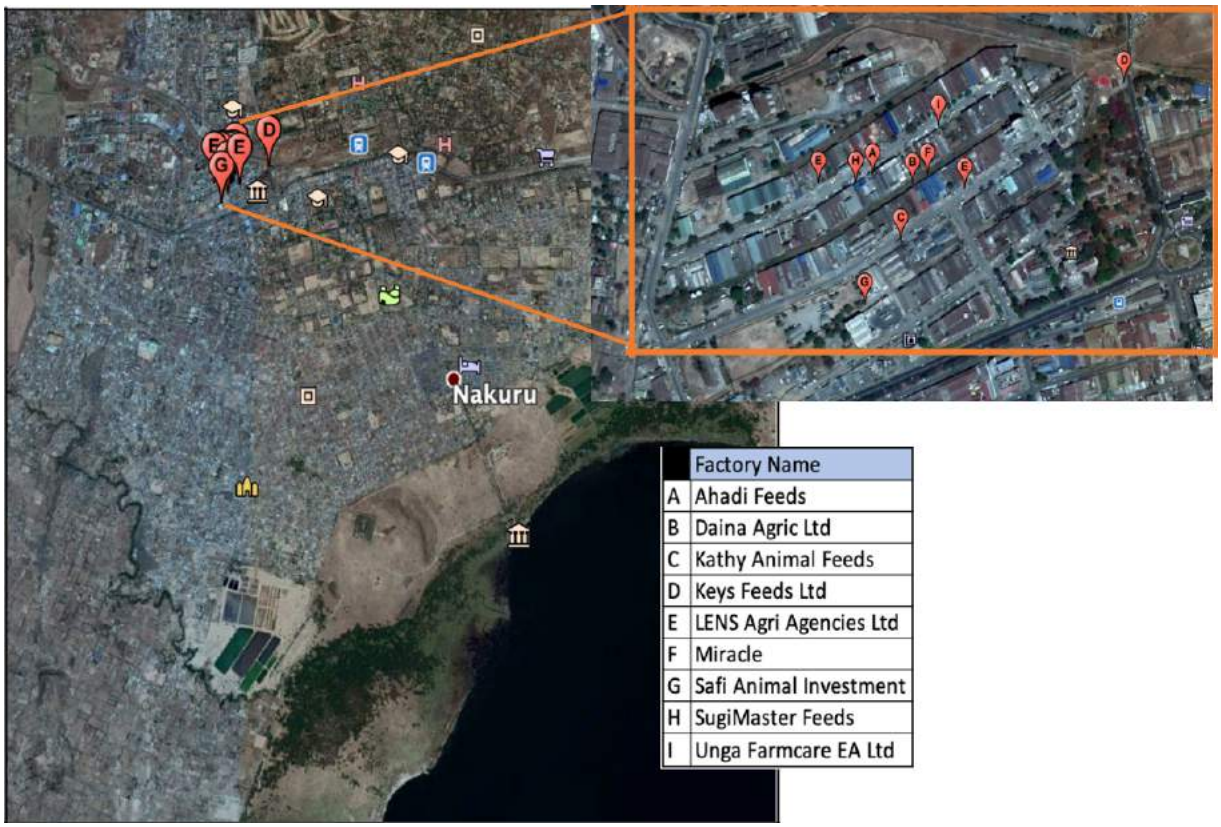

Figure 29: Map and list of reduction plants operating in Nakuru interviewed for this thesis (Source: Google maps with author's own additions)

The following sub-sections explore the reasons behind the clustering of reduction plants as per the theoretical framework established in Chapter Three. As with the Mauritanian case, the factors begin with an examination of the typology of factories operating within the area, understood as 'internal' features of agglomeration.

6.2.1 Internal Factors

Information on active plants is not readily available online as many businesses are unregistered. The empirical findings presented in this section come as a result of online surveys completed by 4 plants and telephone interviews with a further 5 plants, this information is nuanced through contact with related industry experts.

Ownership and Finance Structure	- All plants interviewed in Nakuru owned by Kenyan entrepreneurs - One larger factory owned by a larger Kenyan holding company with minority US shares - No government investment evident in Nakuru cluster
Business Structure	- Mostly small-scale production of feeds - All plants interviewed sell domestically within the Rift Valley and some across county borders - One larger plant doing international exports to neighbouring countries: Uganda, Tanzania and Rwanda

Figure 30: Internal factors influencing industrial agglomeration, Nakuru (Source: author's own)

Ownership and Finance Structure

All of the plants contacted for this research project were owned by Kenyan entrepreneurs, demonstrating that the industry is largely home grown. This also reflects the general pattern found through previous examinations of the industry in the country. Only one of the plants (Factory I) was owned by a larger Kenyan holding company, which also had investment by US shareholders who sit on the board of directors.

None of the plants surveyed stated that they had any support from the government in setting up their company and further highlighted that there is no evidence of government investment into the Nakuru feeds industry. This information is corroborated by Erick Ogello, the Head of Fisheries Department at Maseno University and ex-employee of the KMFRI. In an interview, Ogello highlighted that the failure of the government to ensure the sustainable supply of feeds to the commercial farming sector was a set-back to their 2009 stimulus packages (Ogello, 2020).

Business Structure

Evidence from the registered plants in Kenya suggest that large-scale feed producing companies have not been enthusiastic with investing in the country. According to Ogello (2020), this could be due to high taxation, energy and labour costs. This pattern is reflected in the Nakuru cluster as 8 out of 9 identified plants were classified as small or medium-scale

producers, with the capacity to output less than 5000 tonnes of product per month and the majority of them working at a considerably lower level of approximately 300 tonnes per month. The industry in Kenya is described by Ogello as a "cottage" industry, meaning that it is mostly comprised of small-scale producers, opening as a result of an apparent gap in the market and where they are able to make some money quickly, without much prior knowledge or experience. This goes some way to explain why so many plants are unregistered, and official production figures are difficult to come by.

	Factory Name	Capacity
A	Ahadi Feeds	3t/day (actual)
B	Daina Agric Ltd	3t/day (actual)
C	Kathy Animal Feeds	10t/day (capacity)
D	Keys Feeds Ltd	10t/day (actual)
E	LENS Agri Agencies Ltd	5t/day (actual)
F	Miracle	4t/day (actual)
G	Safi Animal Investment	10t/day (capacity)
H	SugiMaster Feeds	10t/day (capacity)
I	Unga Farmcare EA Ltd	90t/day (capacity)

	Monthly Capacity
Small	<300t
Madium	300-5000t
Large	>5000t

Figure 31: Average capacity (either actual or full capacity depending on information provided) of plants operating in Nakuru (source: primary data)

Moreover, the business structures of the interviewed plants were domestic trade besides one company which exported goods to international markets in neighbouring Kenya, Rwanda and Tanzania (Factory I). This company is the same larger one owned by a Kenyan holding company with US shares invested.

6.2.2 Location Factors

Locational features of the town of Nakuru are helpful to the FMFO industry in the area, which produces animal feeds for the surrounding agricultural region. This section explores the features unique to Nakuru's location that specifically benefit this particular typology of industry, as well as highlighting some of the issues faced by plants in the area.

Access to raw materials	- Far from Lake Victoria as the main source of aquatic protein; plants are reliant on trusted suppliers - Being based in a relatively well-connected city means that access to raw materials is more stable than in rural areas

Size of plots available	- Restricted size of plots available as plants have opened within existing buildings
Access to market	- All plants made animal feeds destined for livestock farmers, there were no pure aquaculture feeds producers evident, though some produced to order and are looking to expand to these new markets - Access to livestock and animal farmer markets - All sold in Rift Valley - Only a few interviewed plants selling across county borders
Transportation infrastructure	- All plants use trucks to transport goods, citing the reliable infrastructure in the town as a bonus of the location
Labour	- Employed between 4 and 30 varying by size – more employees more product development
Industrial energy	- All plants reliant on national energy grid - Larger plant had a backup generator

Figure 32: Locational factors influencing industrial agglomeration, Nakuru (Source: author's own)

Access to Raw Materials

Being based in a relatively well-connected city means that access to raw materials is more stable than in rural areas, despite there being a considerable distance between Nakuru and the source of aquatic protein in Lake Victoria. It is common for smaller and medium size plants - such as the ones operating out of the Nakuru cluster - to use multiple sources of crude protein, due to price, availability and a flexible approach to the formulation of feeds (Holford, 2019). All plants questioned on how they ensured stable supply of raw materials highlighted that they had ample, reliable suppliers due to the high concentration of plants in Nakuru.

Research into how plants ensure adequate supply of raw aquatic protein demonstrated that traders from regional markets will go to landing sites directly in order to buy fish from producers. These goods would be transported by road (either truck or public transport) inland in order to be sold wholesale to regional markets. In the case of wholesale traders, these individuals usually visit the sites when the catch is larger in order to purchase larger quantities (more than 50kg/day) and be able to costs down. Traders will also purchase the considerable

amount of dagaa unfit for human consumption when it has been damaged on the fishing boats or throughout the harvesting process when rainfall causes spoilage by washing away the drying fish or causing it to rot. This is reflected in the average price that factory traders pay, 15-100KSH/kg, compared with producers selling for human consumption, 80-200KSH/kg (*ibid*).

Size of Plots Available

Reduction plants in Nakuru have opened in pre-built building structures, they are not purpose built so the production capacity is restricted by the size of the existing building. Moreover, satellite evidence suggests that due to the location of the cluster within a city, there is little chance that the plots can be expanded. Additionally, the 5 plants interviewed by telephone who were asked about their opening hours and how often they run at capacity all stated that they run at nearly full capacity for 9 hours/day and 6 days per week. While all businesses contacted for this research claimed that they wished to increase production and expand to new markets, it is unclear how they will be able to significantly facilitate this without moving to a new location with larger plots of land.

Access to Market

Crucial to the Nakuru cluster, all plants contacted said that they service the agriculture industry based in the nearby Rift Valley region. The location selection is therefore very strategic for these businesses as they are able to easily source and be found by new customers. As highlighted previously, the is a considerable deficit in the amount of available feeds in Kenya and therefore it is logical for entrepreneurs to service these needs for livestock farmers based in the main agricultural hub of the country. One plant highlighted that they sold their products across county borders, though their main markets were based in the Rift Valley. In order to sell countrywide, these companies required regional agents to source customers. This extra step in the value chain between product and consumer naturally adds a cost to the company, unsurprisingly therefore, the plant with this business structure was also the largest company contacted during the research (Factory I).

Transportation infrastructure

All plants are reliant on trucks and road transportation for the import of raw materials and export of end products. There were no serious complaints about the state of the infrastructure facilitating this means of transportation, however one contact said there was naturally some room for improvement.

Located next to the cluster in Nakuru is an industrial goods railway, which this project initially observed as a useful transport link to Lake Victoria. However, this track has not been utilised for two decades and this means of transport was therefore not mentioned by any of the respondents as useful to their business. However, it has recently been announced that the 100-year old railway will be refurbished using internal resources following the failure to secure a loan from China, which had funded initial phases of a Kenyan railway project (Mulyungi, 2020). Consequently, this announced could mark a useful infrastructure project to the feed's manufacturers based in Nakuru, acting as a crucial transport corridor for the shipment of goods between the town, western Kenya and the border of Uganda.

Labour

Due to the fact that most of the plants operating in Nakuru can be classified as small or medium sized enterprises, the workforce in each plant is relatively small. All plants employ Kenyan people from the local area, again reflecting the general typology of the industry in the country. There was considerable variation in the number of employees in relation to the capacity of the plants. This variation could be explained by some plants having a more established managerial and technical department, perhaps in order to expand or develop production. Factory H, SugiMaster Feeds, had a plant with a capacity of 10t/day, which was the average in the area, though it employed a significantly higher than average number of people. The survey respondent highlighted that the skills required include *"animal nutritionists, informal skills in feed mixing and sales representative who have been in the field before"* (Survey Response: Maina, 30/07/2020), which would suggest that the hypothesis of a larger managerial and technical department is accurate.

	Factory Name	Capacity	Staff
A	Ahadi Feeds	3t/day (actual)	5
B	Daina Agric Ltd	3t/day (actual)	10
C	Kathy Animal Feeds	10t/day (capacity)	5
D	Keys Feeds Ltd	10t/day (actual)	12
E	LENS Agri Agencies Ltd	5t/day (actual)	n/a
F	Miracle	4t/day (actual)	Around 10
G	Safi Animal Investment	10t/day (capacity)	2FT, 4 Casual
H	SugiMaster Feeds	10t/day (capacity)	30
I	Unga Farmcare EA Ltd	90t/day (capacity)	25

Figure 33: Factory capacity in comparison to employment levels in Nakuru plants (Source: primary data)

Industrial energy

The Rift Valley is a generally more affluent area in Kenya, and subsequently has ah more reliable industrial energy infrastructure installed. Arguably, this can be linked to tribal politics and the allocation of resources and Nakuru is considered a stable town in comparison to western Kenya, which has seen more periods of civic unrest in recent years. All plants located in the Nakuru cluster relied on the Kenyan power grid for their energy, with one maintaining that power outages are rare in the city. Factory I, again representing the largest plant contacted, referenced that they had a backup generator as a means of ensuring stable industrial energy supply (Survey Response: *Macharia*, 31/07/2020).

6.2.3 External Factors

There is no evidence of government investment into the Nakuru reduction industry, however there are different ways that government spending is able to positively impact and area and attract business to a certain location.

Regulatory Environment	- Stable power supply in Nakuru due to the politically stable perception of the region and subsequent allocation of resources

Figure 34: External factors influencing industrial agglomeration, Nakuru (Source: author's own)

Regulatory Environment

As highlighted in the previous section, all plants in the cluster are reliant on the national grid as their source of industrial energy. Nakuru and the surrounding regions are considered stable and safer politically that western Kenya and therefore benefit from a higher allocation

of resources to ensure reliable and more robust infrastructure projects. Generally, locating in a city will mean that infrastructure is more developed than in rural areas. None of the plants interviewed expressed complaints about the infrastructure in Nakuru, which paints a positive perception of what is available in the town. Related to Kenya more broadly, all but one of the plants pointed out that the Kenya Bureau Standards (KEBS) certification was the most formally restrictive aspect of their business. KEBS is the national body responsible for enforcing product quality standards and for the feeds industry is enforced through the Food and Agriculture Department. Inspectors will check products and the goods are able to display the certification if they pass, the regulations expect that that manufacturers self-regulate in adherence to the standards, as the renewal of certification and analysis of feeds takes place annually (KMT, 2017). The fact that all respondents mentioned these standards is a sign that they are more established companies as past research has shown that the very small businesses in Kenya operate outside of this certification system (Holford, 2019).

6.2.4 Clustering Factors

There is evident clear evidence of agglomeration in Nakuru, this research explores the perceived benefits of geographic proximity in the industry. It looks at instances of information and resource sharing as well as joint action evident amongst firms in the cluster.

Information and Resource Sharing	- Access to suppliers ensuring stable supply of raw materials at a lower cost - Proximity raises profile to existing and potentially new consumers

Figure 35: Clustering factors influencing industrial agglomeration, Nakuru (Source: author's own)

Information and Resource Sharing

7 out of 9 plants contacted highlighted that proximity meant that raw materials could be accessed more easily and at a better price as local suppliers were in competition with one another. Moreover, 2 plants highlighted that working in a hub meant that they had a feeling of business security derived from enhanced visibility to clients. Though feeds suppliers in Kenya are in short supply in comparison to the domestic demand, it seems that entrepreneurs in the Nakuru cluster place a significant amount of importance on the access to a customer base.

6.3 Regional Issues and Criticisms

The redirection of large quantities of dagaa fish towards the reduction industry for the use in manufacturing feeds for commercial livestock and farmed fish has many implications for food security situation in Kenya. Despite low national fish consumption, dagaa has consistently been a staple in the diets of households around Lake Victoria (Abila, 2000). This region suffers disproportionately from malnutrition and food insecurity issues compared to the rest of the country despite the rich source of aquatic protein and opportunities for employment in the lake. The ready availability and low cost of dagaa has perpetuated a perception that it is a "poor man's food", something often recognised in the literature as a barrier to its effective use as a means to combat food insecurity issues (Abila, 2003; Kolding et al, 2019, LVFO, 2016). The price of human grade dagaa has gradually risen from considerably from less than 20KSH in 1990 to 60KSH in 1995 to between 80-200KSH/kg in 2019 (Abila, 2000; Holford, 2019). This increase has largely been attributed to the demands of reduction plants buying large quantities of human and non-human grade fish to service the feeds industries. This redirection of aquatic protein is only expected to increase as the feeds industry pushes to fill the large deficit in needs of the farming sector in Kenya, alongside the government and international lobbies encouraging the expansion of aquaculture capacity in order to produce more fish for human consumption.

The gap in this logic is highlighted by Kolding et al (2019), who contend that promoting the consumption of more farmed fish will not adequately meet the needs of the most vulnerable people. In an interview for this research, Jeppe Kolding, a professor of Africa's Great Lakes, criticises the influence of international donors and bodies in promoting fish farming as one of the best sources of protein for solving food security problems. Organisations such as the EU, the UN's FAO, WorldFish and other powerful western companies are encouraging the increase of aquaculture production and the Kenyan government is heeding the advice by investing into aquaculture projects and rolling out significant cultural campaigns. The over 500,00t of dagaa harvested from Lake Victoria each year could significantly contribute to nutritional food security if it were appropriately utilised in the East African region, perhaps by using dagaa in the fortification other foods, rather than feeding other foods, in order to provide consumers with more variety of food choices (LVFO, 2016). Kolding agrees that the debate is between scientists and biologists, who advocate for the use of forage fish to directly

feed consumers, and larger international bodies, who lean towards aquaculture production – *"there is a whole industry […] driven by donor countries [such as] the EU and Norway and the whole world that says we have to increase aquaculture production because it's the most efficient way of producing food, but actually that is a lie"* (Kolding, 2020). The use of wild fish to feed farmed fish takes livelihoods away from men and many vulnerable women and is an inefficient way of utilising protein rich materials that exist in relative abundance as a natural stock.

6.4 Concluding Remarks

In Kenya, the animal and aquafeeds industries are directing food-grade fish away from food and nutrient insecure people. The development of a cottage-style reduction industry meaning that many, if not most, producers are small-scale and unregistered comes as a result of Kenya's rich farming sector requiring vast amounts of feeds that the commercial industry cannot meet. Experts suggest that the government is being influenced by aquaculture lobbyists into rolling out fish farming as a means to relieve food security issues and thus is exacerbating the need for more feeds. For feeds manufacturers in Nakuru, the most important factor by far was to have access to these lucrative markets. This compensated for being far from the source of aquatic protein in Lake Victoria and relying on longer links with agents and brokers to source the necessary raw material. The industrial area within the town does not give much opportunity for physical growth, so it is likely that successful companies based in Nakuru will be looking to expand to a new area. This is expected to be nearby as respondents seemed content with the political stability, availability of raw materials and access to consumers in the town. While there was one larger and internationally linked company interviewed during this research project, there is not much further evidence foreign direct investment in the Kenyan industry, however, this is likely to change given the opportunity for growth in the context of little formal governmental regulation.

7. Discussion and Conclusion

This thesis has set out to answer the question *'How does the industrial clustering of fish reduction plants occur in African contexts?'.* In order to address this question, it has used a dual case study design closely examining two different country contexts and a reduction cluster operating within each one. The chosen countries, Mauritania and Kenya, represent contrasting situations, selected in order to discern if there is a common factor exerting influence on both set of units. The reduction plants in both Nouadhibou, Mauritania and Nakuru, Kenya have been found to be situated in urban areas close to habitation, thus contradicting one of the first principles highlighted by the United Nation's Food and Agriculture Organisation (1986) on factors to consider when opening a plant. The storage of raw materials and reduction process creates a putrid smell and there is clear evidence of waste polluting the local environment, begging the question why the clusters have been left to proliferate and, at times, actively encouraged.

The two clusters evidence different needs based on their typology, in Nouadhibou plants are mass-producing, export-based business structures and the Nakuru cluster is made up of smaller, independent businesses servicing domestic markets. In Nouadhibou, businesses mainly populate purpose-built plants in a FTZ area, with a few outliers in other locations in the city on larger plots of land – a pattern exposing possible evidence of high-level corruption. In Nakuru, many plants were concentrated in a small area close to the town centre, setting up operations in pre-built structures within an existing industrial area. Whilst issues of scale and generalisation may be raised, this thesis has not tried to provide a definitive picture of the reduction industry in Africa. Rather, it has provided a measurable framework through which clusters in the manufacturing step of the reduction value chain in a developing country context can be better understood. This is crucial, as the industry in Africa involves various emergent domestic, regional and global actors and is uniquely operating in the context of weak institutional and governance structures. As such, a gap in the literature is met, whereby patterns, themes and narratives can be observed in order to encourage more appropriate management of the industry that is consuming vast amounts of important and finite raw materials.

Without being able to partake in field research, this project has included two levels of analysis, reliant on a socio-political understanding of the contexts of both case studies alongside the collection of primary data. Answering the sub research question, understanding ***what has led to the development of reduction industries***, it is apparent that there has been somewhat of a 'gold-rush' mentality of investors in both cases. Despite differences in scale and typology, entrepreneurs can see that FMFO is a commodity in great demand in global and domestic markets, which has been capitalised upon in both Nouadhibou and Nakuru. Specific to the case of Mauritania, it is apparent that the government is influenced by powerful lobbies and is characterised by high levels of internal corruption. On the other hand, while there is no evidence of government involvement in the reduction industry in Kenya, political involvement in the aquaculture sector was a main catalyst for the proliferation of feeds manufacturers. This decisive political action also comes as a result of powerful international lobbies for the use aquaculture as a means to combat issues of food security.

Secondly, exploring the ***features of industrial clusters that encourage location selection for entrepreneurs*** can be reduced to two prevailing locational factors. Specific to location selection, the availability of raw material was highlighted as a main attraction in both cases, consistent with the literature for an industry reliant on perishable goods. In Mauritania there is evidence of a depletion in stock levels, while Kenya's source of aquatic protein in Lake Victoria remains stable. Additionally, reliable links to end consumers was a strong factor influencing location choice, though this meant different necessary infrastructures in both cases. In Mauritania, infrastructure is made available through active government intervention in the industry using personal links with wealthy international actors and governments to attract investment into the country. In Kenya, independent entrepreneurs are attracted to politically stable locations in order to access more reliable infrastructure without the specifically targeted intervention of the state. These observations link closely the factor of conducive government policy, which is deemed a central factor in influencing industry development (Yamawaki, 2002). This thesis has categorised this factor as an 'external' feature of agglomeration, whereby the regulatory environment (whether in an active or passive capacity) strongly influences the actions of entrepreneurs.

Thirdly, both clusters exhibit ***perceived benefits related to industrial agglomeration***, though they are different to anticipated elements derived from the literature. The literature on agglomeration suggests that technological spill-over and joint action between firms is a central component to the collective efficiency of clusters. No obvious evidence of active information and resource sharing was found in Nouadhibou or Nakuru, though this could be as a result of the desk-study model of research. There were perceived benefits highlighted in the pooling of plants bringing about more reliable access to suppliers of raw materials in Nakuru and Nouadhibou, as well as evidence of a feeling of safety in (large) numbers in Nouadhibou. Moreover, agglomeration patterns of the two units of observation reflect the phenomenon of re-agglomeration, whereby more firms become attracted to an area due to the collective benefit of a lower cost for raw materials, the growth of a specialised labour market, and investment in necessary infrastructure. This re-agglomeration process was observed by Alfred Marshall in 1920 and remains relevant in helping to understand modern location decision as it demonstrates that enterprise clustering is enhanced by structural intervention and transformation.

These sub-research questions answer the main research question as they have distinguished the most influential locational, external and cluster-related factors influencing location selection and subsequent patterns of industrial clustering. A take-away point from this research is that these features cannot be understood without first fully understanding the typology of the industry that is being examined – the 'internal' factors. To understand the typology of a cluster provides the necessary context to be able to assess needs of business structures, understand what influences location choice and subsequently make adequate assessment for potential regional industrial development plans. Comparison of the expected pattern derived from a reading of the relevant literature with the observed pattern of the empirical findings is mostly consistent in both cases. Observations have found that the industries are both operating at a rate that takes food-grade fish away from people in need. This is in line with the literature, which estimates that 90% of pelagic fish used to make FMFO could be used directly for human consumption instead (Cashion et al, 2017). Notably, this study has shown that the reduction industry can develop in a diverse way, there is no clear pattern aside from evidence that entrepreneurs see a good opportunity for investment

return. The way that this investment manifests is strongly dependant on the socio-economic context in which it occurs.

The study used personal interviews of a small number of cases in order to discern why location decisions were made and what range of factors encouraged the apparent patterns of industrial agglomeration within the reduction clusters. This information could not be analysed statistically due to the qualitative study design, therefore it focused on ensuring analytic generalisation and methodical clarity (Bryman, 2012). This study was only conducted on reduction plants in one focus area within each country, despite there being evidence of other clusters in both cases. Naturally, therefore, the findings would likely differ for reduction plants operating within these other contexts. Having the time and resources to analyse other clusters in Mauritania and Kenya would naturally lead to a more holistic view of the industry in both cases. Further research may be conducted on other reduction clusters, either within Mauritania and Kenya, or elsewhere in Africa. Expanding the range of clusters observed using the same theoretical lens would further uncover how variation of socio-economic context impacts location selection and productivity of certain FMFO manufacture entrepreneurs.

In conclusion, this thesis has shown that the use of small pelagic fish species to service animal and aquafeeds industries is negatively impacting the populations reliant on the source of aquatic protein in Africa. There must be more planning and regulation on the manufacturing step of the industry to pre-empt potentially disruptive investment and avoid any further unchecked proliferation of large-scale manufacture in food insecure regions or marine areas with an already unstable natural stock of small pelagics. This can be achieved through an independent standard for the registration of reduction plants (to know the quantity, production levels and involved actors) and sustainable fisheries management (to control the amount of food-grade fish directed away from DHC). The implementation of this will go some way to improve regional planning policy in an industry only set to further proliferate in the future.

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