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Evaluating the economic potential of aquaculture farming: A case of Tilapia fish

(ARP)

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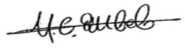
WITS Business School

Thesis presented in partial fulfilment for the degree of Master of Business Administration to the Faculty of Commerce, Law, and Management, University of the Witwatersrand

30th April 2021 & 30th July 2021

DECLARATION

I Nosimilo Mbele declare that this research report entitled 'Evaluating the economic potential of aquaculture farming: A case of Tilapia fish farming' is my unaided work. I have acknowledged, attributed, and referenced all ideas sourced elsewhere. I am hereby submitting it in partial fulfilment of the requirements of the degree of Master of Business Administration at the University of the Witwatersrand, Johannesburg. I have not submitted this report before for any other degree or examination to any other institution.



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Signed at Johannesburg on 30th April 2021

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ABSTRACT

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Thesis title: Evaluating the economic potential of aquaculture farming: A case of Tilapia fish

Tilapia fish is the most consumed fish in the world because it is high in protein. However, there has been depletion in the aquatic family due to numerous environmental factors. That resulted in the new form of reproducing it in a controlled monitored environment called fish farming, which is done in three ways: fish farming, aquaculture, or aquaponics. This type of reproduction will assist in future for securing food because the world population exponential growth is more than what has been estimated. The South African tilapia fish farming sector is very significant, so that the country is heavily dependent on the frozen tilapia that is exported from China.

The exploratory qualitative case study method was used to investigate if it is economically viable by using multi-sources to get a holistic view of the sector. The South African sector has numerous challenges that contribute to the failure of the industry to meet the country's demand which geographical location, weather condition, land, water scarcity and skills.

The findings of the study were that different stakeholders have to work together to grow the sector that has a high potential of producing fresh organic tilapia, in turn, contribute to the economy of the country, create employment and alleviate poverty

Johannesburg, 30th April 2021 & 30th July 2021

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LIST OF ACRONYMS AND ABBREVIATIONS

1. FAO: Food and Agriculture Organisation
2. MT: Million metric tons
3. COVID-19: Coronavirus disease
4. IDC: Industrial Development Corporation
5. TFF: Tilapia Fish Farming
6. VT: Viability Theory
7. GDP: Gross Domestic Product
8. OECD: Organisation for Economic Co-operation and Development
9. SADC: South African Development Community
10. NEDALC: National Economic Development and Labor Council
11. DRC: Democratic Republic of Congo
12. AgriSeta: Agricultural Sector Education and Training Authority
13. *SMMEs*: Small, Medium and Micro Enterprises
14. MS Teams: Microsoft Teams
15. RAS: Recirculation aquaculture systems
16. TSFSA: Tilapia Fish Farmers of South Africa
17. DWAF: Department of Water Affairs and Forestry
18. ICBT: Informal Cross-Border Trade
19. SETA: Sector Education and Training Authority
20. R&D: Research and Development
21. DEFF: Department of Environment, Forestry and Fisheries
22. UN: United Nations
23. USA: United States of America

1 INTRODUCTION TO THE RESEARCH

1.1 Background and context

This research study investigates the economic potential of aquaculture farming: A case of Tilapia fish. In section 1.1, the report briefly provides the background and the context of the study, followed by the research conceptualization in Section 1.2. Flowing from this is the research delimitations and assumptions discussion followed by the research significance on Section 1.4, with the last section being the preface of the research report.

1.1.1 Global tilapia fish farming sector

Tilapia is one of the most economical globally consumed farmed fish (imarc, 2020) and the recent data shows that the global supply increased to 6.8 MT in 2020 compared to 6.6 MT in 2019 (Chase, 2020). This indicates the growth of the farmed fish. In addition, to the development of Tilapia farming in traditional continents such as Africa and Asia, Tilapia fish saw an increase in non-traditional countries of tilapia consumption and acceptance (Gupta & Acosta, 2004). However, its high development potential of tilapia farming in Africa requires proper policy development and sector management driven by the growth in economics and population (Cai, Quagrainie, & Hishamunda, 2017). Nevertheless, the improved genetic technology, selective breeding, and support from government initiatives have stimulated tilapia market growth. Still, due to COVID-19, the changes in the market have been monitored with forecasts done after considering the pandemic impact (imarc, 2020).

1.1.2 Tilapia fish farming sector in South Africa

In South Africa, the most commonly raised fish is tilapia that can survive difficult environmental conditions, according to the shared information by FAO (2014) (Mchunu, Lagerwall, & Senzanje, 2018). Furthermore, fish farming is moving towards the modern methods of farming that are a greenhouse, which assists in the regulation of water temperature that is important for the fish growth rate (Urban - Econ Development Economists, 2018).

The study conducted on behalf of IDC (2015) on engaging with local buyers indicated that tilapia could substitute hake based on the decline in production versus its consistent consumption (Urban-Econ Development Economists, 2015).

South African small farmers are essential for contributing to food security in Africa, generating income, expanding and developing other farming activities, and being resilient against overwhelming components such as weather, markets, and economy (Fincham, 2020).

1.1.3 Growth in the tilapia sector in South Africa

There is a need for development and growth of the tilapia sector, and this can be done in different formats, including but not limited to public-private partnerships (PPPs') to form support structures for the small-scale farmers to be able to be commercial farms to increase the aquaculture contribution to the country's GDP. Central to the development and growth is that the government needs to expedite a programme that will support the sector with credit facility to finance, a technical skill that will bridge the existing technology gap (Shava & Gunhidzirai, 2017). In addition, there must be an improvement in sharing information with the public to understand tilapia (Mapfumo, 2018). South African government must also ensure that all the stakeholders in the sector can overcome market barriers to entry and limitations that will assist the farmers in improving and increasing production, withstanding the international competition, overcome the logistics difficulties and restrictions in trading (Urban - Econ Development Economists, 2018).

1.2 Research conceptualisation

The research conceptualization focuses on the research problem statement, the research purposed, and the research questions of the study.

1.2.1 The research problem statement

Numerous factors affect the global fish farming market: import license process and procedures, lengthy certification procedure, customs cost and classification, valuation and clearance procedures, poor product marketing strategies, and conformance assessment (da Silva, Jose Graziano, 2018). However, World Trade Organisation (2017) explains that there will be the implementation of the Trade Facilitation Agreement that is expected to accelerate the movement, release, and clearance of products across borders and making sure that the negative impacts on trade are kept at minimal (da Silva, Jose Graziano, 2018). South African environmental conditions are appropriate for seafood business production. The sector is a potential but insignificant contributor to national fishery production and economy; based on constraints that are land, water, capital, technology, and policy and

legislation deficiency. In recent years, there has been a hike in prices of traditional fish products in the local market due to the supply shortage, which through fish farming, can be resolved. Tilapia has high qualities that are used in value-added products. This includes a high growth rate, fertility, and it can survive in short periods of poor water quality and a wide temperature range. It uses plant and animal nutrients for growth; meat is white, of good quality, and has a versatile taste and texture. It can be used in value-added products (James, 2020).

The Tilapia fish has been increasing demand as a commodity that will continue to be a vital source of protein, employment opportunities, and foreign exchange for different countries. It is crucial to the economy of food security while opening new markets and economies, which yield good returns, which are used to develop other farming activities and diversification (David Fincham Aquaculture, n.d.). The typical popular South African commercial buyers forecast on the Tilapia stirring being the conventional of consumer conscience and acceptance and take a product due quality that is very close for hake, willing to buy from local suppliers as long constant supply is maintained (The Industrial Development Corporation, 2014).

Despite the usefulness and value of Tilapia fish, it is imperative to investigate its economic potential, as tilapia can meet the growing demand, poverty alleviation, and employment creation (Prabu, Rajagopalsamy, & Ahilan, 2019).

1.2.2 The research purpose (aim and objectives) statement

This research study aims to investigate the economic potential of aquaculture specifically on tilapia fish farming, by responding to the research study questions. It will further expand on the potential available economic opportunities and constraints faced by South Africa to grow and compete in the global industry and market.

These questions are essential to each other, as understanding Tilapia fish farming will play a significant role in food security, poverty alleviation, employment creation, and the country's economy. Therefore, it is also essential to develop the sector in a sustainable manner that is important to sustain food security while tapping into the existing markets and economies, which yield good returns, which are used to develop other farming activities and diversification.

The design of the study is a multi-case study that is used to answer the research questions and meet the objectives of the study by providing a well-structured rationalization for the chosen source of data, collection, and analysis research methods (Saunders, Lewis, & Thornhill, 2015). The entire study was conducted without compromising the ethical issues and the challenges encountered throughout.

1.2.3 The research questions

1.2.3.1 Question 1: What are the economic state and economic benefits of Tilapia fish farming in South Africa?

1.2.3.2 Question 2: What are the critical factors for leveraging the economic potential of Tilapia fish farming in South Africa?

1.2.3.3 Question 3: What are the challenges that hinder the effective economic potential of Tilapia fish farming in South Africa?

1.3 Delimitations and assumptions of the research study

The problem in the tilapia sector globally, within the continent, and in South Africa is the depletion of the natural resource in the ocean and freshwater that results from global exponential growth in population, growing urbanisation and rising remunerations in the emerging countries, and this effect is forecasted to continue (Msangi & Batka, 2015).

There are numerous root causes of the challenge in the South Africa tilapia sector identified by the previous studies. The root causes of the problem are climate change, water shortages, access to finance, skills and development in the industry, infant sector, technology, temperature, load shedding, legislation, research and development, and transport and marketing (AgriSeta, 2020).

The sector being infant requires a lot of support to grow. However, growth will contribute to poverty alleviation; generate employment with the country that has an unemployment rate sitting at 28.48% reported by stats SA 3rd of November 2020, where the population is growing at an exponential rate and contribute to the economy of the Aquaculture in turn South African GDP (Urban - Econ Development Economists, 2018).

The R&D will contribute to the sector's continuous improvement to have a competitive advantage internationally because the World Food Organisation has theoretically proved that the industry can feed the entire world and increase its strength (Cook, 2017).

R&D will be able to find new, improved ways of productivity that will minimise the risks of the Tilapia not meeting the required specification for commercial purposes, which will minimise intensive work in the production process and trade.

1.4 Research study significance

The global human population has been exponentially growing over the decades, such that the seafood supply does not meet the demand. In addition, global warming and sea traffic also are contributing factors to the depletion of the natural resources in the ocean. Aquaculture aims to close the seafood gap demand growing, where aquaculture is the hatching or breeding, rearing, and harvesting of the creatures that originate in water environments. Tilapia has globally gained popularity over the years and is the new way of producing a surplus of fish to meet the demand of the deficiency from the natural course of reproducing and multiply from the ocean, river, and other places.

The tilapia fish farming research study plays a vital role in the contribution of the food security provided for 4.9 billion people globally in 2015 and is estimated to feed 9 billion by 2050 (Bene, et al., 2015). However, South Africa, the sector is in an infant stage, must find how it can grow and be able to international trade and play an essential role in foreign currency earnings while generating employment that results in the households earning income (da Silva, 2016).

The study will contribute to how the small-scale farmers can grow to be commercial farmers who will supply the buyers with fresh tilapia within the country and expand to the continent instead of importing frozen, poor quality tilapia from China (Mapfumo, 2018).



Figure 1.1: 2015 statistics African market consumed 98% of frozen tilapia exported from China.

Source: Mapfumo (2018)

According to the report by DEFF (2013), South African infrastructure will enable the tilapia sector to produce compared to the countries in the continent and requires the government to allow operational not only through policies (Adeleke, Robertson-Andersson, Moodley, & Taylor, 2020)Furthermore, an option of the technology is vital for the success and risk managing against the South African environmental weather conditions where in winter can be very cold below 12^0C that is the minimum required for tilapia fish to survive (Soliman, 2017).

1.5 Preface to the research report

The research study will consist of six chapters in total. Chapter 1 will be a pure introduction, and chapter 2 will cover the literature review of the industry patterns, theoretical background, empirical review, problem analysis, research gap, and the conceptual framework. Research strategy, design, procedures and methods, respondents' description, strengths on research credibility and trustworthiness, and weaknesses on research administration and technical discussion in chapter 3. Chapter 4 will present research results, discussion of the findings in chapter 5 and results, in summary, conclusion with limitations and recommendations in chapter 6.

2 LITERATURE REVIEW

This chapter has three broad objectives: understanding the research problem, identifying the knowledge gap, and developing a framework for interpreting the research findings. Specifically, in Section 2.1, we detail the research problem. Then, in Section 2.2, we review the literature on studies that have attempted a similar study or research. Finally, with information arising from Section 2.2, we identify and detail qualitative attributes or quantitative variables that are key to this research in Section 2.3 and a framework that we will use to interpret our research findings in Section 2.4.

2.1 Patterns of Tilapia fish farming and problem analysis

2.1.1 Global patterns of Tilapia fish farming

Aquaculture is the farming of water animals and plants, which has grown quicker in recent years than any other livestock sector (Little, Newton, & Beveridge, 2015). It is the role of aquaculture to provide food security supply globally and economic development in developing countries (Pradeepkiran, 2019). It continues to accelerate its growth than any other industry that produces food since aquatic animals fed grow faster than the unfed animals (Food and Agriculture Organization of the United Nations, 2018). According to Scorvo-Filho, Frascá-Scorvo, Alves, and Souza (2010), about 40% of aquaculture originates from Tilapia fish production, which increased the importance of Tilapia.
The captured fish has depleted and is no longer capable of sustaining the supply of the globally growing demand. Therefore, tilapia can meet the growing demand, poverty alleviation, and employment creation (Prabu, Rajagopalsamy, & Ahilan, 2019).

In 2018, there is a 6.4 MT of Tilapia produced globally and the most consumed type of farmed fish. It is hard, resistant to diseases, affordable, omnivorous, and easily cultivated by small farmers (Wood, 2019). Tilapia Fish contain vitamin B, iron, vitamin D, selenium, and omega-3 fatty acids. According to Research and Market website (2019), different governments support businesses in aquaculture as part of promoting Tilapia fish farming due to the global increase in people being health-conscious and demand high protein diets. As a result, in 2020, despite the COVID 19 epidemic, production increased by 3.3 per cent for the first time (Fletcher, 2020).

As it is vital for global food security, creates employment, generate income, and make it a valuable traded commodity with substantial earnings from the foreign market (The Tilapia Aquaculture Association of South Africa, 2020)

Tilapia production globally is anticipated to be almost double in 2030, as per table 1 below, from 4.3 to 7.3 million tons (Van der Knaap, 2018). According to UN estimates, the global human population is expected to exceed more than 9 billion, which puts pressure on food security. Tilapia fish farming will be the global solution (Bene, et al., 2015).

	2010–2030 increase in production (million tons)	2010–2030 increase in production (%)	Share of 2010–2030 increase coming from aquaculture (%)
Africa south of the Sahara	0.3	4	64
Middle East and North Africa	0.8	22	97
India	4.8	60	98
Other South Asia	2.4	32	82
Southeast Asia	7.9	38	97
Japan	(0.5)	–9	–
China	16.5	31	101
Other East Asia and Pacific	0.3	7	105
Latin America and Caribbean	2.1	11	94
North America	0.2	4	103
Europe and Central Asia	0.8	6	122
Rest of the world	0.0	1	60
Global total	35.7	24	100

Table 2.1: The production gains from various regions of the world by International Food Policy.
Source: Msangi, Siwa, Batka & Miroslaw (2015)

The USA is the largest market globally for tilapia, while it is the most second consumed food fish in the country (Urban-Econ Development Economists, 2015). China is steadily increasing to be the primary influencer in the Tilapia fish farming and estimated to be 37% by 2030 contributor while 38% of the total global consumers remain the prominent exporter and Asia (South including and India, Southeast) & Latin American (Services, 2013). Tilapia farming has also grown attractive in other countries like Malaysia, Taiwan, Bangladesh, Indonesia, Philippines, Vietnam, and Laos (Prabu, Rajagopalsamy, & Ahilan, 2019).

2.1.2 African continent patterns of Tilapia fish farming

The African continent has been a growing market for Tilapia but mainly majorly exported from China (Urban-Econ Development Economists, 2015). TFF has been successful in Egypt, followed by Nigeria, conducted for ages, and has been evolving intending to maximize its output. As a result, it is the primary source of supply in the whole continent, with more than 0.75 MT per year, according to James (2019), but second internationally (Kaleem & Sabi, 2020).

There are numerous Tilapia farmers in other African countries, even though Egypt shadows them but these farmers shortly will be almost 16% growth rate even though their growth has been constant in the last couple of years (Fletcher, 2020)

Various countries in the African continent use large cages or ponds for commercial purposes, i.e. Lake Harvest, which operates in Zimbabwe and Zambia, producing between 5 and 9 thousand tons of tilapia and Uganda and Lake Victoria had followed suit (James, 2019).

In sub-Saharan Africa, fish farming has quickly gained motion as an innovative and economic mechanism for generating employment and increasing household income. According to FAO (2013), Tanzania presents the most favourable fish farming opportunity, supported by land and water sources. About 14 100 freshwater fish ponds are available in Tanzania, which is still to be tapped. Chenyambuga, Madalla, and Mnembuka (2012) reiterate that aquaculture in Tanzania is still being operationalised at a subsistence level by small-scale farmers of low status. However, they are being constrained by a lack of technology. Furthermore, FAO (2013) argues the lack of capacity in the government to exploit the viable fish farming, which can be diversifying production and developing the export market for the largely rural Tanzanian economy. In Uganda, a study was conducted by Maurice, Knutsson, and Gestsson (2010) to investigate the value chain of farmed African catfish.

Similarly, Kariuki (2013) explores more on fish farming implementation in Kenya. The research explores the existing fish farming – mainly catfish farming – industry with its value chains. These studies responded to questions concerning fish farming culture, value chains, value distribution, and how these links profit farmers and small fish farming commercial businesses. In Nigeria, Ike and Onuegbu (2007) devised aquaculture technology packages for Nigerian farmers. The intervention strategy aimed to mitigate low technology levels in fish farming because of limited funding. Cook (2017) observes

that fish farming has proven to be an innovative strategy for improving communities' economic growth and well-being.

2.1.3 Tilapia patterns in South Africa

There has been a high demand for growing fish through aquaculture in South Africa due to demand not meeting the supply even though the industry remains minimal (Wood, Laura, 2020). However, the majority of the commercial suppliers are prepared to purchase from the local farmers only if they supply good quality Tilapia fish and sustainability (Urban-Econ Development Economists, 2015). According to Mkhize and Mbhele (2017) research conducted, the depletion of the natural resources created business opportunities to explore Tilapia fish farming (Mkhize & Themba, 2017). According to the AgriSeta skills plan, there are 11 sectors in agriculture, with red meat leading at 44.3%, while aquaculture is in the sixth position at 4.2%, and the last one is tobacco at 0.3% (AgriSeta, 2019).
In 2013 according to the IDC (2015) report, were only 53 producers registered, and 79% of them located in Limpopo, North West, Mpumalanga, and Gauteng, containing the majority of producers based on the areas being warmer and more humid environment than other areas of the country but do not meet the quantity required by the market (Urban-Econ Development Economists, 2015). Nevertheless, there is a high potential for commercial Tilapia fish production to meet the current local demand that will alleviate poverty and create employment that will contribute to the country's economy.

2.1.4 Problem analysis

The existing supply of fish does not meet the demand quantities from the market. The sector has potential but insignificant contributors to national fishery production; based on constraints that are temperature, load shedding, land, water, capital, technology, and policy and legislation deficiency.
There is no true reflection of how many existing actively operating farmers is because many small-scale farmers supply the informal markets often located in poor areas like townships and informal settlements and sell the fish directly to the household consumers. The existing large-scale commercialization farmers do not meet the demand quantities required by the current market. With UN of the year 2050, the population will exceed 9 billion globally, posing a risk of food shortages. Tilapia provides relief of high-quality fish protein and can establish in both urban and rural areas. It is vital to the economy of food security while opening new markets and economies, which yield good returns, which are

used to develop other farming activities and diversification. It makes the interest in investigating aqua fish farms' economic potential to assist with 'triple challenges' of unemployment, poverty, and equality in both South Africa and other developing nations.

2.2 Viability Theory (VT) grounding Tilapia fish farming

Schwaninger (2006) explained that viability is the survival of a system or organization and the result of the progress and the setting of position. This view was supported by Golinelli et al. (2011) and Aubin et al. (2011), who l linked this to VT. The VT deals with the dynamic adaptation of uncertain evolutionary systems to environments defined by constraints (Sprenger, Mettler, & Winter, 2017). As such, VT "studies the evolution of dynamical systems under constraints on the system's state and control" (Aubin, 2009, Epigram vii). Thus, the essential elements of VT are control and state variables that are utilized for the system's optimal control to formalize problems arising during the study of different natural and social phenomena (Oubraham & Zaccour, 2018).

VT has two key components, which are functions of its essential elements (Oubraham & Zaccour, 2018) according to Krawczyk and Pharo (2013) that is:

- Differential inclusions, which analyses nondeterministic and stochastic dynamic systems; that is vital in economic and environmental processes and
- Viability, controlled experiments that are seldom executed in social science may not be "rational" to update one's faith on something happening concerning something else, for with no control, nothing to show that this was not the result of some other (possibly unobserved) phenomenon.

According to Oubraham and Zaccou (2018), the two components are the pillar of VT, and their primary concern is the state of the trajectory of the method studied in this case is the Tilapia fish farming that has globally evolved and is continuing to evolve based on global food security constraint against the global population growth. Therefore, the critical issue is decision-making and especially relevant in fast-changing market environments, depleted natural resources and rapid growth on the global population growth; therefore, further global development is required to build a viability theory for Tilapia fish farming. (Sprenger, Mettler, & Winter, 2017).

Problems involving both elements are intermingled in the same differential inclusion; the existence of a viability domain means sufficient control exists to give the system a chance of remaining, but it may not necessarily happen (Krawczyk & Pharo, 2013).
Gathering understanding into an operational ecosystem-based framework is a massive task requiring time, resources, and new tactics. Reaching an agreement for fisheries management with different stakeholders will not be easy on existing ecosystem-based objectives and target reference points. A high probability of contradiction among social, economic, and ecological objectives and a workable balance will be required at the local scale (Cury, Mullon, Garcia, & Shannon, 2005).

The research study focuses on evaluating the economic potential viability opportunities of Aquaculture Farming and concentrates on how Tilapia fish farming contributes to food security, employment creation, poverty alleviation, and contribution to the economy. Objectives to understand how and under which productivity conditions Tilapia fish need to produce to ensure the commercial viability to meet the market response.

In the study conducted, the VT framework intended to quantify two forms of the resilience of a land-based Tilapia fish farming system depending on a highly inconstant environment.

2.3 Empirical review

Many research studies have been conducted on TFF that will contribute to global food security as an innovation for employment creation. Empirical evaluations regarding Tilapia's unpremeditated food security effects are diverse (Shava & Gunhidzirai, 2017). Studies indicated that globally, tilapia farming is growing and contributing to the global economy (Kaminski, Alexander M., 2020). It is predominantly in the Asian countries where they contribute 88% total of the worldwide production and Egypt in the African continent accounts for 71%, Nigeria 16%, Uganda 7% while 6% shared among Ghana, Malawi, Zambia, Kenya, Tunisia, Madagascar and South Africa of the 2,2% that Africa contributes on the global production (Urban-Econ Development Economists, 2015). South African fish farming has minor contributions, and there is no measurable growth even though there are opportunities and infrastructure to pursue the industry (Mkhize & Themba, 2017). There has been an interest indicated on tilapia economic production and

has gained a competitive advantage over other produced aquaculture types based on its essential features (Young & Muir, 2002).

2.3.1 Productivity for the economic viability of Tilapia fish farming (TFF)

During 2000, TFF contributed about 3.6% of the global aquaculture annual production and ranges from small-scale that is for household consumption, non-commercial extensive and low input practices to a largescale that is market-driven, commercial determination and severe capital based on the strength of the hired management. (Gupta & Acosta, 2004). FAO's production data is more reliable and accurate than other sources of data in TFF. The first sale value considered higher than before includes the newly available information of some main producing countries (Food and Agriculture Organization Of the United Nations, 2018). The year 2015 was reported to be the largest global Tilapia production where there was an increase in the number of farms that resulted in the production increase in Brazil, Bangladesh, Mexico, and Egypt, where China remains the main largest producer (Prabu, Rajagopalsamy, & Ahilan, 2019).

TFF production by 2018 increased to 140 additional countries (Mapfumo, 2018). The world total fishery production, which is aquaculture and captured anticipated to increase to 196 million tons by 2025, and the increase, will be the contribution from developing countries (da Silva, José Graziano, 2016)

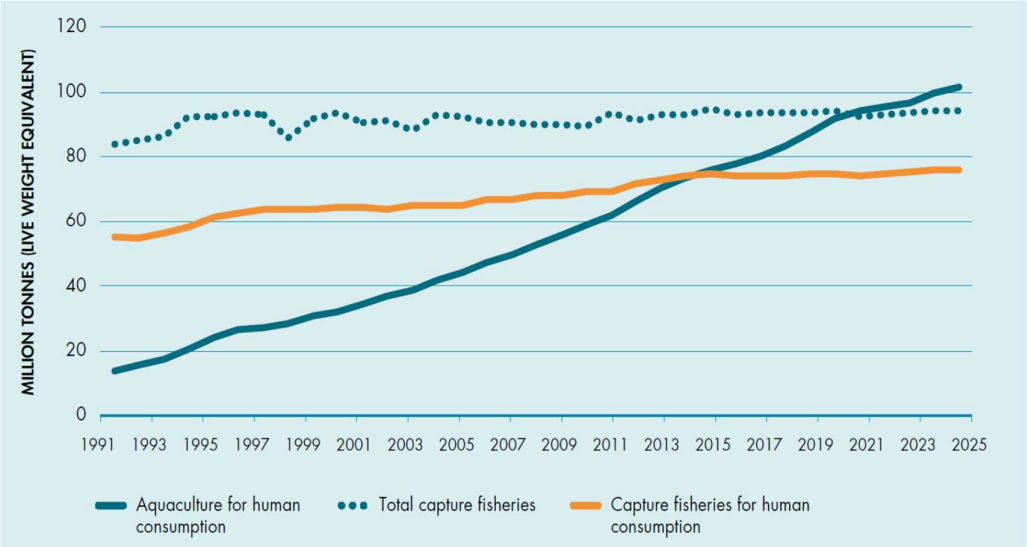


Figure 2.1: Global aquaculture and captured fishery production

Source OECD (2015) and FAO (2015)

The African tilapia production growth has been stagnant and insignificant and lags in developing its global share in global fish production (Chan, et al., 2019). Egypt is the largest producer of tilapia on the continent (Mapfumo, 2018).

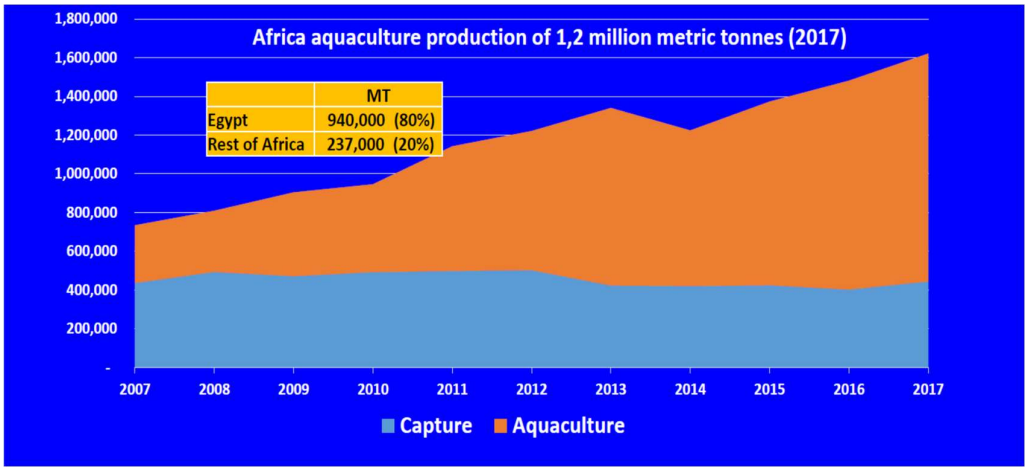


Figure 2.2: African aquaculture and captured Tilapia production 2017
Source OECD (2018) and FAO (2018)

South Africa is a member of the SADC, where Zimbabwe is the one that has the favourable environment for the TFF production and where South Africa the TFF was recently given priority (Mapfumo, 2011). As a result, there has been an increase in TFF production according to the NEDALC, where most farmers consider it an opportunity since considered as hake replacement (Mkhize & Themba, 2017).

2.3.2 Constraints of TFF on the economic potential

The production environment drives the constraints of the TFF on economic potential, improved fish breeds, innovation and training development, poor infrastructure market and access, weak governance and regulation.

2.3.2.1 Production Environment

It is imperative to consider geographic and climate conditions that have a significant effect on the temperature for the tilapia production, which has a crucial manipulating factor as it regulates and influences the type of production systems that indicate what kind of

infrastructure is required to heat water as in needed during the cold season (Urban - Econ Development Economists, 2018)

Geographical location has a vital effect on the commercial tilapia producers and the production growth; the different geographical production environments expose the more tolerance tilapia has to grow in various conditions (Young & Muir, 2002). Controlled breeding where it is quicker, more efficient production, better physical appearance, and environmental conditions that are tolerable produce the tilapia seeds that have 'improved' physical appearance (Gupta & Acosta, 2004). Most of the TFF production, which is more than 80%, is produced in Asia's most inland environments (Young & Muir, 2002).

Egypt has a conducive temperature throughout the year based on the favourable desert temperature environment that continuously keeps the water and land warm. At the same time, Uganda and Nigeria also have a favourable tropical climate that is favourable for TFF production (Adeleke, Robertson-Andersson, Moodley, & Taylor, 2020). On the other hand, South African weather conditions drastically vary from one season to the other limiting tilapia production and the location (James, 2019). According to the published report by Industrial Development Corporation (2015) report South African weather conditions, most areas are not feasible for TFF production. Hence, significant interferences but others the climate is viable, where in other regions, production can only occur seasonally unless the water is heated to maintain high temperatures in winter (Urban-Econ Development Economists, 2015).

2.3.2.2 Improved fish breeds

Fish breeding is affected by different aspects such as environmental degradation, soil erosion, pollution, deforestation, lad shortage, floods, and freshwater shortages (FAO, 2009).

2.3.2.3 Innovation and Training development

Technology and poor fish farming practical implementation result in limited industry growth (Shava & Gunhidzirai, 2017). Therefore, innovation through the implementation of better-quality technology is a vital victory and mitigates risk factors against environmental constraints during the whole process of TFF production (Adeleke, Robertson-Andersson, Moodley, & Taylor, 2020).

2.3.2.4 Poor market infrastructure and access

INFOFISH (2015) mentions that the African continent has a poor infrastructure that imposes severe limits on distribution within the continent. For example, the cold preservation system and roads constrain transportation of fresh tilapia in the Sub-Sahara

African markets and impact commercial purposes. South Africa, in contrast, has a well-developed infrastructure, but its value chain is in the infancy stage or has minimal to no growth. (Urban - Econ Development Economists, 2018).
South Africa can manage to export to the rest of the continent via roads transportation such as the DRC, currently supplied through Zambian traders (Personal Communication, 2012)

2.3.2.5 Weak governance and regulation

South African industry is disadvantaged by the existing policy in acquiring permits to operate. There is no appropriate implementation process existing, not user friendly and not correctly coordinated between different government departments (Urban-Econ Development Economists, 2015). Satia (2011) mentioned that most African governments have developed an interest in creating policies that adapt, coordinate, and accelerate an environment conducive to the TFF while providing rewards and lenient credit (Adeleke, Robertson-Andersson, Moodley, & Taylor, 2020).

2.4 Research knowledge gap analysis

Local, national, and international settings typically affect the industry to generate employment—however, this results in economic recession and inflation unfavoured by policies. Therefore, the market and government should develop policies that will promote the TFF and create employment opportunities to boost the economy (Shava & Gunhidzirai, 2017). Thus, the industry has the high vital potential of reducing unemployment numbers and the chance to improve the African economy (Adeleke, Robertson-Andersson, Moodley, & Taylor, 2020).
TFF production techniques will not be successfully sustainable if not promoted and managed through the developed production tasks (Adeleke, Robertson-Andersson, Moodley, & Taylor, 2020).

The industry patterns indicated that the captured fish has depleted, and there has been an increase in Tilapia fish farming. Still, the exact number cannot be known for many small-scale farmers who sell their products on the market (Food and Agriculture Organization of the United Nations, 2018). Fletcher (2020) further elaborates, "There are some question marks about the data, but it seems that overvaluations for some countries have

been roughly balanced by undervaluation for others, so the errors seem to negate each other".

African continent governments to close the gap by developing well-defined policies, interventions of public, general capacity in the industry development and legal frameworks, and financial assistance and marketing feasibility studies in the SADC countries private commercial part for the business project implementation (Mapfumo, 2011).

South African Tilapia fish farming industry requires more research and development on the existing technology upgrade to boost the tilapia production process to enable the farmers to reduce capital and operational expenses (Urban - Econ Development Economists, 2018). AgriSeta to work closely with the existing emerging farmers to assist in all the process stages to contribute to the South African economy in a significant and quantifiable way (AgriSETA, 2018).

There is a lack of a promotion plan to strengthen trade utilising state services and resources to internationally optimize South African market success (Mkhize & Themba, 2017).

There are no adequate skills, training, and development in the industry; therefore, a massive gap requires programme development that will assist the market and expose opportunities that will create employment opportunities and contribute to the economy and growth of Tilapia fish farming.

2.5 Conceptual Framework for interpreting research findings

In the past decades, the growth in global fish farming has been depleting towards sustaining natural marine and freshwater resources. In developmental circles has been criticised because it focuses more on conservation and environmental protection, neglecting economic, social development and economic growth. With social equity, the focus is typically on jobs, land use and ownership, and distribution of goods supplying the industry and goods produced by the industry. An environmental emphasis typically looks at the effluents from a system, water quality, land use, and energy or natural resources used to regenerate those inputs.

2.6 Summary and conclusion

2.6.1 Summary of literature reviewed

Globally, the aquaculture sector has contributed significantly to critical socio-economic priorities: job creation, poverty alleviations, household income, and food security. However, there is a lot that needs to improve, especially technology and infrastructure, while providing the training and support to the small-scale farmers for their production to be commercially viable. South African context, there is a high potential for commercial Tilapia fish production to meet the current local demand that will currently alleviate poverty and create employment that will contribute to the country's economy.

2.6.2 Proposed research strategy, design, procedure, and methods arising from the literature review

The research study uses a qualitative multi-case study choice of method, which is appropriate for the study because it will analyse different cases and compare within and between cases. Furthermore, as Denzin and Lincoln (2011) stated, the qualitative approach linked to interpretive philosophy means the researcher must access the in-depth understanding of tilapia fish farming by establishing a trust to participate in the credible research participants study results fully. Therefore, the strategy will be the multi-case study of tilapia fish farming.

The data and information collection and analysis methods and literature review will contribute significantly to the knowledge of Tilapia fish farming. The data and information collected will be done via three semi-structured interviews, field observation, and document review. Thus, the study will be an interconnected process between collecting, analysing and interpreting as the interviews and observations.

The research questions throughout the report result from working together to formulate discussion, conclusions, and recommendations on South African TFF.

It will assist in ensuring that South African trade policy tools are prioritised toward initiatives that will yield the maximum economic benefits to South African Aquaculture industry workers and businesses while also unlocking the potential of SMMEs, cooperatives, townships, and rural enterprises

3 RESEARCH STRATEGY, DESIGN, PROCEDURE AND METHODS

In Section 1.2.3, three questions were posed that this research report was intended to provide a solution—that is, 'What are the economic state and economic benefits of Tilapia fish farming in South Africa?', 'What are the critical factors for leveraging the economic potential of Tilapia fish farming in South Africa?', and 'What are the challenges that hinder the effective economic potential of Tilapia fish farming in South Africa?' We viewed literature that resulted in an interpretative and conceptual framework developed, which guided the techniques of choices used. Chapter 3 identified and described the research approach, design, procedure, and methods applied in this particular research to gather, process, and analyse empirical evidence. Generally, it had three intentions, namely, to identify and describe the research strategy (Section 3.1), the research design (Section 3.2), as well as procedure and methods (Section 3.3). The chapter also described the credibility and trustworthiness measures (Section 3.4) that this research applied to make it credible and the limitations in technical and administrative of the choices made (Section 3.5).

3.1 Research strategy

The case study methodology approach is an approach used to investigate intensely to advance awareness and understanding of phenomena that are not understood (Yin, 2008). According to Carroll and Johnson (1990, p. 44) further elaborate "for those interested in the richness of actual cases, understanding a good story, staying close to naturalistic events, exploring new areas and discovering new phenomena, and applying our understanding to therapeutic ends" can offer an influential illustration on a particular social phenomenon (Yin, 2008). Mtotywa (2019) further elaborated that a case study is an ideal methodology to be used when conducting an in-depth investigation.

The research strategy is a qualitative case study methodology approach, where it simplifies the study of a phenomenon within its framework by using multiple data sources, as part of ensuring that the subject matter is not explored through one lens, which allows for numerous sides of the phenomenon to be revealed and understood (Baxter & Jack, 2008). It focuses on the process on how is it done and the outcome if it does work

The case study is further categorised into three types according to Yin (2003), which is descriptive, explanatory, or exploratory, where this particular study adopted the exploratory case study (Baxter & Jack, 2008). Yin (2003) further explains that an exploratory case study is used to discover those conditions in which the intervention being assessed had no clear, one set of results (Lotzkar & Bottorff, 2001).

The system of views and assumptions about knowledge development is referred to as research philosophy, might not mean intense as a new theory of human drive, but even responding to an explicit problem in particular industry research, however, developing further information (Saunders, Lewis, & Thornhill, 2009). It was intended to gain insight and gaining the overall industry understanding. The philosophical research orientation for this study is anti-positivist. Yin (2003) anti-positivists hold that social phenomena are multi-layered and deserve multiple interpretations. The aim is to develop the Tilapia fish farm to secure food, poverty alleviation, job creation, and contribute to the economy. Have a holistic overview of the industry to contribute to the aquaculture industry.

3.2 Research design

Research design is a plan and investigation structure to obtain responses to research study questions, where the plan is a complete research study. The structure is the framework (Blumberg, Cooper, & Schindler, 2008), where there are five generic research designs: experimental, comparative, case study, longitudinal and cross-sectional, according to Bryman's (2012).

The research study is similar to the methodology where it is a case study, where Yin (2003) and Stake (1995) further describe different terms to define a variety of case studies (Baxter & Jack, 2008). There were six generic types of case studies: intrinsic, collective, instrumental, explanatory, descriptive, or exploratory. A case study is categorised as descriptive, exploratory, or explanatory and further differentiated between holistic, single, and multiple-case studies (Yin, 2008) but is identified as collective, instrumental, or intrinsic by Stake (1995).

This research study adopted the exploratory case study but in particular, using the multiple-case studies is appropriate for the study because it can analyse different cases and compare within and between cases. Moreover, it is applicable because in the literature

within the study, there were different types' of participants is commercial and non-commercial.

The study applied a similar research design by Shava & Gunhidzirai (2017). The aim and to use fish farming as an innovation strategy for food security stimulation in areas affected by poverty in Zimbabwe used this particular design methodology to recognize the opinions of fish farmers and if employment creation improved the living condition and benefited the locals on generating employment, family income and food security improvement (Shava & Gunhidzirai, 2017).

3.3 Research procedure and methods

The actual collecting, organizing, processing, and analysing empirical evidence used in this research study was completed in the research procedure and methods section. The instruments of data and information collection (Section 3.3.1), target population and selection of cases (Section 3.3.2), consideration of ethics through the research study (Section 3.3.3), collection and storage process of data and information (Section 3.3.4), processing and analysis of data and information (Section 3.3.5) including the description of respondents backgrounds who provided empirical evidence (Section 3.3.6) are detailed.

3.3.1 Data and information collection instruments

Based that this study is a case study, it uses multiple sources of data. The research study of the exploratory qualitative case study uses multiple sources of data to ensure that the matter is not explored over a single lens but instead through various lenses that permit numerous sides of the phenomenon to be discovered and understood (Baxter & Jack, 2008). Therefore, three types of data and information collection (See Appendix 1.1: Data collection instruments) were adopted in this study: interviews, observations, and documents review that are relevant to the study's research questions.

The interview guide was used when conducting the interview (see Appendix 1.2.1), the observation checklist (See Appendix 1.2.2) developed and used during visits to conduct observations, and the document review (See Appendix 1.2.3) was conducted to request for the documents to gather more information. The use of document review to receive information that did not transpire during the interview and observation and to enhance the study.

The research data and information collection instruments are necessary for answering the research questions and be in line with the literature in Chapter 2.

3.3.2 Target population and selection of cases

3.3.2.1 Research target population

The target population is the group of participants who are the centre of the study research and from where a sample is drawn (Saunders, Lewis, & Thornhill, 2015). The interest of the research study was conducted on the South African Tilapia Fish Farming sector.

A review of the factors affecting tilapia aquaculture production in Southern Africa by Moyo and Rapatsa (2021) shows that tilapia farming is not growing in Southern Africa even though the potential is very high to alleviate poverty and food security, and employment creation. Therefore, this sector must be viewed as a business instead of life-saving for survival.

3.3.2.2 Sampling cases from the target population

Sampling is selecting the elements in a population where a conclusion can be drawn about the entire population (Blumberg, Cooper, & Schindler, 2008). The study is exploratory qualitative multiple-case study research conducted on the eight commercial Tilapia fish farms and one non-commercial farm of the tilapia. Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers by Baxter & Jack (2008), been adopted for the sampling strategy.

The aim is to direct the novice researcher in recognising the essential elements for designing and implementing qualitative case study research projects to allow the researcher to analyse within each setting and across settings to understand the similarities and differences between the cases. It is considered robust and reliable. The intent is to gain an understanding and vision of a phenomenon.

The sample size was 9 cases that were part of this research study, as Yin (2014) states that in the multiple case study six (6) to ten (10) cases are required to reach the saturation, and for this research study, nine cases were researched which are within the range (Gentles, Charles, Ploeg, & McKibbon, 2015)

3.3.3 Ethical considerations when collecting research data

Ethics are the norms for conduct that differentiate between suitable and improper behaviour and mainly centres on the standards of conduct of the research study discipline

(Resnik, David B., 2015). Ethics is about protecting the rights of the participants of the research study, where during the interview, observation have the rights that their safety are not compromised infect it must be designed in such a way that it will not cause any detrimental physical harm, loss of privacy, distress, embarrassment or pain (Blumberg, Cooper, & Schindler, 2008).

Ethics are critical in any research, and it is the researcher's responsibility to make sure that it is being upheld. The picture of the study is partly dependent on the risk classification of the study and for this type of research, the risk is low. It is of low risk because it does not have a human experiment, but the focus will be on the critical elements.

It was critical to tell people about their rights, explain to people about the objective of the study and after which the consent was requested, where it was explained and that the participation was voluntary and can be able to withdraw anytime they wished to and felt they don't want to participate anymore. There was privacy and confidentiality where real names of the participants are not used but instead, coding will be used, such as INT which is the interviewee as part of protecting their original identity, in any part of the research.

There were protected from harm and provided the details of inquiries should there be at any time I fail to uphold the ethical standard and organise counselling for discomfort if there is a proof of that action through the university. The data storage only a few people have an access to it and those are researcher, supervisor and the university authorised individuals and is kept in a password-protected place electronically base like Dropbox.

3.3.4 Data and information collection process

Data collection of the research is gathering, capturing, and editing information using different methods of instruments that enabled to answer of the research questions (Blumberg, Cooper, & Schindler, 2008). The collection process of data and information in this specific research study was done via three methods that are interview, field observation, and documentation review.

Conducted eight interviews one-on-one and one that was not possible electronic interview via MS Teams was conducted. The electronic interview was impossible to conduct the observation based on the absence of physical interaction, but the documentation was requested for review. The interviews conducted were guided by the interview

questionnaire that was a semi-structured interview that was not closed question but not opened also in a way structured. The names of all prospective case partakers were obtained, contacted before they participated in interviews and other information gathering activities, and an interview schedule were used to obtain information. The check sheet guided the field observation on information to request during the site visit and the documentation review guided on what documents to request to acquire the information that was not covered and validated during the interview and observation process.

The prospect, potential, and constraints of the aquaculture in Nigeria and Egypt that will able to meet food security needs of the millions of people in the developing countries and the reason selected the mode of data collection is the manager to have the holistic overview of the study and able to collect data on other modes where data is not sufficient to conclude the results from one mode. It will provide a better presentation of results that will provide adequate information to complete the study.

The electronic data will be stored on the password-protected files and hard copies will be put on the files that will be stored on the locked file cabinet. People that will have the access to the data only those that form part of the study that is, the researcher, supervisor, and the university authorised individuals that will only utilise it for the research purpose due to personnel security reasons and ethical purposes.

3.3.5 Research data and information processing and analysis

3.3.5.1 Research data and information processing

Data processing is documented in stages that are implemented to arrange, validate, transform, adjust and extract data inappropriate results for later use during the presentation of results (Chapter 4), discussion of results (Chapter 5) and summary, conclusion, limitations, and recommendation (Chapter 6) of the research study. The data and information processing comprises of all actions accepted from the beginning when gathered up until ready for analysis either manually or by dedicated software (Kabir, 2016). Consent was requested from the interviewee to record and transcribed data verbatim. The data and information were explicitly described and organise to make sense for the interpretation.

3.3.5.2 Research data and information analysis

The transcribed data were analysed using thematic analysis based on Braun & Clarke (2006) and used the two common strategies of the case study, which were pattern

matching and explanation building. The thematic analysis highlighted the distinctiveness, scrutinised and interpreted patterns within the qualitative research (Braun & Clarke, 2006).

3.3.6 Description of the potential research cases

The research study was conducted on the cases of eight commercial Tilapia fish farms and one non-commercial farm of tilapia. The cases experience ranges from a minimum of 6 years to more than 30 years' experience of being in the tilapia sector. The majority of the cases were white African males excluding Lambda who was a black African male and Beta who was a black African female Tilapia Fish Farmer. The table below further elaborate description all the cases that participated in this research study

Table 3.1: Case studies

Case	Farm Name	Area Based	Type Of Farming	Number of years' experience
1	Alpha	Gauteng - Midrand	Hydroponics	17
2	Beta	North West - Ventersdorp	Aquaculture	8
3	Gamma	Gauteng - Johannesburg	Fish Farming	7
4	Delta	Gauteng - Midrand	Fish Farming	15
5	Epsilon	Gauteng - Pretoria	Fish Farming	6
6	Kappa	Gauteng - Roodepoort	Fish Farming	35
7	Lambda	KwaZulu Natal -Port Edward	Fish Farming	10
8	Phi	North West - Hartbeespoort	Fish Farming	+30
9	Omega	Gauteng - Pretoria	Hobby Fish Farming	20

The cases were individually analysed and then combined to summarize the outcome.

3.4 Research strengthens—credibility and trustworthiness applied

The trustworthiness of qualitative research is usually interrogated by positivists where Guba (1985) proposed four criteria is credibility, transferability, dependability, and confirmability that were considered when pursuing the trustworthy study (Shenton, 2004). Credibility as one of the important criteria addresses the internal validity to ensure that the study measures or tests what it is intended for, where according to Merriam (1998) it addresses the question of "How congruent were the findings with reality?" and Lincoln

and Guba (1985) continued to argue that credibility develops trustworthiness (Shenton, 2004).

Multiple data sources are joined together during the data analysis process instead of being individually analysed, where each source contributes to the overall to create an understanding of the whole phenomenon and that strengthens the results (Baxter & Jack, 2008). Triangulation was conducted through observations and individual interviews conducted as part of reducing the effect of the investigator being biased.

3.5 Research weaknesses—technical and administrative limitations

This particular research study adopted the exploratory multiple-case study, which is part of determining conditions of the study in which the interventions evaluated do not have any simple, one fixed results.

The completion of the study was within a limited time frame. During the COVID-19 pandemic, the respondents took a while to accept the interview appointment due to fear of spreading the infection during country-level three lockdown. Therefore, during the interview: sanitising before, during and after the consultation, social distancing, wearing the mask throughout, and even wearing gloves. Moreover, adjusting to the new way of living was still in the early stages, not yet used to it. Therefore, accessibility to the respondents was not successful as it was required.

Environmental factors, that is, the presence of other people in the space during the interview, caused hesitancy in the way other respondents were answering through body language. However, the multiple data source collection assisted observations and documentation review with the validation and authentication in closing the gaps that arose.

The sample population size was small, making it difficult to justify and conclude valid research results; they might be less precise. In addition, the sample population size did not represent the whole country. Still, it concentrated on Gauteng Province respondents with six (6) respondents, two (2) from North West and one (1) online via MS Teams from Port Edwards – KwaZulu-Natal province and no observations.

Travelling during the pandemic because it was not safe to sleep over hotels or bread and breakfasts accommodations' and to finish the study time was limited. In addition,

travelling would have required more time to collect data that would still need to be processed and analysed.

3.6 Summary

The qualitative case study methodology was the adopted strategy for this research study. It is an exploratory multiple-case study where different cases are analysed and compared and this is appropriate because there were different types' of participants that is commercial and non-commercial in the literature of the study.

Data and information were collected via semi-structured interviews, site visit observations and document review to gather the information that was not covered during the two instruments as part of enhancing the study holistically.

All interviews were conducted face-to-face one-on-one excluding one that was via MS Teams where the observation was not conducted but a soft copy of documents as requested. Nine cases were researched eight were commercially and one was non-commercial. The cases experience ranges from a minimum of 6 years to more than 30 years' experience of being in the tilapia sector. The study was conducted ethically where the cases consent was requested, protected from any harm and could withdraw from any time of the study if not comfortable to continue. Data is protected from people excluding the researcher, supervisor and the university authorised individuals and kept in a password-protected place electronically.

The transcribed data were analysed using thematic analysis highlighted the distinctiveness, scrutinised and interpreted patterns within the qualitative research (Braun & Clarke, 2006).

The research is credible and trustworthy because there are multiple data sources is that joined together during the data analysis process instead of being individually analysed, where each source contributes to the overall to create an understanding of the whole phenomenon and that strengthens the results (Baxter & Jack, 2008).

There were limits on this particular research study because of the COVID-19 pandemic, the way people were answering, the size of the sample population, travelling and was regionally based.

4 FINDINGS OF THE RESEARCH

The purpose of this research study is to investigate the economic potential of aquaculture specifically on tilapia fish farming in focusing on the potential available economic opportunities and constraints faced by South Africa to be able to grow and compete in the global industry and market. The study was investigated using the multiple-case study which is a contemporary phenomenon inquiry set with a real-world context. This multiple-case study consists of nine cases from different Provinces in South Africa, which are Alpha, Beta, Gamma, Delta, Epsilon, Kappa, Lambda, Phi, and Omega. The findings of the study are presented in this chapter, starting with an overview and relevance of the sample, followed by the overall themes of the study and their linkage to the research questions. Flowing from this is the findings from each case then the triangulation of the case to draw cross-case conclusions.

4.1 Themes linked to the research questions

The empirical data for the cases was based on the semi-structured interviews, the document review as well as observations by the researcher. Based on the data, five themes are linked to the research question in the study. Theme one was on the economic viability of the Tilapia fish farming, theme two on the enabling environment for economic viability, and theme three on the economic benefits. These themes are the focus to investigate and answer the first research questions which are based on understanding the economic state and economic benefits of Tilapia fish farming in South Africa.

Theme four is leveraging the economic potential of Tilapia fish farming, which helps to answer the second research question, which is what the critical factors for are leveraging the economic potential of Tilapia fish farming in South Africa. Theme five is Hindrance of effective economic potential which help to understand the challenges that hinder the effective economic potential of Tilapia fish farming in South Africa (research question three)

Table 4.1: Themes linked to the research questions of the study

Themes	Code Groups	Research Questions
Theme 1: Economic viability of Tilapia fish farming	Location-based economic viability	RQ1: What are the economic state and economic benefits of Tilapia fish farming in South Africa?
	High and low Scale Technology	
	Business Model	
Theme 2: Enabling environment for economic viability	Power (electricity) availability	
	Water resources	
	Feed supply including hormones and medicinal supply	
	Skills for fish management & technical to operate	
	A system that functions to full capacity	
Theme 3: Economic benefits of Tilapia fish farming	Job creation for the community	
	Food Security	
	Create jobs indirectly in other industries i.e. feed, equipment, marketing, processing, distribution, and selling	
Theme 4: Leveraging of the economic potential of Tilapia fish farming	Low risk specification fish size	RQ2: What are the critical factors for leveraging the economic potential of Tilapia fish farming in South Africa?
	Systems capacity with turn-key capability	
	Partnership with feed suppliers	
	Sell different sizes from pan friars and fingerlings	
	By-products i.e. tin fish, fish fingers	
	Timer on the pump	

	Feed as natural plant e.g. black weed	
Theme 5: Hindrance of effective economic potential	Imports from other countries	RQ3: What are the challenges that hinder the effective economic potential of Tilapia fish farming in South Africa?
	Cost of feed and operational cost	
	The tedious process to get the permit	
	Unreliability of power due to load shedding	
	The government funding is restricted on what goner	
	Government interference and regulations	
	Industry skills and knowledge	
	Mentoring from expertise	

4.2 Findings of the study with cases analysis

4.2.1 Alpha Tilapia fish farm



Alpha was originally started in 2004 and changed over the years, with areas of expertise in a hatchery, breeding, different stages of fish grow-out, online retailer, technical consulting, design experts, proven farmers, training, and coaching. The type of farming is like aquaculture, but here we are doing Aquaponics one portion is fish farming, and the other portion is growing and producing hydroponic using effluent water from the fish and purifies with the plants and recirculate it back to the fish, so it the RAS. They farm different types of fish with Tilapia being one of them. The document review and observation checklist show that the TFF was viable, with ten employees, employing a turnkey approach in executing the value chain, producing 0.5 – 1.0 ton of fish per month, taking 9 -11 months to produce these fish from hatching to harvest (Table 4.2). These fishes were about 200g to 400g in weight and were order through email, website, and walk-in with existing delivery receipts and purchase receipts.

This business is accredited and comply with the government regulations and has a certification of accreditation and compliance from the Aquaponics Institute of Australia.

Table 4.2: Document review and observation check sheet of Alpha Tilapia fishing farm

Document review		**Observation check sheet**	
Permits	Valid Permit	Value Chain execution	Turnkey
Number of employees	10	Daily/monthly/yearly production	0.5 – 1 ton monthly
Order process	Equipment and fish orders via email, website, and walk-in	Time to harvest good quality fish	9 – 11 months from hatching to harvest
Production schedule	weekly schedule	Fish sampling quality checks	From 200 – 400 g
Training records	Valid training records in place	training conducted on-site	Online
Dispatch documents	Delivery receipt and purchase receipt	accreditation and compliance	Government compliance and accredited Certification of accreditation and compliance from the Aquaponics Institute of Australia

4.2.1.1 Economic state and economic benefits of Tilapia fish farming

Alpha personnel indicated that there is the economic viability of TFF, but this depends on the location of the country, as there are different markets and different preferences from the different parts of the country. In explaining this, Alpha noted that there is less demand in coastal areas such as Western Cape, where their market has a high preference for salt water fish, but in the inland, there is a high demand for the Tilapia fish.

> *In the Cape, they do not enjoy tilapia because they have access to saltwater fish and that is the kind of fish they prefer. In Gauteng, there is a great demand for tilapia and able to tap into it and there is also future growth*

This farming is viable if there is an enabling environment, which depends on Power availability, water resources availability, access to good Feed supply including hormones and medicinal supply as well as skills for fish management. In explaining some of these dynamics, personnel from Alpha explained as follows:

The tilapia grows best with the temperature being controlled and that can be done by heating water, but it does cost a lot of money so need to find a more sustainable method of increasing the water temperature to get better grades of fish and that is not easy. We use groundwater instead of municipal water because it has chlorine content, it will require to be de-gassed and holding ponds before it can be used which will cost money and that will increase operational expenditure.

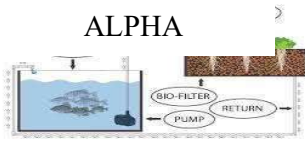
The main highlighted economic benefits of TFF from the perspective of Alpha was important to job creation in South Africa considering the triple challenges of high unemployment, poverty, and high inequality. Alpha highlighted that this is possible for sustainability though if there is an education, knowledge, and high passion workforce. This is because creating the job is important only if the business is sustainable.



Yes, it can create future jobs but what is vital is the actual education, knowledge, and passion. It can create a lot of employment but understanding and passion or if do not have the correct people for the job then the business going to fail.

4.2.1.2 Critical factors for leveraging the economic potential of Tilapia fish farming

The critical factors that can assist to leverage the economic potential of the Tilapia fish farming highlighted were the low-risk specification fish size, Systems capacity with turn-key capability.



The fish size that we sell depends on if it is the most economically viable because the smaller you can grow the least it poses risks.

4.2.1.3 Challenges that hinder the effective economic potential of Tilapia fish farming

Alpha enlisted several challenges that hinder the economic potential of TFF in South Africa being the imports from other countries, especially China. This creates a problem for competitiveness, as they have an advantage from subsidies.

Chinese feed is subsidised, fish farmers do not have to pay for it and can be able to land their Tilapia on our doorstep and through Africa cheaper. The Chinese numbers are high and consumers choosing frozen that is cheaper is due to the socio-economic situation that the country is finding itself in instead of the high quality produced.

The other challenges include the high costs of feed and operational costs, tedious processes to obtain the permit for the Department of Agriculture, Forestry and Fisheries as well unreliability of the power due to load shedding.

If there is load shedding at 2 am in aquaculture have 20 minutes before the fish can die. Need to be on top of everything, in touch, and tune because if you are not can kill the fish and the business.

4.2.2 Beta Tilapia Fish Farm

Beta was originally started in 2003 and through searching for sustainable opportunities in farming over the years where the first interest was in piggery and due to oversupply of it branched to fish farming grow-out. The type of farming is aquaculture, where one portion is fish farming and the other vegetable growing. The farm managed to secure government funding.

The document review and observation checklist show that the TFF was viable, with four employees, breeding and out-growing fish in executing of the value chain, producing 1.0 ton of fish per month, taking pan-fries 3, fingerlings 4 -5, and market fish 8 months to produce these fish from hatching to harvest (Table 4.3), where order through phone calls and WhatsApp with existing delivery receipts and purchase receipts. This business complies with the government regulations and TSFSA.

Table 4.3: Document review and observation check sheet of Beta Tilapia fishing farm

Document review		**Observation check sheet**	
Permits	Valid Permit	Value Chain execution	Breeding and out-grow fish
Number of employees	4	Daily/monthly/yearly production	1 ton monthly
Order process	Pan-fries, fingerlings, and fish orders via phone calls and WhatsApp	Time to harvest good quality fish	8 months from hatching to harvest
Production schedule	monthly schedule	Fish sampling quality checks	From 250 – 300 g
Training records	No training was conducted on-site	training conducted on-site	No training conducted
Dispatch documents	Delivery receipt and purchase receipt	accreditation and compliance	Government and TSFSA compliance

4.2.2.1 Economic state and economic benefits of Tilapia fish farming

Beta personnel indicated that there is the economic viability of the TFF, but it can have the divert source of income from pan-friars and fingerlings and include the crop rotation full-scale Aquaculture.

The main highlighted economic benefit of TFF from the perspective of Beta on jobs creation was if there is a slaughterhouse that requires a large number of people to slaughter, clean, pack, and weigh the fish, which is important in South Africa considering the triple challenges of high unemployment, poverty, and high inequality. Beta highlighted that this is possible for sustainability though if there is passion from the community.

It will create more jobs if there is a slaughterhouse where fish is being slaughtered, cleaned, and packed but for now, it does secure food for those community members that are given fingerling to grow.

4.2.1.2 Critical factors for leveraging the economic potential of Tilapia fish farming





It is to embark on the whole Aquaculture that results in Beta leveraging on the economic potential of the Tilapia fish farming.

Aquaculture can have the divert source of income, that is, vegetables, friars, and fingerlings. Methyltestosterone is introduced on fingerlings to convert the fish to be male-only sell male fish so I sell meat.

4.2.2.3 Challenges that hinder the effective economic potential of Tilapia fish farming

Beta highlighted several challenges that hinder the economic potential which includes frozen import, the high costs of feed, operational costs, and the assistance that is not based on the needs of the farmer.

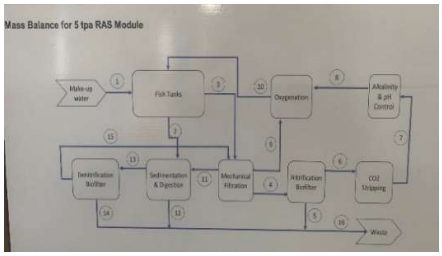


The government funding is to build the infrastructure every year depending on what the farm is short of. The first funding was to build the first tunnel, 45 solar panels 2017-2018, then 2018-2019 the second tunnel and 2019-2020 reservoir. The second tunnel has never worked ever since it was built unlike the first one that one built by the RAS specialist, the second tunnel was based on the government procurement tender process and the lowest bidder was appointed. I have the system that has never worked ever since it was commissioned even if I report nothing has ever been done. The system that not creating any income.

4.2.3 Gamma Tilapia Fish Farm

Gamma has 25 years' business experience on Koi Fish and for the 6 – 7 years back been keeping tilapia as a hobby but for the last two years decided to embark on something substantial that will generate income. The farm has four shareholders where the two are injecting capital while the two Chemical Engineers by profession are running the farm full-time basis.

The engineering process adopted for fish farming is that of mineral processing which is the Metallurgical Engineering process that is long term, high intensity, capital deployment, and high element of risk.



The document review and observation checklist show that there Tilapia Fish farm was viable, with two employees and an intern from the University of Pretoria currently doing Agriculture in Economics 3rd Year, the Closed-loop for the whole production process, and the equipment manufacturing in executing the value chain, producing every ten days and 680-gram fish takes 8 months to harvest (Table 4.4), where order through phone calls and e-mail with existing delivery receipts and purchase receipts while complying with the government regulations.

Table 4.4: Document review and observation check sheet of Gamma Tilapia fishing farm

Document review		**Observation check sheet**	
Permits	Valid Permit	Value Chain execution	Closed-loop
Number of employees & Intern	2 & 1	Daily/monthly/yearly production	Every ten days but cannot quantify
Order process	Pan-fries, fingerlings, and fish orders via phone calls and e-mail	Time to harvest good quality fish	8 months from hatching to harvest
Production schedule	Every ten days schedule	Fish sampling quality checks	680g
Training records	No training was conducted on-site	training conducted on-site	No training conducted
Dispatch documents	Delivery receipt and purchase receipt	accreditation and compliance	Government compliance

4.2.3.1 Economic state and economic benefits of Tilapia fish farming

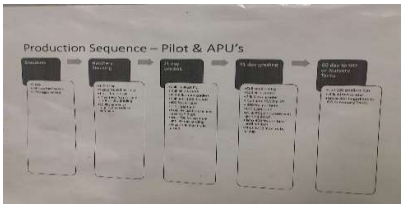
Gamma personnel indicated that there is the economic viability of the Tilapia fish farming but requires to adopt the business model that will start from scratch (hatching) up to the customer plate otherwise good as importing the cheap frozen tilapia.

Strongly believe in the long-term planning required due to demand vs supply and the two are at the point where demand far outstrips supply and that gives the demand-supply pricing model and there is a significant shortfall of tilapia in the market and have a substantial opportunity.

It is very economically viable that is the reason we injected 1 million on the pilot plant but it requires a high technology scale because it is an in-depth technical process that needs to be properly engineered and executed therefore it is not for small businesses to operate and requires large scale to be able to make a profit.

4.2.3.2 Critical factors for leveraging the economic potential of Tilapia fish farming

Strongly believe in long-term investments by having an approved concept which is the design, project execution, and process that is working. This will strengthen the process model.



We are designing the process and tests if it works or not, if it fails conduct the root cause analysis by conducting a design review on the proves retest it again on the pilot-scale so that if it fails, fail small until getting it right. The process is highly controlled and monitored, documentation to be filled throughout the day, every day all the systems get tested. The compartments are insulated to keep the fish warm and minimise heating up water using electricity. There is a lot of research that has been done through reading and trial and error and is still continuous.

4.2.3.3 Challenges that hinder the effective economic potential of Tilapia fish farming

South African government is the main contributor to the hindrance of the sector with too much interference while regulating from pillar to post.

> *Government contributes a big setback to the investment development of aquaculture and they are killing the industry. The 5-year permit to have tilapia on the premises with the discretion of the government on renewal and no capital deployment can take a risk with those terms and conditions. No business can succeed depending on the government subsidy. That is the reason the industry is sitting at the level it was in the 1980s'.*

DWAF for water usage licence applied six years back but never even receive the acknowledgement response on receiving the application.

4.2.4 Delta Tilapia fish farm



Delta has been established for many years and Tilapia breeding for about more than 15 years. Delta has been specialising in the hatchery, breeding, different stages of fish grow-out, and development of the RAS for the upcoming and small-scale farmers. Delta strongly believes that breeding is the engine of the process than the grow-out process.

The observation checklist shows that there Tilapia Fish farm was viable, with two employees, employing a closed-loop approach in executing the value chain, producing 1.0 tons of fish per month, taking 8 months to produce these fish from hatching to harvest (Table 4.5). These fishes were about 450g to 500g in weight and were ordered through the website, customer WhatsApp group, and walk-in customers with existing delivery receipts and purchase receipts. This business is complying with government regulations.

Table 4.5: Document review and observation check sheet of Delta Tilapia fishing farm

Document review		**Observation check sheet**	
Permits	Valid Permit	Value Chain execution	Closed-loop
Number of employees	2	Daily/monthly/yearly production	1 ton monthly
Order process	Equipment and fish orders via email, website, WhatsApp, and walk-in	Time to harvest good quality fish	8 months from hatching to harvest
Production schedule	monthly schedule	Fish sampling quality checks	From 450 – 500 g
Training records	no training records in place	training conducted on-site	None
Dispatch documents	Delivery receipt and purchase receipt	compliance	Government compliance

4.2.4.1 Economic state and economic benefits of Tilapia fish farming

Gamma personnel stated that this type of farming is economically viable because is still in the infancy stage in this country even though it has been here for the longest time but the supply does not meet the demand it is not flooded.

> *There is a big opportunity for fish farmers in South Africa to come on board in the sector because the existing few farmers cannot produce enough tonnage to supply and there is no consistency in the minimal that they produce.*

This farming is viable if starts correctly from the inception with the support from the experts of fish management and water quality expertise. In explaining some of these dynamics, personnel from Gamma explained as follows:



Currently expecting two guys from Nigeria that are coming next week have bought the system but will come and spend two weeks with us for practical training on assembling the equipment and fish nurturing from hatching to harvesting

There are job opportunities but requires lots of fish knowledge that goes with passion.

It will create employment but requires people that have patience and passionate especially women who have the element of nurturing.

4.2.4.2 Critical factors for leveraging the economic potential of Tilapia fish farming

The critical factors that can assist to leverage the economic potential of the Tilapia fish farming highlighted were to start right and small with training, support, and mentoring.

It's the young sector and young fish farmers can learn to do subsidiaries products of the tilapia like medical tilapia where it is groomed differently to use its skin for the healing of the burn, fish bones can be ground to make fish food, vegetable garden, and the tilapia scales can be used for people that makes glue and jelly tots. There is nothing that goes to waste in tilapia fish farming.

4.2.4.3 Challenges that hinder the effective economic potential of Tilapia fish farming

Delta personnel listed several challenges even the fact that the sector itself is not growing including the knowledge of fish genetics makes it impossible to breed and produce, the skills to operate the system.

If there is no knowledge on how to nurture fish and what of fish genetic to grow, they will die that will cause failure to the business. The functioning of equipment (reticulation) to understand when to test water quality, flush fish waste, and continuously add oxygen for fish breathing.

4.2.5 Epsilon Tilapia fish farm

Epsilon Fish Farm was established in 2014 by two partners, where one has operational experience and the other partners the family invested financially in the business only have business management studies from the college. The farm specializes in the breeding, growing, selling, and distribution of tilapia (whole fish) to individuals and small businesses. The fish are bred and cultivated in man-made dams and an intensive RAS (recirculating aquaculture system).



The 5-6 years' experience building own dams, that are approximately 2 meters deep. The dam is half out the ground and half in the ground where geothermal (ground temperature) contributes to keeping the water temperature at the correct temperature for the production purpose and black weed is planted as part of water cleaning. If it gets too hot in summer the ground keeps it cool and in winter vice versa. The ground temperature is constant throughout 16 – 19^0C. Also, use gravity to move water (the dam is not on the same level).

The observation checklist shows that there TFF was viable, with 3 employees, employing a hatching, breeding, and out-growing fish approach in executing the value chain, producing less than four ton of fingerlings and fish per month, taking plus-minus four months for fingerlings and 8 – 9 months for fish to produce from hatching to harvest (Table 4.6). These fishes were about 350g to 400g in weight and fingerlings were from 5 – 20cm long, and were ordered through phone calls, email and walk-in with existing delivery receipts and purchase receipts. This business complies with government regulations.

Table 4.6: Document review and observation check sheet of Alpha Tilapia fishing farm

Document review		**Observation check sheet**	
Permits	Valid Permit	Value Chain execution	Hatching, breeding, and growing-out
Number of employees	3	Daily/monthly/yearly production	Less than 4 tons monthly including fingerlings
Order process	fish orders via email, phone calls, and walk-in	Time to harvest good quality fish	8 - 9 months from hatching to harvest
Production schedule	weekly schedule	Fish sampling quality checks	From 350 – 400 g
Training records	No records	training conducted on-site	No training
Dispatch documents	Delivery receipt and purchase receipt	compliance	Government

4.2.5.1 Economic state and economic benefits of Tilapia fish farming

Epsilon personnel indicated that there is the economic viability of the Tilapia fish farming, but the greenhouse is the way to go because there is cost saving on following that route and the fish is organic based on the natural resources that are being used and the customers prefer fresh fish than frozen. Also, stated that must always have the continuous improvement of finding a new way of cost-saving while preserving the natural ways of produce fish.

> *Oxygen is supplied using air pumps that are cheaper than using electricity and this has reduced electricity cost from R20, 000.00 to R4, 000.00 per month. Greenhouse to save water that prevents water evaporation and grow black weed that acts as filtration for the water it feeds on nitrate for eat to grow while cleaning water for the fish to live in. Use bubbles to move water. To produce the 90% organic fish must feed black weed and is full of nutrients that are healthy for the fish. Water re-circulation is important as part of water savings.*
>
> *No ingredients must be compromised correct ratios of all the required ingredients (water, feed & oxygen). Inland everything is freshwater so change the domain by adding a bit of coarse salt, the ratio of 1kg into 100 litres of water. Planning to do the waterfall effect that will able to pump less water as part of minimising cost.*

4.2.5.2 Critical factors for leveraging the economic potential of Tilapia fish farming

The critical factor that can assist to leverage the economic potential of the Tilapia fish farming highlighted is the correct calculation per cubic meter of water versus fish quantity, versus oxygen content. Dark weed is beneficial to minimise the cost on the feed.



The way to go is to follow the natural way (organic) of breeding and growing fish. Our products are 90% organic because of the use of dark week as fish feed and 10% feed bought from the supplier. It also acts as a filtration system. Water with fish waste is pumped to another tank where dark week uses nitrate to grow while filtrating / cleaning water then re-pumped back to be used by the fish.

4.2.5.3 Challenges that hinder the effective economic potential of Tilapia fish farming

Government poses a threat to investors because profits cannot be made immediately. After all, the time it takes from hatchery to harvest is not immediate and the results of the overhead cost to business loss and the frozen import are consumed as the alternative or replacement by the customers.

The future is there but not as bright as it is supposed to be due to a lack of support from the government. This type of farming requires a large amount of capital injection to be sustainable and makes a profit.

4.2.6 Kappa Tilapia fish farm

Kappa has 35 years of experience in the sector and studied aquaculture in Scotland to do study Aquaculture for a year. Other business interests in the continent are trained the farmers, project planning, build the greenhouse, sell and install a production system, and mentorship programme for the first 6 months after training.

The document review and observation checklist show that there Tilapia Fish farm was viable, with 3 employees, employing a closed-loop approach in executing the value chain, producing 0.5 ton of fish per month, taking 3 -6 months to produce fingerlings and fish from hatching to harvest (Table 4.7). The fishes were about 200g to 3500g in weight and were order through email, and phone calls with existing delivery receipts and purchase receipts. This business applied for a government permit two years ago currently operates without a permit.

Table 4.7: Document review and observation check sheet of Kappa Tilapia fishing farm

Document review		**Observation check sheet**	
Permits	No Valid Permit	Value Chain execution	Closed-loop
Number of employees	3 (1 permanent and 2 interns from the department of agriculture)	Daily/monthly/yearly production	50 000 monthly
Order process	Equipment and fish orders via phone calls and email	Time to harvest good quality fish	3 months fingerlings and 6 months market fish from hatching to harvest
Production schedule	Monthly schedule	Fish sampling quality checks	From 200 – 350 g
Training records	Valid training records in place	training conducted on-site	On-site
Dispatch documents	Delivery receipt and purchase receipt	accreditation and compliance	None

4.2.6.1 Economic state and economic benefits of Tilapia fish farming

Kappa personnel indicated that there is the economic viability of the Tilapia fish farming, but very minimal, for the business to be sustainable and successful because have to work with other small scale farmers, much easier and manageable at that level.

This farming is viable if there is an enabling environment, which depends on the availability of its basic resources that as a production system, water, feed, electricity for the generation of oxygen. In explaining some of these underlying aspects, personnel from Kappa explained as follows:

> *Having a great filter and a great system requires a good stock and buy our stock from the Netherlands. The reason for the choice of stock supplier is because that company has been working with Tilapia genetics for 20 years. They are not on the genetic modification but genetic selection selecting the best female and best male for growth, colour, fertility, and body shape. The other important thing is that the male selected can only produce male babies. Males are important in your production because they grow faster and bigger than females and stop breeding in the production system*

The main highlighted economic benefits of Tilapia fish farming from the perspective of Kappa were the numbers and the work for tilapia farming speak volumes on how will future create a massive number of jobs, food security, skills, and research while alleviating poverty.

> *Tilapia is the second most farmed fish in the world, farmed in more than 100 countries in the world. It is a versatile food loved by chefs and supermarkets.*

4.2.6.2 Critical factors for leveraging the economic potential of Tilapia fish farming

The critical factor that can assist to leverage the economic potential of the Tilapia fish farming highlighted was the technology (Aquaculture Production Units) to focus on low energy use, small land use, low water usage, and less labour intensity. The greenhouse conditions have all great conditions because they maintain the temperature for production purposes. Solid fertilizer is used by the centre for their garden.

> *South African is currently pioneering recirculating the aquaculture system. The solar plant is going to cost 70 million plants to build an intensive tilapia farm. Use borehole water. The whole unit system costs R35, 000.00 rands and it is a minimal risk.*



4.2.6.3 Challenges that hinder the effective economic potential of Tilapia fish farming

Kappa enlisted several challenges that hinder the economic potential of Tilapia fish farming in South Africa being the cost of electricity, stock, feed, and selling price.

> *Load shedding affects the production growth rate and solar panels are expensive to install, the properly selected male and female for breeding to produce, to consistently regular feed the fish at the regular time intervals without fail, and selling price determine the profit.*

The other challenge includes the government department DEFF.

> *The government approach communities and inform them to do aquaculture and first they have to do is to apply for the permit but they are rejected based on the species and the place to farm. The right hand does not know what is the left hand is doing. For example, if you build a fish farm near the coast to acquire the permit have to comply with 25 pieces of legislation from 4 - 6 different government departments. We have lost hundreds of millions of investments in this sector because who has to wait 2 years to go through the paper exercise to invest.*

4.2.7 Lambda Tilapia fish farm



Lambda has been in the industry for 10 years but started with other species and with Tilapia in the last 2 – 3 years ago, with areas of expertise fish grow-out and raining The document review shows that here Tilapia Fish farm was viable, with 3 employees, employing a grow-out approach in executing the value chain, producing 0.6 ton of fish per month, taking 6 -8 months to produce market size fish (Table 4.8). These fishes were about 300g to 350g in weight and were order through email, telephone, and WhatsApp with existing delivery receipts and purchase receipts. This business complies with government regulations.

Table 4.8: Document review and observation check sheet of Lambda Tilapia fishing farm

Document review		**Observation check sheet**	
Permits	Valid Permit	Value Chain execution	Grow-out
Number of employees	3	Daily/monthly/yearly production	0.6 ton monthly
Order process	Equipment and fish orders via email, telephone, and WhatsApp	Time to harvest good quality fish	6 – 8 months to harvest

Production schedule	monthly schedule	Fish sampling quality checks	From 300 – 350 g
Training records	Valid training records in place	training conducted on-site	onsite
Dispatch documents	Delivery receipt and purchase receipt	accreditation and compliance	Government compliance

4.2.7.1 Economic state and economic benefits of Tilapia fish farming

Lambda personnel indicated that there is no economic viability of Tilapia fish farming because this depends on the location of the country. This farming is viable if there is an enabling environment, which depends mainly on the temperature, water availability, and access to the feed. In explaining some of these dynamics, personnel from Lambda explained as follows:

> *The rate of growth differs as the temperature rises:*
> *@ <15^{0}C: there is no growth, 16^{0}C - 20^{0}C: slow growth, 21^{0}C - 26^{0}C: average growth & 27^{0}C - 32^{0}C: fast growth (during December – March)*

The main highlighted economic benefit of Tilapia fish farming from the perspective of Lambda was job creation which is important in South Africa. Lambda highlighted that this is possible for sustainability if the existing major issues in the sector are sorted out to prepare for job creation, poverty alleviation

> *In 2013 the South African Government had prioritized the aquaculture sector for growth but did not show any initiatives and even the Land Bank which is the agriculture development bank does not understand the sector. These entities do not include the expertise of the sector to be on par with what is happening on the ground.*

4.2.7.2 Critical factors for leveraging the economic potential of Tilapia fish farming

The critical factors that can assist to leverage the economic potential of the Tilapia fish farming highlighted were the Temperature, oxygen, and water acidity.

> *Tilapia is a warm water species. When the temperature goes down, the fish does not grow because the metabolism rate shuts down and the fish does not eat. When the oxygen level goes down in the water the feed is not digestible and cannot swim because it requires oxygen to swim.*

4.2.7.3 Challenges that hinder the effective economic potential of Tilapia fish farming

Lambda enlisted several challenges that hinder the economic potential of Tilapia fish farming in South Africa being the imports from other countries.

Table 4.9: Currently in South Africa there are 5 market segments of tilapia:

Annual	*Imported Frozen from China*	*Local Fish Farmers*	*Inland Fisheries (Fishermen)*	*Informal cross-border trade (ICBT)*	*Imported From other than China*
Percentage	*70*	*4*	*4*	*18*	*4*
Tons	*>3 700*	*>200*	*<200*	*>800*	*<200*

The tilapia from China costs R13 – 14 per kilogram to the retail industry and they sell to the consumer at R30 per kilogram. The local farmers sell at R28 – 30 per kilogram due to high operational costs. South Africa cannot meet the demand.

The other challenges include the high operational costs, funding, and support

The sector requires an enabling environment from the government, currently, we have concluded government representatives do not understand how the sector operates. The reports on the study conducted on the sector by different government departments are not the true reflection of what is happening on the ground. They conduct the desktop research and the reports impact us negatively on acquiring the funding. The day-to-day operational cost is high on feed, fingerling, and electricity and runs the business at a loss.

4.2.8 Phi Tilapia fish farm



Phi has more than 30 years of experience in the hatchery, breeding, fish grow-out, technical consulting, training, and coaching. Phi has 200 dams where bred tilapia, catfish, and carp and a shop where the sales take place 10 – 20 kilometres away from the dams, the fish that is ready to be sold is caught from the dams and sent there for customers. Most of the business is to store the indigenous dams with 4 -5 indigenous fish species as part of creating a healthy system because when the no fish in the water there is algae, grass & mosquitos so it must create a self-sustaining ecosystem to make healthy. The dams are hired from the farmers that use them for irrigation purposes and fish is kept for free to breed, grow and harvest.

The document review and observation checklist show that there Tilapia Fish farm was viable, with 18 employees, employing a closed-loop approach in executing the value chain, producing fish per week, taking 12 - 24 months to produce these fish from hatching to harvest (Table 4.10). These fishes were about 800g to 2kg in weight and were order

through email, phone call, WhatsApp, and walk-in with existing delivery receipts and purchase receipts. This business complies with government regulations.

Table 4.10: Document review and observation check sheet of Phi Tilapia fishing farm

Document review		**Observation check sheet**	
Permits	Valid Permit	Value Chain execution	Closed-loop
Number of employees	80	Daily/monthly/yearly production	weekly
Order process	Equipment and fish orders via email, WhatsApp, phone call, and walk-in	Time to harvest good quality fish	12 – 24 months from hatching to harvest
Production schedule	weekly schedule	Fish sampling quality checks	From 800g – 2kg
Training records	Valid training records in place	training conducted on-site	On-site
Dispatch documents	Delivery receipt and purchase receipt	compliance	Government compliance

4.2.8.1 Economic state and economic benefits of Tilapia fish farming

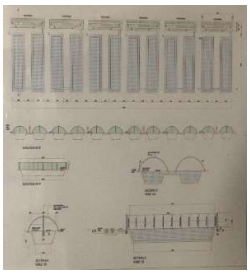
Phi personnel indicated that there is the economic viability of Tilapia fish farming in South Africa and the neighbouring countries but knowledge, supply, and temperature are the main constraints. In explaining some of these dynamics, personnel from Phi explained as follows:

> *The problem is the cost to grow it is quite high but it is overall the best fish to grow for self-sustaining but for re-selling the market is huge but the price will be very competitive with the importers from Zimbabwe because there is much cheaper than we can grow here in South Africa. It is easy to grow it in Zimbabwe because of the tropical area the temperature and the big lakes. They do not grow it in captivity like here but grow them in the cages on the floating dams. China grows the fish using too many steroids makes it not great for health.*

The main highlighted economic benefits of Tilapia fish farming from the perspective of Phi was job creation in the future which is important in South Africa considering the triple challenges of high unemployment, poverty, and high inequality.

> *Yes, freshwater fish with the correct training then can create a job but growing Tilapia does not create a lot of jobs, can only create more job when having the slaughterhouse were cut, clean and package fish for the market. To run a fish farm 1-2 guys will do and as an owner has to hands-on 24 hours.*

4.2.8.2 Critical factors for leveraging the economic potential of Tilapia fish farming



The critical factors that can assist to leverage the economic potential of the Tilapia fish farming highlighted were to build the correct size and depth at least 1, 6 meter deep, the correct filter system, sanction and placed in the right area so the cleaning can happen on daily basis and top up with clean water 500 – 1000 litres per day it will not have the impact.

> *Continuous sustainability of the tilapia fish supply is very important because it takes them longer to be the market required size. There must be more dams, ponds, or places where you grow the fish to meet the market demand and be able to continuously supply because South African customers want fresh fish instead of frozen and there is a big market and opportunities for it. Any fish needs a lot of oxygen, clean and fresh water like human beings. Oxygen cleans water while creating and maintaining a healthy system.*

4.2.8.3 Challenges that hinder the effective economic potential of Tilapia fish farming

Phi enlisted several challenges that hinder the economic potential of Tilapia fish farming in South Africa being knowledge, different temperatures, and the feed cost. In places where there is frost electricity costs will be high causing business failure.

> *Knowledge, different temperatures in South Africa, food is expensive. In places like Mesina and Limpopo where there is no frost, there can be a high success. In places where there is frost electricity costs will be high and must have a system in place should there be load shedding which is adding to the cost of growing tilapia and causing the business to be unprofitable and unsustainable.*

The other challenges include misaligned government support and market oversupplied with the fry pan and fingerlings instead of big fish.

> *The support from the government is there but not great because the money goes wasted. After all, the government supplies only the infrastructure that costs 1.2 million that accommodate less fish. The farmers run at a loss and not afford to pay a loan back and end up selling a lot of fry pan and fingerlings. A new programme needs to be done properly with training on growing full market size fish and the profit which will roughly take 2 – 3 years.*

4.2.9 Omega Tilapia fish farm





Omega was originally started a long time ago in the Koi fish business but in the year 2000 branched to Tilapia farming on a small scale because was run on a part-time basis while was permanently employed in the corporate world. Due to difficulty on juggling time between permanent employment and tilapia fish farming one had to suffer which was fishing farming but revive the passion for tilapia fish farming as a hobby two years back after went on pension. The farm uses two production operating systems that is technology and manual.

The observation checklist confirmed that there Tilapia Fish farm was viable, with no employees, employing a hatching and grow-out approach in executing the value chain, producing 50 000 – 100 000 fish per month, taking 6 -12 months to produce these fish from hatching to harvest (Table 4.11). The six months harvest is when the environmental conditions are favourable but twelve months during difficult conditions. These fishes were about pan size and were order through phone calls and walk-in with existing delivery receipts and purchase receipts.

Table 4.11: Observation check sheet of Omega Tilapia fishing farm

Document review		**Observation check sheet**	
Permits	No Permit	Value Chain execution	Hatching and outgrow
Number of employees	Two family members	Daily/monthly/yearly production	50 000 – 100 000 monthly
Order process	Fingerlings and fish orders via phone calls and walk-in	Time to harvest good quality fish	6 – 12 months from hatching to harvest
Production schedule	weekly schedule	Fish sampling quality checks	Pan size
Training records	No training records in place	training conducted on-site	Physical training on request
Dispatch documents	Delivery receipt and purchase receipt	compliance	Government non-compliance

4.2.9.1 Economic state and economic benefits of Tilapia fish farming

Omega personnel indicated that there is the economic viability of Tilapia fish farming, but this depends on what you want as a farmer because others are more interested in getting quick rich schemes which also requires large capital for the infrastructure, feed,

and operating system. Those that are in it for the love of the business have to start small scale then grow.

> *With the right & enough resources under normal circumstances six months is the minimum to get the pan size fish but if there is a shortage of resources a year is a minimum there are always ways and means to overcome the difficulties. Have to be hands-on for it to work successfully.*

This farming is viable if the timing is correct on how the process is done. In explaining some of these dynamics, personnel from Omega explained as follows:

> *Breeding is the easiest process and starts breeding from late September till March every 6 weeks. Keep the water temperature constant at 260C then increase the temperature to 320C after 5 minutes that will trigger the fish to breed and female fish will even change the colour.*



The Omega strongly believe that empowering communities to start on the small will be part of job creation with proper mentoring in six months will be eating from that scale by that will be securing food for the community and sell to other members that will be alleviating poverty while investing back on the business as part of a sustainable source of income.

> *Keep several people busy on a small scale.*

4.2.9.2 Critical factors for leveraging the economic potential of Tilapia fish farming

The critical factors that can assist to leverage the economic potential of the Tilapia fish farming highlighted feed, electricity, and oxygen are critical but there are ways to go around it.

> *We feed the tilapia the earthworms and at some time we had the earthworm farm that we used to feed the fish, only bought the first batch of earthworms. The earthworm keeps the feed cost low. The pumps operate with the time switch as part of cost savings 2 hours in the morning, 2 hours during the day, in the evening, and at night. A dark week and water lilies are oxygen creators, used to clean the fish water, it gets nutrients from the nitrates that are excreted as waste by the fish.*

4.2.9.3 Challenges that hinder the effective economic potential of Tilapia fish farming

Omega stated challenges that hinder the economic potential of Tilapia fish farming in South Africa being skills and knowledge. This creates a problem for growth as a successful farmer.

> *Skills & knowledge about the fish is minimal to scarce. Fish breathe oxygen to live, and the cleaner the water, the higher the oxygen content, therefore, a proper reticulation system that uses electricity, electricity is expensive to be use 24hours.*

4.3 Summary

The data collected from nine cases by scheduling the appointment telephonically. All the parties and copies signed the consent forms were issued to all the parties after the researcher explained the rights of the cases. The researcher gave the clearance certificates to all the instances to keep should they consent to contact the university. The interviews were conducted using the semi-structured questionnaire that was developed, and eight sites were visited there was a walk-down of the site with permission and accompanied. The documents were supplied for review to cover the information that did not transpire during the interview and site walk-down.

The cases experience is almost the same with minor differences, and this assisted in getting the holistic view of the industry.

It was done to answer the three research questions where five themes came up with their respective group codes. The themes are the following:

- The economic viability of Tilapia fish farming
- Enabling environment for economic viability
- Economic benefits of Tilapia fish farming
- Leveraging of the economic potential of Tilapia fish farming
- Hindrance of effective economic potential

5 DISCUSSION OF RESEARCH FINDINGS

5.1 Introduction

The findings presented in Chapter 4 explore the study's objective: to investigate the economic potential of aquaculture farming, precisely the case of Tilapia Fish.

The significant findings on the discussion of research findings illustrate three questions: the economic state and economic benefits, the critical factors for leveraging the economic potential, and the challenges that hinder the effective economic potential of Tilapia fish farming in South Africa.

5.2 Economic state and economic benefits of Tilapia fish farming in South Africa

The literature review stipulated that the study proves that there are business opportunities to explore Tilapia fish farming due to the depletion of natural resources (Mkhize & Mbhele, 2017). Therefore, observations with the existing supporting documentation/ records reviewed of the nine respondents that were part of the study literature were tested during the interviews.

It has been picked up during observations and confirmed during the interview that for the business's success, there are things that are required to be strategical in place. Economically according to cases is not where it is supposed to be. There are no signs of growth in the sector, as Moyo & Rapatsa (2021) agree with them in the article 'A review of the factors affecting tilapia aquaculture production in Southern Africa'.

The different success factors contribute to the economic viability of the business. For example, due to the weather conditions, the type of technology selected can assist in closing the gap that will be detrimental to the business; this is part of managing the risk. The business model choice is essential.

Available and reliable power supply; otherwise, invest in the backup to enable the business. The different energy sources like solar panels, the Beta farm operates on solar funded by the Department of Agriculture in the North West Province. Others raised that issue and mentioned that it would impact their capital expenditure and use a generator as backup during the load shedding that heavily killed small businesses.

The water source is vital to the process. For example, municipal water has chlorine and several days, stored in an open container de-chlorinated before usage. Other cases just

built the dams where there are plants that keep the water clean because they survive on the fish waste while cleaning the water for the fish.

The feed is significant to produce the fresh organic fish that the customers' requirements for maintaining a healthy living lifestyle since it is a high source of protein. In contrast, the export has hormones that grow the fish quicker than the minimum of six months naturally. Moreover, fish skin heals for medicinal purposes on burn wounds. Therefore, it assists in recovering it and faster without it being septic.

The success relies on water quality, fish management & technical to operate the production system, but with fish, there must be more passion and patience; otherwise, the business fails before its inception.

The sector does not create the jobs as expected by the country with an increasingly high unemployment rate as the results are communicated by the statistics South Africa but indirectly create employment in other industries, i.e. feed, equipment, marketing, processing, distribution, and distribution selling. It can expand if there could be a rise in the farmers, even if the majority are small scale farmers, because, in the other industries that support fish farming, there will be a gap to be filled.

All the South African research studies, either government departments, institutes of higher learning, or private industry, results in the literature review shown and proven based on the international and local market that the economic potential and opportunities are very high. Still, there is no growth because they need capital to invest long-term for successful and sustainable business results.

5.3 Critical factors for leveraging the economic potential of Tilapia fish farming in South Africa

In the literature review, the study did not dwell on leverage. Still, during the interview and observation, there were identified from different cases because the fish are hatched after the minimum period of six months under the standard conditions where there is reliable electricity for the supply of oxygen and required specific minimum temperature for the fish to grow.

In most cases, leverage on the aquaculture where the fish wastewater is used for the growing crops as the fertilizer, whereas those that concentrate on fish farming only share the land with communities that have vegetable gardens to give back to the community. According to Kaminski, Alexander M. (2020), in the article a review of inclusive business models and their application in aquaculture development, most African countries fish farmers make a joint venture with crop farmers that are what Phi and Lambda followed suit. In contrast, others conduct aquaculture like Beta (Adeleke, Robertson-Andersson, Moodley, & Taylor, 2020).

The farmers' leverage on selling the pan-fries, fingerlings, and low-risk specification fish size. They sell directly to the consumers to cut the middle man to minimise cutting on their profit, and the retailers selling at the high price to the consumers as part of profit-making. The farmers are more comfortable with this kind of arrangement because it is more sustainable for them even though the growth is minimal or no at all.

Alpha, Gamma, and Kappa build their production systems and sell to their counterparts or the newbies on the market and provide training on how to operate and after-sale service. Alpha provides the classroom training, but during COVID, it was virtual and the app for support. Alpha is hydroponic, where the vegetables clean water and are recycled back for fish usage. There is no discard of water like aquaculture, which is what Beta farm adapted even though there is not much water discarded. Kappa also sells and builds the greenhouse.

Omega uses earthworms as part of the feed to minimise the cost of feed, and the pump has a timer that works two hours in the morning, during the day and evening in total six hours per day instead of twenty-four hours is part of the measure cost savings. In addition, Omega and Epsilon use seaweed, a natural plant that feeds on the fish waste and cleans water to create oxygen content for fish.

Phi and Epsilon have built dams or ponds that are at least two meters deep where one meter above ground and one meter below the base keep the water temperature warm during drastic temperature changes.

The aquaculture systems for production vary globally, witnessed and observed during the visits to all nine different fish farms. From September to March, the farmers take advantage of temperature to ensure that the breeding occurs every six weeks.

5.4 Challenges that hinder the effective economic potential of Tilapia fish farming in South Africa

The study through the literature review on Aquaculture sub-sector skills plans 2018-2019 has proven their economic potential (AgriSETA, 2018). During the interviews and observations, information shared by the cases requires further research on how it is well-executed. They believed there must be consultations with those who have experience in the sector; nevertheless, the case studies were adamant that there is enormous potential. TFF in South Africa requires the specified infrastructure, affordable feed, and operational costs that need a capital injection for the successful sustainable commercial supply to meet the market demand.

They were also concern about the figures of the Chinese frozen imported tilapia on the literature review that were not the practical figures under-reported and that those frozen are not healthy due to steroids, less than the normal organic fresh ones. The frozen is sold at the lower price of 13-14 rand per kilogram because the Chinese government subsidises the production process, the South African retailer which is the like of Pick 'n Pay, Woolworths Food, etc., prefers it and sell to the consumers at 30 rands per kilogram. The South African farmers sell fresh organic tilapia at 28 – 30 rand per kilogram due to high operational costs, so they make money from the informal markets of selling directly to the consumer cut the middle man.

The literate did not mention the ICBT, costing the local small-scale farmers, which contributes 16% according to Lambda. The market is significant in central Johannesburg, and that one comes as the preserved dry tilapia.

The accountable and responsible government departments must assist and support the permit application process and review and revise the legislation specifically on the species. There seems to be a conflict on the issuing of the permit because the permit cover is growing, keeping, selling, and cross-border provincial selling of tilapia. The permit issuers

chose what they will permit, which at times limits the growth of the farmers and promotes the informal markets.

The permit to operate renewal is every half a decade but depends on the government discretion, which harms the investors that will result in the sector being a total failure because the security not guaranteed will be on business for how long, therefore, it becomes the high risk. Moreover, the government is continuously changing the regulations, and no consultations according to the cases.

The government approach and recruit communities to explore the sector but not provide the support unlike in Egypt, Nigeria, and Uganda government support on the small scale farmers unlike the South African government (Adeleke, Robertson-Andersson, Moodley, & Taylor, 2020). The skills and the knowledge limited on managing the fish, water, breeding, feed, and the production process.

The findings of the reports Aquaculture sub-sector skills plan 2018-2019 and 2020-2021 (AgriSETA, 2018) & (AgriSeta, 2020), National Economic Development and Labour Council (Mkhize & Mbhele, 2017) legislation that is not adequate, lack of support from the government, skills and development programme required.

The load shedding due to unreliable power supply is the problem for the farmers requiring electricity to heat water to increase temperature and the oxygen supply. The feed, temperature, and oxygen are the necessities for survival and a thriving market requiring fish growth. As Alpha stated, "If there is load shedding in aquaculture, have 20 minutes before the fish can die. Need to be on top of everything, in touch and tune because if you are not, can kill the fish and the business".

6 SUMMARY, CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

6.1 Introduction

This research study aims to investigate the economic potential of aquaculture, specifically tilapia fish farming. It was done by responding to the questions of the research study, which are "What is the economic state and economic benefits, what are the critical factors for leveraging the economic potential and the challenges that hinder the effective economic potential of Tilapia fish farming in South Africa?".

Fish farming is the modern global way of producing fish depleted from reproducing as the natural resource in the ocean and freshwater due to multiple factors and cannot sustain the demand for human consumption (Prabu, Rajagopalsamy, & Ahilan, 2019). The most globally consumed is indicated by the increase in the 2020 statistics to 6.8MT from 2019 6.6MT and do not include the small-scale farmers that sell directly to the consumers (Chase, 2020).

6.2 Summary and Conceptual Model

China has been the leading exporter globally (Services, 2013), followed by Egypt in Africa (Kaleem & Sabi, 2020). However, the African tilapia production growth has been stagnant, insignificant, and lags in developing its global share in global fish production (Chan, et al., 2019).

The South African sector can contribute to national fishery production and economy; due to constraints that are weather conditions, land, water, capital, technology, and policy and legislation deficiency, importing frozen, deficient quality tilapia from China (Mapfumo, 2018).

South Africa has a well-developed infrastructure, but its value chain is in the infancy stage that encompasses poor policy in attaining permits (Urban-Econ Development Economists, 2015 & 2018).

This research study adopted the exploratory using the multiple-case studies. Yin (2003) further explains that exploratory used to discover those conditions in which the intervention assessed had no clear, one set of results (Lotzkar & Bottorff, 2001). The philosophical research orientation is anti-positivist, where it holds that social phenomena

are multi-layered and deserve multiple interpretations (Yin, 2003). The aim is to develop the Tilapia fish farm to secure food, poverty alleviation, job creation, and contribute to the economy.

Nine case studies were conducted where eight were commercial and one non-commercial tilapia farmers with 6 to more than 30 years' experience. Eight interviews were one-on-one. One via MS Teams, and it was impossible to conduct the observation based on the absence of the physical interaction, but submitted the documentation for review was submitted. The data and information collection instruments were necessary to answer the three questions. Through interview, semi-structured questionnaire, consultation was not closed question but not also opened in a structured way. Check sheets for the field observation during the site visit and the documentation review on what documents to request to acquire the information that was not covered and validated during the interview and observation process.

The researcher was responsible for collecting data ethically by explaining the study objective and requesting consent while further explaining that participation was voluntary and can draw anytime.

The data and information are described in detail and organised to make sense for interpretation. The transcribed data were analysed using thematic analysis based on Braun & Clarke (2006) and used two common strategies of the case study, which was pattern matching and explanation building

Positivists usually interrogate the trustworthiness of qualitative research. Guba (1985) proposed four credibility criteria to address the internal validity to ensure that the study measures or tests what it is intended for and argues that credibility develops trustworthiness (Shenton, 2004).

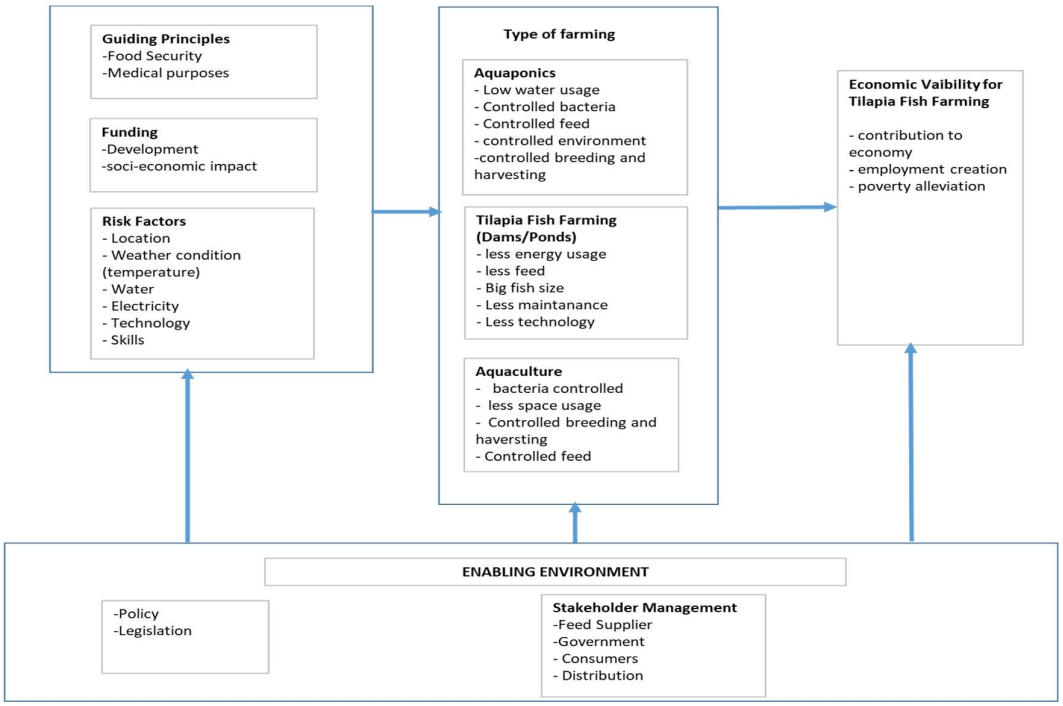
Multiple data sources a merged during the data analysis process instead of being individually analysed. Thus, each source contributes to the overall understanding of the whole phenomenon and strengthens the results (Baxter & Jack, 2008).

The findings on the overview and relevance of the sample and five themes linked to research questions, where the flow from individual case findings triangulation draw cross-case conclusions.

Five themes linked to the research question were economic viability, enabling environment for economic viability, and economic benefits to investigate and answer the

understanding of the Tilapia fish farming's financial state and economic benefits in South Africa. Theme four, leveraging the economic potential of Tilapia fish farming, answer critical factors for leveraging the economic potential and hindrance of effective economic potential to understand challenges that hinder the effective economic potential of Tilapia fish farming in South Africa.

Based on the theoretical findings, the initial conceptual model (Figure 6.1) was developed for the tilapia fish farming sector to be viable in South Africa since the country has the potential.



The conceptual model talks to the VT, where Schwaninger (2006) explained that viability is the survival of a system or organization and the result of the progress and position setting. Global development builds a VT for Tilapia fish farming (Sprenger, Mettler, & Winter, 2017). The fundamental elements of VT are control and state variables that are utilized for the system's optimal control to formalize problems arising during the study of different natural and social phenomena (Oubraham & Zaccour, 2018).

South Africa has to follow suit on identifying which type of tilapia farming will be viable, considering the guiding principles, risk factors, and funding type. Tilapia can meet the growing demand, alleviate poverty, and create employment (Prabu, Rajagopalsamy, & Ahilan, 2019) while securing food for an exponentially growing global population estimated to be 9 billion by 2050 (Bene, et al., 2015).

South African weather conditions are not feasible in most areas unless the water is heated to maintain high temperatures in winter (Urban-Econ Development Economists, 2015). Controlled breeding for efficient production and 'improved' physical appearance (Gupta & Acosta, 2004). Innovation is vital for success in technology and risk mitigation during the production process (Adeleke, Robertson-Andersson, Moodley, & Taylor, 2020).

Further research is required to validate the developed initial conceptual model for the economic viability of tilapia fish farming.

Tilapia fish farming consists of sequential phases of seed hatchery, nurturing, and grow-out (Edwards, 2020); various fish farming technology select from the appropriate technology is vital for commercialised income-generating (Shava & Gunhidzirai, 2017).

The global, continental, and local patterns impact the economic viability of the fish farm in generating employment further in conjunction with the economic recession, which depresses markets, price fluctuation and policies (Shava & Gunhidzirai, 2017).

Numerous economic aspects affect the tilapia industry in South Africa. First, the investors' withdrawals will collapse due to the lack of financial support where high production requires a high cost to be sustainable. Second, the ratio of the stock in the system, fish market value and management level determines the business success (Moyo & Rapatsa, 2021).

The fish feed is costly, roughly 60% of the production cost, according to the research finding by FAO (2016). However, there is minimal understanding in the country on financial and social performance, and the value chain analysis can tackle the misunderstanding. Small scale farmers have proven to be unsustainable and unprofitable based on production cost (Chan, et al., 2019).

6.3 Limitations

There were limitations in this study research that affected the findings of the results to be conclusive on this sector, which are:

- In most cases, eight out of nine are based on the geographic location area that has a similar environmental impact, focused on the same region. In the winter season, there is frost in the morning that decreases the water temperature that affects the behaviour and growth of the fish. The cases did not cover all nine provinces of the country.

- Research and development are minimal to nothing in the South African sector; not much of the research study has been conducted, continuously improving tilapia fish farming. No research article was found on the Chinese Tilapia Fish Farming process to understand how they have become the world's number one exporter on this particular commodity.
- The limited time to finish the research study. In addition, the cases did not include all the stakeholders that are part of the sector; further research will be required from other stakeholders to have a holistic view of the sector.

6.4 Conclusions

It was evaluating the economic potential of aquaculture farming with interest in the case of TFF economic viability. The TFF is vital as an innovative mechanism for securing food currently and in the future of the exponentially growing population while creating employment which will improve socio-economics. In South Africa, the sector must discover means to develop from its current stagnant stage and trade globally where there will be foreign currency earnings.

The naturally captured fish can no longer sustain the growing international demand for Tilapia through natural resources production. Tilapia Fish Farming has been identified as the solution to maintain supply in the market. Governments globally have supported a healthy living lifestyle, and Tilapia is a high protein that is low-priced. The main Tilapia consumed in Africa is frozen exported from China throughout the continent even though Egypt shades many small-scale farmers. The Chinese government subsides its farmers; fish is fed steroids for rapid growth while compromising quality and sold at a low cost than the local produce organic tilapia.

South African market demand by the existing small-scale farmers has not been met since supply the informal market that sells directly to the consumer. Therefore, the recorded data is not the actual statistics of the total produced Tilapia through modern farming. The sector experiences several challenges that are detrimental to its success and growth. Water quality is vital for the fish quality, development, and the entire production; therefore, monitoring oxygen, nitrates and pH levels must be continuously supervised in the process. The use of reticulation aquaculture systems (RAS) plays a vital role in minimising water

usage through re-cycle and oxygen level ratio maintenance. The temperature that drastically changes in the winter season affects the fish mobility and results in fish not eating as required for growth purposes. Access to funding is difficult to none due to the lack of knowledge of the commercial banks and investors' sector, which is considered a very high-risk sector. Insufficient legislation is complex to comply with because there is no coordination between different government departments. There has been growing globally, but South Africa is not measurable due to its insignificant.

In South Africa, the success of farming depends on the geographic area where the Gauteng area is not conducive due to temperature change. The system selected for the process is the most vital; cold winter weather requires water heating necessary for the successful production process. The environment under which the farmers operate depict if the business is profitable and sustainable based on the load shedding that will require the backup energy and impact the operating costs and capital expenditure going up and less profit even loss. The results in most farmers not operating in total capacity. There aren't many skills in fish management, water quality, and production process operation, but few farmers expanded their source of income through experience are training those that developed the interest in the sector but no formal qualification. The feed is expensive to produce organic fresh fish because it is free of hormones and increases operating costs. The minimum period to harvest from breeding is six months if the production process occurs under favourable conditions before harvest. Farmers find other streams of source of income like growing crop or hydroponic, where other manufacture RAS systems, sell, train on how to operate and after-sales service and the greenhouse manufacturing, sell and erection. There is also a market for pan-fries and fingerlings. Therefore, the small-scale farmer does create employment even though the numbers are not that significant and most of the time is temporal, especially when the customer requests the slaughtered and cleaned fish.

Most farmers had been innovative as part of overcoming difficulties experienced in the production process. However, several challenges are faced by the sector, from permit attaining to funding and fish selling price.

The farmers should consider specialising in growing Tilapia for medical purposes: tilapia skin cures burn wounds, tilapia tin fish even the cake fish and fish fingers as part of innovation and expanding source of income. The government should initiate a programme from the findings on the research reports that will cover community awareness of the sector, marketing, and recruit individuals for training that will be

compliant and accredited by SETA, funding, mentoring, and monitoring progress continuous improvement. The policy and legislation should be reviewed with all the stakeholders, especially the small farmers and those indirectly affected: feed suppliers, RAS manufacturers, and even the Department of Agriculture, to make sure to address all concerns. All the stakeholders must be contributing to the growth of the sector that will create sustainable employment, be the source of household income, and future trade as the commodity for foreign currency income that will contribute to the GDP. It concluded that currently, in South Africa, it is not viable but has potential.

6.5 Recommendations

Three recommendations proposed to the current and future tilapia fish farmers:

- The farmers must select the optimum type of farming based on the initial conceptual model to be effective and efficient to run the successful and sustainable production process transformed into a commercial venture.
- The farmers must start small-scale farming to manage all the risk factors because the South African sector has challenges before exploring the intensive production scale. Mitigations of risk will result in consistently high-quality organic tilapia fish production and a decrease in the fingerlings overproduced as a source of income to sustain the business.
- The farmer must have the capital required for the selected type of farming to sustain the daily running operational costs that include feed cost and system for the production process and have a profitable business that can create employment. Farmers must also consider other natural feed to minimise cost without compromise on organic quality tilapia.

Three recommendations to the policymakers:

- The government programme will coordinate and support integration between the new up-coming farmers with the industry knowledgeable, skilled, and experienced, where there is transparency and inclusiveness to all stakeholders. Second, the food industry, commercial sector, and agriculture should be part of the programme to secure food.
- The legislation will assist in growing and supporting tilapia fish farming through funding and skills development to be economically viable to contribute to the

economy, create employment, alleviate poverty, and securing food for the country. In addition, the marketing of investors to develop the interest to invest. The government can also subsidies the feed suppliers to decrease the feed cost, which will enable the farmers to sell at a lower price but still generate profit. In addition, it will provide a competitive advantage in the market since Tilapia is fresh and organic.

- Government to compel and reward tax relief the private sectors to be involved in the development and support of empowering the small-scale farmers to have consistent supply and be sustainable. It can be done through a joint venture for a specified period and monitored appropriately.

Three recommendations on the Research and Development:

- The tilapia skin has properties of rebuilding the skin cells; further research on medical purposes curing burn wounds using tilapia skin. In the standard dressing, the patient has to be changed every second day, whereas when dressed with the Tilapia skin, it is required to be changed after ten days, as the skin retains moisture far more than a standard dressing. Brazil has trailed the procedure; it promotes natural medicine. In addition, a high number of kids get water and burns in the country; therefore, the method can be handy for medical purposes and inexpensive. Furthermore, this procedure uses the skin only.
- Research on the Government sustainable Funding Model that will work for the sector and identify capable private investors. Currently, the government funds the infrastructure, and the day-to-day operational cost is high on feed, fingerling, and electricity, resulting in profit loss for the business.
- Research on the workable Training model will identify what type of training, skills, and support programs must be developed for competence in the sector to be economically viable and meet the market demand.

All the recommendations are monitored and reviewed after a certain period if they are practical and efficient; otherwise, adjusted should the need arise while ensuring they serve the purpose.

7 REFERENCES

1. Adeleke, B., Robertson-Andersson, D., Moodley, G., & Taylor, S. (2020). Aquaculture in Africa: A Comparative Review of Egypt, Nigeria, and Uganda Vis-À-Vis South Africa. *Reviews in Fisheries Science & Aquaculture*, 01 - 31.

2. AgriSETA. (2018). *Aquaculture sub-sector skills plan.* Pretoria, RSA: AgriSETA.

3. AgriSETA. (2018). *Aquaculture Sub-sector skills plan 2018 - 2019.* Pretoria, Gauteng, RSA: AgriSETA.

4. AgriSeta. (2019). *Aquaculture: Subsector Skill Plan.* Pretoria: AgriSeta.

5. AgriSeta. (2020). *Aquaculture: Subsector Skill Plan 2020 -2021.* Pretoria: AgriSeta.

6. Aubin, J.-P. (1991). *Viability Theory.* New York: Springer Science+Business Media.

7. Aubin, J.-P., Bayen, A., & Saint-Pierre, P. (2011). Introduction. In J.-P. Aubin, A. Bayen, & P. Saint-Pierre, *Viability Theory. New Directions* (pp. 01 - 34). New York: Springer Science.

8. Baxter, P., & Jack, S. (2008, December 1). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. *The Qualitative Report, Volume 13, Number 4, Article 2*, pp. 544-559.

9. Bene, C., Barange, M., Subasinghe, R., Pinstrup-Andersen, P., Merino, G., Hemre, G. I., & Williams, M. (2015). Feeding 9 billion by 2050 - Putting fish back on the menu. *Food Security*, 261 - 274.

10. Blumberg, B., Cooper, D. R., & Schindler, P. S. (2008). Quantitative and qualitative research. In B. Blumberg, D. R. Cooper, & P. S. Schindler, *Business Research Methods* (pp. 191 - 222). London, UK: McGraw-Hill Higher Education.

11. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 77-101.

12. Cai, J., Quagrainie, K., & Hishamunda, N. (2017). *Social and Economic Performance of Tialapia Farming in Africa* . Rome: Food and Agriculture Organization of the United Nations.

13. Chan, C. Y., Trana, N., Pethiyagodaa, S., Crissmanc, C. C., Sulserb, T. B., & Phillipsa, M. J. (2019, March). Prospects and challenges of fish for food security in Africa. *Global Food Security*, pp. 17 - 25.

14. Chase, C. (2020, January 23). *Industry experts: Tilapia market has room to grow.* Retrieved from Seafoodsource Website: https://www.seafoodsource.com/news/supply-trade/industry-experts-agree-tilapia-market-has-room-to-grow

15. Chibba, S. (2014, October 14). *The growth of fish farming in South Africa.* Retrieved from Brand South Africa Website: https://www.brandsouthafrica.com/investments-immigration/science-technology/the-growth-of-fish-farming-in-south-africa?gclid=CjwKCAjwrKr8BRB_EiwA7eFapqyMx8fA1HNIoNKcUqdGqV_YICgzWPKbq4UykvS5x5S2drvsNbsq8BoCqcYQAvD_BwE

16. Cook, B. (2017, May 24). *Fish Farms - Reviewing the Rise of African Aquaculture.* Retrieved from Deep Trekker Web site: https://www.deeptrekker.com/news/fish-farms-african-aquaculture

17. Cook, B. (2017, May 24). *Fish Farms - Reviewing the Rise of African Aquaculture.* Retrieved from Deep Trekker Web site: https://www.deeptrekker.com/news/fish-farms-african-aquaculture

18. Creswell, J. W. (2013). Philosophical Assumptions and Interpretive Frameworks. In J. W. Creswell, *Qualitative inquiry and research design : choosing among five approaches* (pp. 15 - 16). United States of America: SAGE Publications.

19. Creswell, J. W. (2014). The Selection of a Research Approach. In J. W. Creswell, *Research design: qualitative, quantitative, and mixed methods approaches - 4th ed.* (p. 32). United States of America: SAGE Publications.

20. Cury, P. M., Mullon, C., Garcia, S. M., & Shannon, L. J. (2005). Viability theory for an ecosystem approach to fisheries. *ICES Journal of Marine Science*, 577 - 584.

21. da Silva, J. G. (2016). *The State of World Fisheries and Aquaculture.* Paris, France: Food and Agriculture Organization of the United Nations.

22. da Silva, Jose Graziano. (2009). *The state of world fisheries and aquaculture, 2008, p. 176*. Rome: Food and Agriculture Organization (FAO), 2009, The state of world fisheries and Agriculture Organization of the United Nations.

23. da Silva, Jose Graziano. (2018). *The State of World Fisheries and Aquaculture*. Rome: Food and Agriculture Organization of the United Nations.

24. da Silva, Jose Graziano. (2018). *The State of World Fisheries and Aquaculture: Meeting the Sustainable Development Goals*. Rome: Food and Agriculture Organization Of the United Nations.

25. David Fincham Aquaculture. (n.d.). *Farm Talipia as a way to feed people in the cities*. Retrieved from Talipia Farming: https://www.tilapiafarming.co.za/

26. Edwards, P. (2020, June). Aquaculture, Poverty Impacts and Livelihoods. *The Overseas Development Institute, Number 56*, pp. 01 - 04.

27. Fincham, D. (2020, October 9). *Tilapia farming Untapped SA market holds opportunity for growth*. Retrieved from Farmer's Weekly Website: https://www.magzter.com/article/Business/Farmers-Weekly/Tilapia-farming-Untapped-SA-market-holds-opportunity-for-growth

28. Fletcher, R. (2020, October 6). *2020 tilapia production figures revealed*. Retrieved from The Fish Site Website: https://thefishsite.com/articles/2020-tilapia-production-figures-revealed

29. Gentles, S. J., Charles, C., Ploeg, J., & McKibbon, K. A. (2015, September 11). Sampling in Qualitative Research: Insights from an Overview of the Methods Literature. *The Qualitative Report, Volume 20, Number 1, Article 4*, pp. 1772-1789.

30. Gupta, M. V., & Acosta, B. O. (2004). A review of global tilapia farming practices. *Aquaculture Asia*, 07 - 16.

31. imarc. (2020, September 06). *Tilapia Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2020-2025*. Retrieved from imarc web site: https://www.imarcgroup.com/tilapia-market

32. James, N. (2019, August 2019). *A tilapia model that SA should be emulating*. Retrieved from Farmer's Weekly Website:

https://www.farmersweekly.co.za/animals/aquaculture/a-tilapia-model-that-sa-should-be-emulating/

33. James, N. (2020, July 28). *Tilapia Farming in South Africa* . Retrieved from Freshwater Aquaculture in South Africa: http://southafrica.co.za/tilapia-farming-south-africa.html

34. Kabir, S. M. (2016). Methods of data collection. *Researchgate*, 202 - 276.

35. Kaleem, O., & Sabi, A.-F. B. (2020, July 22). *Overview of aquaculture systems in Egypt and Nigeria, prospects, potentials, and constraints*. Retrieved from ScienceDirect Website: www.keaipublishing.com/en/journals/aquaculture-and-fisheries

36. Kaminski, Alexander M. (2020, January 02). A review of inclusive business models and their application in aquaculture development. *Reviews in Aquaculture, 10.1111/raq.12415*, pp. 01 - 22.

37. Kánnai, Z., & Tallos, P. (2008). *Viability Theory and Economic Modeling*. Hungary: Corvinus University of Budapest.

38. Krawczyk, J. B., & Pharo, A. (2013). Viability theory: an applied mathematics tool for achieving dynamic systems' sustainability. *MATHEMATICA APPLICANDA*, 97 - 126.

39. Levitt, H. M., Creswell, J. W., Josselson, R., Bamberg, M., Frost, D. M., & Suárez-Orozco, C. (2018). Journal Article Reporting Standards for Qualitative Primary, Qualitative Meta-Analytic, and Mixed Methods Research in Psychology: The APA Publications and Communications Board Task Force Report. *American Psychologist*, 26 - 46.

40. Little, D. C., Newton, R. W., & Beveridge, M. C. (2015). Aquaculture: a rapidly growing and significant source of sustainable food? Status, transitions and potential. *Aquaculture: a rapidly growing and significant source of sustainable food?Status, transitions and potential* (pp. 274 - 286). Via Delle Terme di Caracalla, Rome, Italy: Proceedings of the Nutrition Society.

41. Lotzkar, M., & Bottorff, J. (2001). An observational study of the development of a nurse-patient relationship. *Clinical Nursing Research, 10*, 275-294.

42. Mapfumo, B. (2011). An overview on desert aquaculture in the Southern Africa. *Fisheries Industry in Southern Africa*, 119 - 140.

43. Mapfumo, B. (2018, December). *Tilapia Trade - Global and Regional Trends*. Retrieved from Food and Agriculture Organization of the United Nations: http://www.fao.org/fi/static-media/MeetingDocuments/TiLV/dec2018/p13.pdf.

44. Mchunu, N., Lagerwall, G., & Senzanje, A. (2018, August 20). Aquaponics in South Africa: Results of a national survey. *Aquaculture Reports 12 (2018) 12–19*, pp. 12 - 19.

45. Mkhize, S., & Mbhele, T. (2017). *Unlocking the Economic Potential of the Ocean Economy through aquaculture*. Johannesburg: National Economic Development Council and Labour Council.

46. Mkhize, S., & Themba, M. (2017). *Unlocking the Economic Potential of the Ocean Economy through aquaculture. A study on inclusive economic growth through aquaculture*. Johannesburg, Gauteng, RSA: National Economic Development and Labour Council.

47. Moyo, N. A., & Rapatsa, M. M. (2021, March 30). A review of the factors affecting tilapia aquaculture production in Southern Africa. *Aquaculture, Volume 535 (2021) 736386*, pp. 1-10.

48. Msangi, S., & Batka, M. (2015). *Chapter 8: The Rise of Aquaculture Aquaculture: The Role of Fish in Global Food Security*. Washington, DC.: International Food Policy Research Institute. Retrieved from https://www.ifpri.org/sites/default/files/gfpr/2015/feature_3087.html#ch08tab01

49. Msangi, Siwa; Batka, Miroslav . (2015). *The rise of Aquaculture: The Role of Fish in Global Food Security - Chapter 8*. Washington, D.C., USA: International Food Policy Research Institute.

50. Oubraham, A., & Zaccour, G. (2018). A Survey of Applications of Viability Theory to the Sustainable Exploitation. *Ecological Economics*, 346 - 367.

51. Prabu, E., Rajagopalsamy, C. B., & Ahilan, B. (2019). Tilapia – An Excellent Candidate Species for World Aquaculture. *ReseachGate*, 01 - 14.

52. Pradeepkiran, J. A. (2019). *Aquaculture role in global food security with nutritional value: a review*. England, U.K: Oxford University Press.

53. Resnik, David B. . (2015, December 1). *What Is Ethics in Research & Why Is It Important?* Retrieved from National Institute of Environmental Health Sciences: https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

54. Sabatiera, R., Joly, F., & Hubertd, B. (2017). Assessing both ecological and engineering resilience of a steppe agroecosystem using the viability theory. *Agricultural Systems*, 146–156.

55. Saunders, M., Lewis, P., & Thornhill, A. (2009). Understanding research philosophies and approaches. In M. Saunders, P. Lewis, & A. Thornhill, *Research Methods for Business Students, 5th Edition* (pp. 123 - 161). Birmingham, UK: Pearson Education Limited.

56. Saunders, M., Lewis, P., & Thornhill, A. (2015). Formulating the research design. In M. Saunders, P. Lewis, & A. Thornhill, *Research Methods for business studies* (pp. 162 - 219). London: Pearson.

57. Services, A. a. (2013). *Fish to 2030 Prospects for Fisheries and Aquaculture*. Washington, D.C., USA: The World Bank.

58. Shava, E., & Gunhidzirai, C. (2017). *Fish farming as an innovative strategy for promoting food security in drought risk regions of Zimbabwe*. Alice, Eastern Cape, South Africa: University of Fort Hare.

59. Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Researchgate*, 63 - 75.

60. Soliman, N. F. (2017, January). *Aquaculture in Egypt under Changing*. Retrieved from Alexandria Research Center for Adaptation to Climate Change (ARCA): http://arca-eg.org/wp-content/uploads/2017/06/Working-Paper-4-Jan.2017.pdf

61. Sprenger, M., Mettler, T., & Winter, R. (2017). A Viability Theory for Digital Businesses: Exploring the Evolutionary Changes of Revenue Mechanisms to Support Managerial Decisions. *Springer*, 01 - 34.

62. The Industrial Development Corporation. (2014). *Potential for the Production, Processing and Export of Tilapia for the Southern African Market*. Johannesburg: Urban-Econ Development Economists.

63. The Tilapia Aquaculture association of South Africa. (2020, April 07). *Markets and Trade in Aquaculture*. Retrieved from The Tilapia Aquaculture association of South Africa Website: https://www.thetilapiasite.co.za/article-19-markets-and-trade-in-aquaculture.html

64. Urban - Econ Development Economists. (2018). *Nile & Mozambique Tilapia Feasibility Study*. Pretoria, Gauteng, RSA: Department of Agriculture, Forestry and Fisheries.

65. Urban-Econ Development Economists. (2015). *Research into the Potential for the Production, Processing and Export of Tilapia for the Southern African Market*. Johannesburg, Gauteng, RSA: The Industrial Development Corporation.

66. Van der Knaap, M. (2018). Status of tilapia aquaculture in Africa and production projections (regional and international). *Enhancing capacity/risk reduction of emerging Tilapia Lake Virus (TiLV) to African tilapia aquaculture* (pp. 01 - 25). Nairobi, Kenya: Food and Agriculture Organization of the United Nations.

67. Wood, L. (2019, August 26). *Global Tilapia Market Report 2019: Industry Trends, Share, Size, Growth, Opportunity and Forecast 2018-2024*. Retrieved from Business Wire Website: https://www.businesswire.com/news/home/20190826005503/en/Global-Tilapia-Market-Report-2019-Industry-Trends-Share-Size-Growth-Opportunity-and-Forecast-2018-2024---ResearchAndMarkets.com

68. Wood, Laura. (2020, March 09). *South African Ocean and Coastal Fishing and Fish Farming Industry, 2020: Size & State of the Market*. Retrieved from Research and Markerts Website: http://www.globenewswire.com/news-release/2020/03/09/1997028/0/en/South-Africa-Ocean-Coastal-Fishing-Fish-Farming-Industry-2020-Size-State-of-the-Market

69. Yin, R. K. (2008). Case Study Research: Design and methods. *Sciencedirect*, 59 - 60.

70. Young, J. A., & Muir, J. F. (2002). Tilapia: Both Fish and Fowl? *Marine Resource Economics*, 163 - 173.

8 APPENDICES

Appendix 1.1: Consent form

CONSENT FORM

Title of the research project:

Evaluating the economic potential of aquaculture farming: A case of Tilapia fish

Name and position of researcher:

Nosimilo Mbele, MBA Final year student, Wits Business School

Please tick the box

	Yes	No
I confirm that I have read and understand the information for the above study and have had the opportunity to ask questions.		
I understand that my participation is voluntary and that I am free to withdraw at any time without giving reason.		
I agree to take part in the study		
I agree to the interview being audio recorded		
I agree to use of anonymised quotes in publications		

Name of participant: **Nosimilo Mbele (researcher)**

Date: **Date:**

Signature: **Signature:**

Appendix 1.2: Data collection instruments

Appendix 1.2.1: Interview questionnaires

1. Please explain or tell me about your experience with TFF and the details of your TFF establishment

   .....

   .....

2. What is the economic state of Tilapia fish farming in South Africa?

   .....

   .....

3. What are your reasons for saying that about the economic state of Tilapia fish farming in South Africa?

   .....

   .....

4. What are the critical factors for leveraging the economic potential of Tilapia fish farming in South Africa?

   .....

   .....

5. The critical factors are they related to each other, and how are they prioritized according to criticality?

   .....

   .....

6. What are the challenges that hinder the effective economic potential of Tilapia fish farming in South Africa?

   .....

   .....

7. How do they hinder effective economic potential?

   .....

   .....

8. What is the future role of TFF in job creation, poverty alleviation, and food security in South Africa?

.....

.....

9. Can please add any beneficiary information to the study that we did not cover from the questions asked.

.....

.....

Appendix 1.2.2: Documents review

1. Permits
2. Delivery receipts
3. Method statements
4. Quality control records
5. Calibration certificates
6. Orders
7. Production schedule
8. Waste records
9. Dispatch documents
10. Certificates for accreditation and or compliance
11. Training records

Appendix 1.2.3: Field Observation checklist

No.	Observation	Remarks
1	How many workers?	
2	Any trainees?	
3	What process in the Value Chain executing?	
4	How do they choose the feed supplier?	
5	How feeds checked on delivery?	
6	Is the water temperature ideal for production?	
7	What time is the temperature measured and how many times a day?	
8	Type of thermometer used and why?	
9	How temperature verified if it is correct?	
10	Fish sampling quality checks on weight (what is the acceptable weight)	
11	How long does it take to harvest good quality fish?	
12	How to handle non-confirming poor production processes and poor quality products?	
13	What are communication processes in place for the suppliers and customers	
14	What are action in place for production process risks	
15	What are daily/monthly/yearly production	
16	Any training conducted on-site	

17	Part of any association: accreditation and compliance	
18	What are the support structures available, internal and /or external?	
19	Additional extra information	

Appendix 2.1: Ethics documentation

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF GRADUATE SCHOOL OF BUSINESS ADMINISTRATION ETHICS COMMITTEE
CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER WBS/BA2278407/920**
PROJECT TITLE	Evaluating the economic potential of aquaculture farming: A case of Tilapia Fish
INVESTIGATOR	Miss Nosimilo Mbele
SCHOOL/DEPARTMENT OF INVESTIGATOR	MBA (Research Article)
DATE CONSIDERED	24 November 2020
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	MINIMAL RISK
EXPIRY DATE	30 JUNE 2021

ISSUE DATE OF CERTIFICATE 15 December 2020 **CHAIRPERSON** __ _____
(Dr MDJ Matshabaphala)

cc: Supervisor: Mr Conradie

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

_____ 15 / 12 / 2020
Signature **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES