Gordon Institute of Business Science
University of Pretoria

Aquaculture in South Africa:
Using the triple helix model to explore innovation activity in institutional spheres

Student name: Tumi Nkosi
Student number: 14452953

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Abstract

The quest for economic growth across the globe and the focus on Africa as an emerging economic giant are resulting in the need for appropriate structures aimed at nurturing the growth of regions in Africa. The decentralisation of globalisation in favor of regionalisation is accompanied by the requirement for regional competitiveness that is underpinned by innovation. The rapid pace of change as a characteristic of the modern day business environment highlights a paradigm shift of the generation and commercialisation of innovative new ideas. Collaboration in innovation introduces brand new ways of realising the benefits of recreating the roles and responsibilities of the three pillars of any given economy: the government, the academia and the industry. The main purpose of this study was to use the triple helix model of innovation to explore the model in practice within the context of an industry that has high growth potential but that was experiencing slugging growth, with the aim of identifying the structure of the triple helix system and the elements thereof that may be inhibiting the sector. Secondary data collection and primary data collection phases were used during the study, the latter of which was in the form of a qualitative data collection methodology. The first phase of secondary data collection was used to gain insights into an underdeveloped industry that was deficient of comprehensive industry information sources as a result of its development status. The output of the first phase of data collection was used as input to design a questionnaire to be to collect primary data. A sample of ten respondents was interviewed during the primary data collection process. The sample consisted of two respondents from the government, two respondents from academia and six respondents from industry.

The outcome of the study revealed that the presence of a well-structured and well-functioning triple helix system did not guarantee collaborative innovation success. The absence legislation in a triple helix system seemed to weaken the benefits sought from a triple helix approach to innovation in a sector. The key finding of the study was that the rules of the game within a triple helix system should precede the efforts of managing the elements of the triple helix system. By setting the rules of the game upfront, the individual institutional spheres would be in a position to willingly adopt the roles of the other institutional spheres from a position of positive collaboration instead of frustration.

Keywords

Aquaculture, triple helix model, innovation, institutional spheres

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria.

It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorization and consent to carry out this research.

Signature: 

Name of student: Tumishang Nkosi

Date: 9 November 2015

Table of contents

Table of figures

List of tables

1. CHAPTER ONE: INTRODUCTION TO RESEARCH PROBLEM

The purpose of this chapter is to introduce the topic of "Aquaculture in South Africa: Using the triple helix model to explore innovation activity in institutional spheres". The section also argues the relevance of the topic to business as well as to research in both business and academia.

1.1.Introduction

Many African states such as South Africa face the challenge of diversifying economies that are historically resource-dependent (Wiig & Kolstad, 2011). The recent fall in commodity prices backs up the urgency around the need for rapid economic diversification of such nations (Wallis, 2015). Lower commodity prices have a negative impact on the flow of the national revenues of economies, exposing them to negative balance of payments, stunted economic growth and the inability to reverse worrying levels of poverty that most African states continue to wrestle with (Miles, Scott & Breedon, 2012). One of the most effective methods of avoiding this typical consequence of natural resource overdependence is economic diversification (Wiig & Kolstad, 2011). It is therefore imperative for economies, particularly those at risk of resource overdependence and those that face slowing economic growth, to consider investments in alternative industries that deliver quick growth to allow nations to realise the benefits of a wider economic revenue base (Miles, Scott & Breedon, 2012). Aquaculture is one such industry (Food and Agriculture Organisation of the United Nations [FAO], 2014).

"Aquaculture has been growing rapidly – faster than any other food production sector – over the past three decades, and continuing" (FAO, 2014). A sub-sector of agriculture, aquaculture or aquafarming focuses on the farming of aquatic plants and animals under controlled conditions (Department of Agriculture, Forestry and Fisheries [DAFF], 2015). The products harvested from aquaculture operations supplement wild-caught aquatic stock to meet the rising demand for food fish (Department of Trade and Industry, [DTI], 2015). Aquaculture enables nations to be proactive about the supply of food fish while maintaining the environmental integrity of water resources such as rivers, dams and oceans (FAO, 2014). The impressive and continuous growth rates reported by aquaculture, as well as the positive impact that the sector has had on social and economic wellbeing, makes it an attractive industry for focused investments and concerted efforts to transform it into a meaningful contributor to national income (FAO, 2014).

While Asian economies have successfully commercialised aquaculture, the opposite seems to hold be true for South Africa (DAFF, 2015). In spite of dedicated resources being made available by government for the betterment of the South Africa aquaculture industry (the sector), the country is seemingly lagging in developing the aquaculture sector adequately and quickly enough to fully realise its potential (Operation Phakisa, 2013; FAO, 2014; DAFF, 2015). Economic diversification requires dedicated efforts to develop alternative sectors (Danmola & Wakili, 2013), but this level of sectoral development does not happen automatically. Proper structures, policies and systems in institutional spheres that are specifically designed to nurture the development of a particular industry need to be in place in order for development to take place (Siddiqui & Athmay, 2012). One such structure is a well-functioning structure of collaboration between government, academia and industry – the so-called triple helix model of innovation (THM) (Etzkowitz, 1995). Innovation has been successfully used in the past to address a wide range of problems in varying contexts – slow growth in the motoring business (Abernathy & Wayne, 1974), low market share in the Information and Communication Technology sector (Silcoff, McNish & Ladurantaye, 2013), and resistance to change as experienced (Bouquet & Renault, 2014) by Ford, Apple and Uber respectively. Could the South African aquaculture sector stand to benefit from collaborative innovation?

Bold production and employment growth objectives have been set by the South African government for its aquaculture sector (Operation Phakisa, 2013). The researcher is interested in using this study to explore innovation activity between the three institutional spheres of government, academia and industry within the sector and as proposed by the THM. Given the goals that are in place for the industry, the study seeks to understand if the THM in the sector is appropriately structured to enhance and drive innovation activity.

1.2.Research background

A diversified national economy is capable of delivering long-term economic growth, and sustained economic growth affords the nation a better quality of life while also enhancing economic vibrancy that contributes to the prosperity of the private sector (Yan, 2012). This diversified economy sustains economic growth, maintains job creation efforts, and broadens the economic base of a nation; it also increases immunity against natural resource overreliance (Miles, Scott & Breedon, 2012). An undiversified economy, especially one that is resource reliant, is vulnerable to unstable commodity prices and when these plunge, national revenues suffer. Economic development through investment into innovation-driven high-growth industries

is a methodology that can be applied by nations on a quest to achieve the benefits of a diversified economy (Wiig & Kolstad, 2011). Innovation-driven economies, supported by innovation-driven entrepreneurship, are known to grow aggressively and therefore generate a higher number of new jobs than traditional Small and Medium Enterprises (SME) entrepreneurs (Aulet, 2013). Aquaculture is one of the fastest growing food sectors in the world (FAO, 2014). A country such as South Africa could benefit greatly from focused investment efforts into such industries which have strong potential to create jobs and therefore meaningfully and sustainably reverse high unemployment rates, high levels of poverty and unacceptable income inequalities (Miles, Scott & Breedon, 2012).

1.3.Overview of the research problem

The global aquaculture sector, an agricultural sub-sector, continues to record impressive growth rates of between 9% and 11% per annum (DAFF, 2015). Emerging economies such as China and Egypt continue to enjoy good growth in their respective aquaculture sectors, while the South African aquaculture industry performs comparatively poorly with the country producing less than 1% of the continental production yield in spite of strengthening global demand and increased investments from the public sector (FAO, 2014; DAFF, 2015). One of the biggest culprits for this disappointing growth is said to be the high cost of aquaculture production in South Africa, which renders the country uncompetitive against the likes of industry leaders such as China (FAO, 2014). If the high cost of production is to blame for the sector being uncompetitive, then innovation interventions to reduce costs in the areas of, for example, product innovation (Slater, Mohr & Sengupta, 2014) and process innovation (Piening & Salge, 2015) could be extensively beneficial to strengthening the competitiveness of the sector. The importance of national innovation seems to resonate with the government of South Africa as evidenced by its inclusion in the National Development Plan (NDP) Vision 2030, a long-term national strategy for the country (Butler, 2013). The government does not only identify the importance of innovation, but also brings this concept into operationalisation through Operation Phakisa (Operation Phakisa, 2013). Operation Phakisa is a tactical plan whose objective is to fast-track the goals of the NDP. The NDP identifies innovation as “the what”. Operation Phakisa emphasises collaboration between the institutional spheres of government, academia and industry as “the how”. This resonates with the spirit of the triple helix system as outlined in the THM. Operation Phakisa also prioritises the growth of the aquaculture sector (Operation Phakisa, 2013). This study therefore seeks to explore, using THM, collaboration between the

three institutional spheres in the South African aquaculture sector based on the above-mentioned observations.

Aquaculture is used to generate food for human consumption and for interior decorating purposes such as in private aquariums (DAFF, 2015). The scope of this research study is limited to aquaculture as a means by which food fish is produced. South Africa is chosen as the geographical scope of this study. This choice of scope, as well as the motivation for undertaking this study, can be articulated in the following six statements:

- Collaboration between the three institutional spheres is highlighted by Operation Phakisa as a means by which it will realise the goals of the NDP (Operation Phakisa, 2015). This necessitates a study to determine if these structures are in place to facilitate such collaboration, particularly in the aquaculture sector which is Operation Phakisa has prioritised as one of its key sectors.
- The South African aquaculture industry has reported disappointingly lower growth rates in comparison to its Asian and Southern American economic counterparts (FAO, 2014). This necessitates studies to understand the reasons behind this phenomenon if the growth inhibitors are to be understood and countered.
- Recent studies indicate that divestments are taking place in certain South African commodity markets such as in the gold and platinum sectors of the country, both of which are traditionally important sectors for the South African economy (Business Monitor Online, 2015). This necessitates a process of economic diversification to broaden the economic base of the country, replace dwindling industries with more progressive and vibrant sectors, and reduce the country's reliance on the aforementioned natural minerals.
- Transformation of key industries, such as agriculture, is an important goal for the government of South Africa (DAFF, 2015). The agriculture sector is particularly difficult to transform as the outright removal of predominately white farmers in favor of inexperienced black farmers can result in food security threats as witnessed in Zimbabwe (Forbes Africa, 2015). Aquaculture, being a sub-sector of agriculture, is a strategic tool with which the South African government can realise agricultural transformation by making aquaculture an attractive option for black entrepreneurs and potential black farmers where experiments can be encouraged to quickly upskills these farmers without destabilising food security in the country.

- The South African economy is in desperate need of high-growth sectors such as aquaculture that can help with poverty eradication, job creation and the sustenance of a clean environment (NDP, 2013). The country can re-energise its economic growth by focusing on the "Big Five" opportunities, of which one of them is the unlocking of production and exporting of raw and processed agricultural exports into sub-Saharan Africa and Asia – a move which could see South Africa triple its agricultural exports by 2030 (McKinsey, 2015) and a proposition that is aligned to the NDP (NDP, 2013). It is reiterated that aquaculture is a sub-sector of agriculture, so there remains untapped opportunities for the future of the sector.

1.4.Conclusion

South Africa has made impressive progress since its transition into a democracy as evidenced by its larger middle class and the doubling of its Gross Domestic Product (GDP), but economic growth has slowed since 2008 and unemployment has remained high (McKinsey, 2015). It is important for the country to identify and exploit available opportunities so that economic growth can be re-energised and revitalized (McKinsey, 2015). Aquaculture finds itself at the juncture of the NDP, Operation Phakisa and the McKinsey "Big Five" (NDP, 2013; Operation Phakisa, 2014; McKinsey, 2015). The importance of innovation has been highlighted as part of the growth plans of the country (NDP, 2013), the use of collaboration of the three institutional spheres has been identified as a tool by which to achieve growth, and aquaculture in South Africa has been earmarked as a priority sector to diversity the economic portfolio of the country (Operation Phakisa, 2014).

Limited studies are available about the sector so this study seeks to reveal the state of affairs in terms of innovation activity as a product of collaboration between the institutional spheres in the aquaculture sector in South Africa. This result of the study will be to fill this gap in knowledge as to whether or not the current level of collaboration between the institutional spheres is productive enough to contribute positively to the objectives of the NDP. Business will benefit from the knowledge by understanding the innovation landscape of the sector and succinctly identifying areas in the landscape that require further research. The benefit for government will be to assess the sector insofar as the goals in Operation Phakisa are concerned and fine-tune, if necessary, areas that threaten to derail the progress of the plan. Lastly, academia can use the results of the study to understand its perceived role in the sector versus its actual role, and take steps in addressing any variations that will impact its sense of relevance and its contribution to this particular sector in particular and the economy in general.

2. CHAPTER 2: LITERATURE REVIEW

This second chapter introduces the theory on which the study was based.

2.1.Introduction

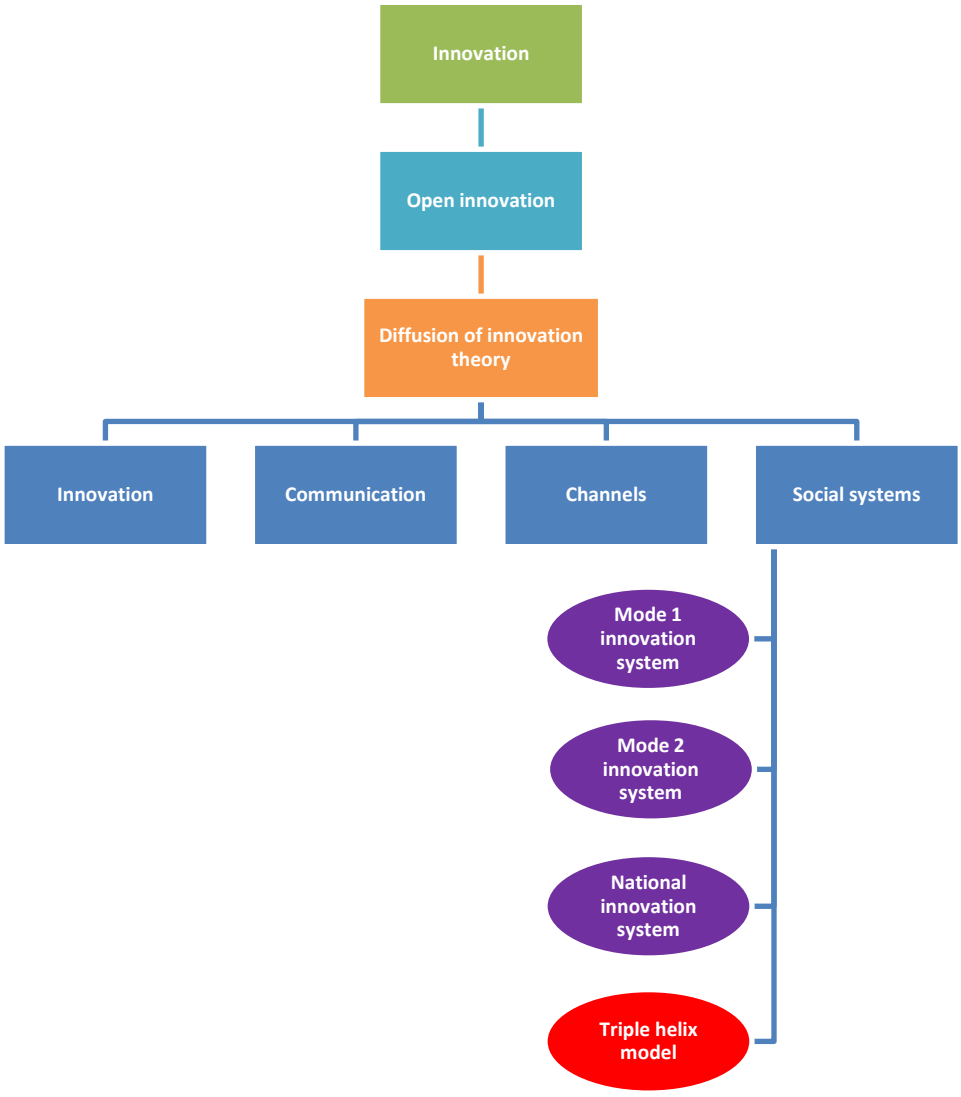
It is import for a thorough review of literature to be undertaken as a foundation on which a research study can be built (Wiid & Diggines, 2009). For example, a body of literature is required upfront if a research decides on a deductive research approach (Saunders & Lewis, 2012).

Chapter One introduced the research with the aim of exploring innovation activity in the sector as a result of collaboration between the three institutional spheres. This aim triggered three key concepts: innovation, collaboration and institutional spheres. The theory on which this research study was based sought to echo these concepts, and the theoretical portfolio comprised: (a) innovation as an overarching master concept of the study and how innovation diffuses (Rogers, 1995); (b) open innovation as a mechanism by which innovation can be produced through collaborative networks (Chesbrough, 2003) such as the institutional spheres of the triple helix and; (c) the triple helix model as a model of collaborative innovation that is specifically defines the institutional spheres of government, academia and industry as the parties that comprise these collaborative networks (Etzkowitz, 2012).

An overview of the innovation theory was introduced, followed by a look at open innovation theory as a contemporary yet controversial method of breaking through innovation barriers that can exist as a result of an inward focus by organisations (Chesbrough, 2003). Since uncommercialised innovation is nothing more than invention (Ismail, 2015), the literature review continued with an examination of the theory of diffusion of innovations as a means by which an idea transforms from an invention to an innovation (Rogers, 1995). One of the elements of the diffusion of innovation theory is “social networks” as an audience of potential adopters of an innovation (Rogers, 1995). In the context of the research study, the potential adopters are the aforementioned institutional spheres, be it singularly or collectively: collaboration of the spheres as inventors and idea generators, academia as inventors too but also as testers of inventions, industry as commercialisation agents of the invention and transformers of inventions to innovations and government as facilitators of the process as a whole through policy and legislation (Etzkowitz, 2000). The literature review therefore zoned in on social networks as

they apply at institutional level in the form of innovation systems (Nelson, 1993; Lundvall, 2010; Hari, 2013) and provides an overview of the evolution of innovation systems. The theoretical journey finally settles on theory of the THM as a framework through which the study was to be structured with respect to how the South African aquaculture sector produces and manages innovation as a result of three-way collaboration between government, academia and industry (Figure 1).

Figure 1: Overview of theoretical framework



The THM has been previously applied to numerous nations that are economically similar to South Africa, for example in Taiwan (Chen, Lin & Chu, 2013), Mexico (Villasana, 2011), the Middle East and Central Asia (Hira, 2013) and in a variety of sectors and industries. No cases could be found of the application of the triple helix model in the aquaculture sector of South Africa, and herein lays the potential contribution from the perspective of application of available literature to an existing body of knowledge.

There is very little business-related information available about aquaculture in general (DAFF, 2015). The research study therefore positioned itself as a contributor to industry research that investors and entrepreneurs find critical to have access to when conducting feasibility assessments prior to making investment decisions into an earmarked sector (Barringer & Ireland, 2012). The choice of the theoretical base is in line with a desire by the researcher to contribute to ongoing academic conversations and debates that have been taking place over the last three years around innovation in general (Yalabik, Howard & Roden, 2012; Moustaghfir & Schiuma, 2013; Stosic & Milutinovic, 2014) and the triple helix model in particular (Bangun & Sukarya, 2012; Lundberg, 2013; Sorensen & Hu, 2014).

2.2. Innovation

2.2.1. What is innovation?

Innovation is a compelling management theme that is inextricably linked to the growth and prosperity of organisations (Yalabik, Howard & Roden, 2012). Innovation as a managerial concept has received increasing literary coverage over the last few decades, with theorists in general agreement that the very survival of an organisation depends on how well it incorporates innovation into mainstream business operations and strategies (Porter, 1985; Scherer, 1986; Kanter, 1990; Hamel, 2006; Yalabik, Howard & Roden, 2012). The level to which a product or item is considered to be innovative is dependent on the perception of its newness to the audience (Rogers, 2003). This supports the idea that the perception of novelty of a product, process or item underpins the qualification of it as innovative. Aquaculture is a an old practice in certain parts of the world such as China, but the practice is perceived as new in South Africa hence it can be classified as an innovative concept within this scope. The scope of innovation application has grown to encompass processes and services as well as products (Crumpton, 2012) as well as technology, business model, positioning and various other varieties (Aulet, 2013).

Captivating a management concept as it is, it is necessary to define innovation as it applies in this research study. Innovation is a simple term that refers to the ability to commercialise an invention (Aulet, 2013). Invention without commercialisation is not innovation, and neither is commercialisation without invention (Ismail, 2015). Innovation academics agree that the source of innovation is not as important as the ability to commercialise the product of innovation (Aulet, 2013). This links to the earlier discussion that although aquaculture is not a new concept in South Africa, the successful commercialisation of the concept in the country has the potential of qualifying itself as an innovation. The South African aquaculture industry should therefore see itself as a commercialisation agent of aquaculture in the country. A good example of this observation is the commercialisation of the computer mouse, which was created by Xerox PARC but successfully commercialised by Steve Jobs through Apple (Aulet, 2013). The idea holds that although aquaculture is not a new concept in other settings such as China and Taiwan, its successful commercialisation in South Africa can transform it from a mere idea to a very successful case of an industry in the idea stage to one that is successfully commercial.

In continuation of the unpacking of innovation as the point of junction between commercialisation and invention, has innovation remained a novel idea particularly when one considers its considerably weak incorporation into the strategy of a myriad of global organisations (Raza & Bank, 2014)? As great a concept as innovation is, its success depends heavily on the culture within which it is implemented (Crumpton, 2012). At corporate level, innovation flourishes in the collective presence of numerous factors that have shown to act as motivators of innovation: communication, a complex matrix of intrinsic and extrinsic factors that together motivate creative workers and leadership that facilitates the innovation process (Gobble, 2012). This context-reliant nature of innovation transcends the organisational level to include the national level where studies show that innovation at country level was positively affected by democracy and negatively affected by high public debt and inequality (DiPietro, 2012). Considering South Africa as the context for this research study, these propositions were consistent with the conclusion that a country with considerable income disproportions such as South Africa are unlikely to benefit from innovation efforts implemented at country level – a discouraging suggestion considering the need for such economies to pursue innovative projects that maximise growth and development (Yalabik, Howard & Roden, 20120. The pursuit of democracy and an egalitarian society, combined with prudence in the management of public debt, are all therefore necessary measures for a nation to undertake if innovation was to be successfully employed as a driver of economic growth in the longer term. Innovation

proponents are steadfast in their belief that an entity, be it an organisation or a country, should "innovate or die" (Strategic Direction, 2011). This begs the question of which should come first: the preparation of context to accommodate innovation or the application of innovation regardless of its context? The proposals made by DiPietro (2012) disqualify South Africa as a favorable environment for innovation to thrive what with its high public debt partly due to its culture of saving discouragement and high income inequality (Statistics South Africa, 2015). Using an example, China is not a democratic nation yet the country is considered as being more innovative than South Africa (Global Innovation Index, 2015). This observation somewhat weakens to a certain extent the suggestions put forth as to the importance of the presence of certain contextual elements at national level that will guarantee or improve the health of innovation. This lends itself to the assumption that context on its own may not be the sole key success factor in the implementation of innovation projects at national level.

2.2.2. How innovations spread

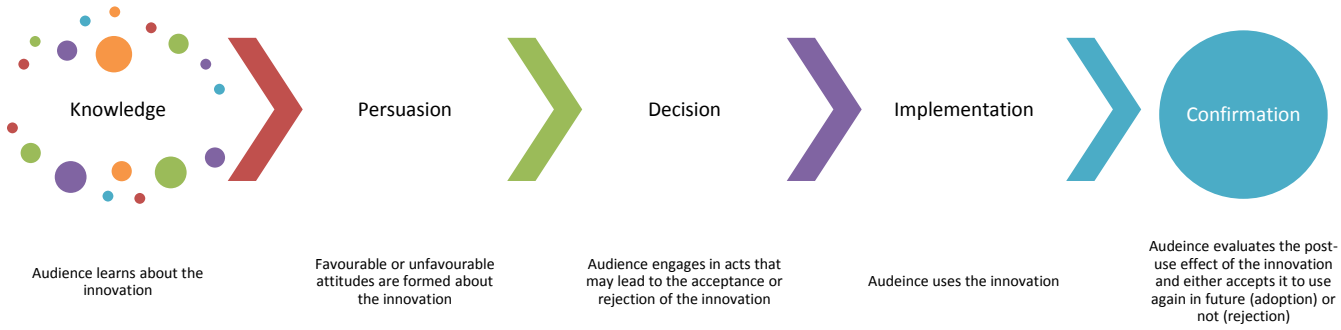
Rogers (1995) asserted that the process of communicating new ideas, for adoption or rejection by people, involves the interaction of four main factors: (1) the innovation itself (2) communicated through channels by (3) members of a social system (4) over the passage of time. Thus, the commercialisation of a new invention in order for it to be qualified as an innovation needs to be known by the people or parties responsible for its acceptance or rejection.

The concept of aquaculture will remain an invention in South Africa for as long as any one or more of the aforementioned elements of the innovation diffusion process was weakened or absent (Oldenburg & Glanz, 2008). It therefore made sense to comment that aquaculture and its newness to South Africa will remain an invention unless institutional innovation networks or channels are adequately structured to communicate the idea to identified members of a social system, such as potential entrepreneurs, over a certain period of time. One cannot help but wonder if this is indeed the case or if the opposite applies and is contributing to the sluggish growth of the sector.

The communication of new ideas results in either their acceptance or rejection, and how this happens is reflected in the innovation-decision process in Figure 2. Marketing literature highlights the importance of understanding the innovation-decision process to ensure that the correct marketing communication messages are formulated and implemented appropriately

depending on where in the process the intended target market finds itself (Shimp & Andrews, 2014). This translates into the ability of the various stakeholders in the sector to communicate the concept of aquaculture to potential entrepreneurs with the aim of attracting them to enter the sector and contribute to production growth and job creation. The "change agent" concept (Oldenbug & Glanz, 2008) can be used to communicate a specific message to certain audience which will help speed up the process of transforming an invention into innovation through commercialisation (Rogers, 2003).

Figure 2: Innovation-decision process



The diffusion of innovation theory is celebrated for its ability give insights into human actions to allow for mechanisms to be put into place, such as marketing messages, to influence the actions in a manner that benefits an organisation (Kreps, 2004; Shimp & Andrews, 2014). Antagonists of the diffusion of innovation framework criticise its simplification of an otherwise complex topic of human behavior (Kreps, 2004) and inconsideration of biases and other externalities that can affect the progress of innovation diffusion (MacVaugh & Schiavone, 2010). Kreps (2004) and Rogers (1995) both argue that the model overlooks the potential presence of ignorance over innovation as a reason for non-adoption, the adoption of a product as a result of the tendency of society to blame an individual for non-adoption, the potential inaccuracy by the individual of the exact moment in time when an innovation was adopted, and the fact that the diffusion of innovation widens the inequality gap in resource-poor contexts.

If the diffusion of innovation framework was to have a positive impact on speeding up the rate of aquaculture adoption in South Africa, and maximising the growth of the sector as a result, the aforementioned blind spots would have to be adequately addressed (Kreps, 2004). For example, the correct units of analysis could be chosen to overcome the individual blame bias and information could be collected at different points of time during the diffusion process to neutralise the recollection bias (Rogers, 1995). The importance of diffusing new ideas was appreciated but the volatile, uncertain, complex and ambiguous element that charactise the modern business environment necessitates a continuous stream of new ideas without which entity performance and survival is threatened (Petrou & Daskalopoulou, 2013). Idea generation introduces its own challenges, some of which birthed the practice of open innovation. Bank & Reza (2014) herald open innovation as the key to unlocking the elusive and continuous sustainable competitive advantage.

2.2.3. The business case for innovation

The global environment within which businesses and governments are operating is characterised by volatility, uncertainty, complexity and ambiguity and this reality is unlikely to change (Harvard Business Review, 2014). One way of surviving in these uncertain conditions is innovation: organisations must develop innovation strategies that stimulate creativity and that adds value to end customers (Strategic Direction, 2011).

Innovation identifies new markets, drives the economy, keeps institutions relevant and improves the livelihood of nations (Gobble, 2012). Crumpton (2012) argues that the absence of innovation can lead to irrelevance of products, processes or concepts, slow growth, loss of market share and obsolete processes and products that may be expensive to maintain and that will lead to the erosion of profits. Refocusing on the context of the study, it can be said that innovation is a method that can be used by the sector to realise its objectives of production growth and job creation. It would seem sensible to explore activities that are being currently undertaken to grow the sector innovatively. The notion of accepting innovation as one of the methods available to safeguard against the demise of entities is well documented (Gobble, 2012; Harvard Business Review, 2014).

2.2.4. Innovation in practice

There may not be a replicable set of standards and practices that transform innovation into a practice that produces reliable products each time without fail, but research data shows that culture and talent are at the center of successful innovation practices (Gobble, 2012). Central to culture and talent is management in its capacity to make decisions about the ebb and flow of talent within an organisation and to build organisational culture (Smit, Cronje, Brevis & Vrba, 2011). It is widely accepted that management plays an important role in the shaping of an organisation but too much management stifles creativity (Amabile & Kramer, 2010), with a suggestion made that innovators and creative workers should just be left alone (Gobble, 2012). If the loose management, or any management at all for that matter, of innovators and creative workers is the key to innovation productivity then how does one explain the very same approach that LEGO used that resulted in the firm teetering dangerously close to innovation-induced bankruptcy (Knowledge@Wharton, 2012)? A popular misconception of the application of innovation is that it is a process of creative destruction that weakens when managed and that should be left to its own device; an unbridled state of chaos that is commonly mistaken as the ideal environment for innovation to flourish (Knowledge@Wharton, 2012). This wildcat, undirected and unfocused approach to innovation can prove fatal to the very same business goals of organisational sustainability and adaptability that it is meant to achieve (Wharton, 2012). The other end of the continuum represents management overregulation and thus the complete absence of innovation, which can be as a result of a possible myriad of organisational ailments such as market disconnection as highlighted by Ford in previous years (Abernathy & Wayne, 1974). This can also include bsessive denial about the extent of the changes occurring in the marketplace as well as chronic internal focus as was the case in the continuing war between traditional taxis and Uber (Bouquet & Renault, 2014). Pink (2009) and Amabile & Kramer (2010) suggest a managerial approach that includes affording employees some level of autonomy; the managers can also exercise selective control and provide learning opportunities to employees.

Legrand & LaJoei (2013) presented an argument against the role of culture in innovation by asserting that culture existed for one reason alone - to defend the status quo. An innovative culture is therefore not a pre-requisite for building an innovative organisation, promoting instead a culture that is open towards learning, risk, changeability and diversity (Legrand & LaJoei, 2013). Leaders must understand the intricacies of how innovation occurred in organisations to ensure that innovation efforts were supported at senior level and that the workforce was trained

on the rigorous methodology of innovative thinking (Legrand & LaJoei, 2013). The process of managing innovation requires a fine balancing act between enforcing discipline and allowing space for creativity while also making provision for failure (Amabile & Kramer, 2013).

In spite of its challenges, innovation holds great potential for organisations across the globe especially given the presence of modern-day innovation success stories from Apple and Procter & Gamble. The advantages of innovation include cost reduction in production, new rewards as a result of the introduction of new products in the market, better quality of life for customers and citizens, the power to restructure the structure of the marketer through the introduction of new processes and products and, seizure of profitable opportunities (Schumpeter, 1939; Gobble, 2012; LeGrand & LaJoei, 2013).

2.2.5. Conclusion

These benefits are in line with the goals of the NDP as specifically directed at the sector: production growth, employment creation and meaningful contribution to national revenues, and these collective goals translate into a better quality of life for the citizens of South Africa.

The element of commercialisation as it relates to the transformation of an invention to an innovation involves the process of commercialisation, which in turn is driven by the diffusion of the innovation in question through its communication by members of a particular social system through certain channels (Kreps, 2004; Rogers, 1995). This introduces a related body of theory that addresses the importance of commercialisation and how this elevates an invention into an innovation – the theory of the diffusion of innovation.

2.3. Open innovation

2.3.1. Introduction

Open innovation represents a process of collaborative idea generation and management by a number of institutions, at times comprising a collective of direct competitors, fueled by the idea that the collective is greater than the sum of its individual parts (Bank & Raza, 2014). While collaborative idea generation spreads the responsibility to innovate, from a single division to the entire organisation (Bank & Raza, 2014), a more radical approach to open innovation involves the collaboration of various organisations that exist outside of the borders of a company (Hoosain, 2013). The latter view of open innovation links to its original intention as a “paradigm that assumes that firms can and should use external and internal ideas, and internal and

external paths to market, to advance technology" (Chesbrough, 2003). The focus of open innovation is on the mutual sharing of information within and between organisations for the greater good of the parties in question (Abouzeedan & Hedner, 2012). Although open innovation has gained traction in scholarly circles since its introduction by Chesbrough (2013), critics of this proposal continue to remark negatively about it. For example, cases where open innovation has been successfully executed are scarce (Hoosain, 2013).

2.3.2. The limitations of the theory

The definition, scope, boundaries and distinctiveness of open innovation remain unclear in spite of flourishing growth of the idea in recent years (Hoosain, 2013). What is clear about the proposition represented by open innovation is that it is a relationship between a variety of institutions for the purpose of innovation (Chesbrough, 2012). A source of confusion as to exactly what is open innovation is partly driven by its close resemblance to the related concepts of user innovation, crowd-sourcing, open-source, co-creation and distributed innovations (Hoosain, 2013). Be that as it may, open innovation is revered for its ability to maintain continuous innovation processes, create radical new products with fewer internal resources, enhance collaboration, share risks and protect the welfare of industries (Chesbrough & Garman, 2009).

It is also not difficult to appreciate the criticisms brought against open innovation: it proposes the involvement a wide range of different people and organisations, some from outside of the company, to create as well as diffuse and commercialise new products (Hoosain, 2013). Opponents of open innovation agree that the practice is fraught with "unnecessary" risks: opportunism, loss of control over valuable intellectual property, the need to share resources when these have been traditionally competed over and the loss of control over staff due to the need to liberate workers from traditional and familiar hierarchical management-controlled work structures (Jarvenpaa & Wernick, 2011).

2.3.3. Arguing for open innovation

The greatest paradox stemming from open innovation is by far the loss of control over intellectual property – the very same property that is intricately linked to the bottom line of many organisations (Javernpaa & Wernick, 2011). Indeed, open innovation and those who embrace it are faced with known, unknown and unknowable factors but there are means and ways of identifying and managing these (Christensen, Olesen & Kjaer, 2005). The paradox

management perspective is one tool with which open innovation can be managed, and it involves the identification of paradoxical tensions in an open innovation system and a proposition of the management thereof (Javernpaa & Wernick, 2011). Overall, the pursuit of sustainable competitive advantage seems set to transcend the boundaries of organisations with proponents of open innovation fiercely defending their ground by insisting that no company should ever innovate on its own; that not all intelligent people work for a single company; that it is better to build a better business model than to rush to be first on the market (Tidd, Bessant & Pavitt, 2009); and that the innovation leader will eventually be the one who can enhance and maximise innovation collaboration with an external network (Battistella & Nonino, 2012). The argument for open innovation is firmed up by highlighting the advantages of collective learning, collective risk taking and collective efficiency (Tidd, Bessant & Pavitt, 2009).

2.3.4. Conclusion

Open innovation was showcased as a process that can be applied at various levels (Tidd, Bessant & Pavitt, 2009). Open innovation can be used by organisations of varying types (Javernpaa & Wernick, 2011) – from government and non-profit organisations whose goals are to improve the lives of a certain profile of entities and individuals to for-profit firms that desire greater growth and a larger slice of the market share. Each open innovation network can comprise a matrix of different types of innovations, too (Chesbrough, 2003). For example, industry counterparts can decide to innovate, government and industry can do the same or industry and academia. The choice of who to innovate with, rather than the question of whether to open innovate or not, can help mitigate the risks of open innovation (Javernpaa & Wernick, 2011).

The benefits of a slow growing industry such as aquaculture in South Africa can only benefit a select few industry players, if at all, so there exists an incentive for the players to engage in open innovation. By collaborating through the pooling different types of scarce resources such as skilled labour and practical knowledge, the sector can benefit from the sharing of old insights and the creation of new knowledge. This type of collaboration, if practiced over time with clear deliverables, can maintain growth and sustain a continuous stream of benefits over time (Tidd, Bessant & Pavitt, 2009).

Innovation was introduced earlier as a tool by which the sector can be grown, followed by a review of open innovation which proposed a collaborative approach within the sector towards

innovation that will lead to the growth of the aquaculture sector in South Africa. This was followed by a review of theory of innovation diffusion to understand how innovations spread and diffuse. The next and last section of the literature review will focus on models that propose alternative methods of collaborative innovation given the risks posed by the practice of open innovation.

2.4. Institutional social networks of innovation

2.4.1. Introduction and evolution

Innovation as an area of study can be traced back to the Great Depression following revolutionary work by Joseph Schumpeter when he attempted to understand the biology of and reasoning behind business cycles. Schumpeter (1939) confirmed that "creative destruction" lies at the center of economic, industry and business cycles. He argued that innovation leads to an economic boom while lack thereof, or the dying of an old innovation, may lead to an economic bust (Hira, 2013). This observation links to the propositions of "Mode 1 innovation" which states that an economic upturn may begin with an entrepreneur noticing a gap in the market and forging forward to capture this opportunity with an innovation, be it process- or product-related, shaking up the industry as a result and resulting in an economic upturn when the innovation is diffused (Schumpeter, 1939).

The weakness of Mode 1 innovation is that an entire industry, especially if it is a large sector, is unlikely to be shaken up by a single entrepreneur or that such instances may be too few and too far between. This observation was made by Schumpeter himself, leading to Mode 2 innovation which asserted that the ability of large firms to engage in long-term research and development projects limits the ability of a single entrepreneurial individual to shake up the industry in question (Gibbons, Limoges, Nowotny, Swartzman, Scott & Trow, 1994). The common weakness shown by these two schools of thought is that they do not incorporate government into any of their proposed innovation processes. Considering a scenario where the role of government is to govern, exactly where must governance focus on – the single entrepreneur as proposed by Mode 1 or the sector in its entirety as proposed by Mode 2 (Hira, 2013)?

Among many other insights, endogenous growth theory includes alpha or technological change to the economic growth factors of labour, land and capital (Romer, 1994). However, endogenous growth propositions are unable to inform government of how to spark the initial

innovation that has led to recent economic upturns or how to help initial innovators with catching up if and when they fall behind (Hira, 2013). When firms create innovation that leads to organisational growth, it is important that innovation be kept continuous to avoid a decline of the firm and ultimately the industry and the entire economy (Hira, 2013). The continuous availability of brand new innovations which are ripe for diffusion plays a role as well in the continued growth of a firm and in the avoidance of the dreaded "comfort zone" that leads to monopolistic rents (Hira, 2013). The Laissez-Faire approach to the management of the national economy vilifies government by proposing that market dynamics have the potential to remedy any economic ills that a country experiences (Wiig & Kolstad, 2011). On the other hand, the government of the United States of America played a significant role in the creation of breakthrough technologies such as cellular phones, genetic medicines, Global Positioning Systems (GPS) and the internet (Hari, 2013). This shows that although government intervention is not always welcomed by proponents of laissez-faire, such interventions as shown afore can yield positive results insofar as innovation and its subsequent diffusion is concerned. Perhaps this acknowledgement of the importance of government in innovation processes of a nation is what led to the emergence of the national innovation systems approach.

The national innovation system brought to an end the debate that both Mode 1 and Mode 2 are important by not only accepting this fact but also focusing instead on the importance of institutions playing equal roles in the process of learning in the economy, which leads to innovation-led economic growth (Johnson, 1992). Lundvall (2010) asserted that two factors are needed in order for this type of economic growth to materialise: the usual transactions between institutions and, most importantly, the continuous relationships between these parties that are based on trust, loyalty and power. The progression of an economy towards a knowledge-based one tended to de-emphasise the role of a single entrepreneur (Mode 1) and highlighted instead the need for the existence of a system that involves the cooperation of academia or university (research), policy (government) and production (industry) (Hari, 2013). This point of view changed the role of innovation from a focus on one entrepreneur to a more holistic view of innovation that focused on the wider economy (Lundvall, 2010). Whereas the focus of Mode 1 innovation was on the entrepreneur and Mode 2 on the larger industry, the national innovation system approach extended the traditional governmental roles of planning or direction to include the responsibility of leading innovation processes (Nelson, 1993). The national system of innovation approach was widely accepted back in the 1990s. The case of Finland and its application of the propositions made by the national system of innovation to guide its

telecommunications entity, Nokia, is but one of the instances of the success of the model or theory (Hari, 2013). The national innovation system birthed a myriad of innovation systems each varied in its scale and scope: some of these spin-offs focused on regions while some focused on specific industries or sectors (Hira, 2013).

2.5. The national innovation system

2.5.1. The basic anatomy of the national innovation system

The national innovation system was conceptualised as "the means by which a country seeks to create, acquire, diffuse and put into practice new knowledge that will help that country and its people achieve their individual and collective goals" (Manzini, 2012). This theory proposes that the firm will take the position of power in leading innovation in an industry (Lundvall, 1988). The concept of learning as an enabler of innovation (Hamel, 2006) is central to national innovation system theory due to its focus on the generation, diffusion and adaptation of new knowledge through a network of interrelated institutions (Manzini, 2012). The additional objectives of the national innovation system are the importation and modification of new technologies while creating information that enhances the economic functioning of the nation (Lundvall, 1992), as well as to determine the innovative performance of national firms through the interaction of the network of organisations that comprise the national innovation system (Nelson & Rosenberg, 1993). Lastly, the national innovation system exists to facilitate the creation, storage and transfer of knowledge and skills which collectively define and shape new technologies (Manzini, 2012). The three crucial themes upon which the national innovation system is conceived are (1) a variety of institutions from the public- and the private sectors, (2) interactions and (3) technological learning (Manzini, 2012). In an attempt to determine the productivity of the institutional innovation network, the researcher appreciated the need to understand the current structure of the South African aquaculture national innovation system by examining its active participants, the interactions between these participants and any technological learning that may has resulted as a result of these interactions. The national innovation system is important to the economic health of countries (Lundvall, 2012) and it is stated that the concept characterises the collaborative efforts of a country towards the fostering of technological innovation (Manzini, 2012). Identifying the degree to which government, academia and industry determine the national innovation system and basing relevant innovation policies on it is important if development is to be successful (Bartels, Voss, Lederer & Bachtrog, 2012).

2.5.2. Arguments against the national innovation system

The existence of a framework that aims to strengthen the innovative capabilities of nations should surely result in the enthusiastic uptake and implementation of its propositions. Indeed, this is supported by earlier utterings about the difficulty of securing a one-size-fits-all innovation model that delivers success in every context, every time. Why is it then that some countries such as China are better at embracing innovation while others seemingly lag behind (Global Innovation Index, 2015)? The argument against the national innovation system theory is that it is a product of the developed world and its applicability within the context of developing or emerging economies is limited (Arocena & Sutz, 2000). The concept was arguably based on empirical evidence, the relevance of which was limited to the time period and the context within which it was conceived (Arocena & Sutz, 2000). The result is a prescriptive theoretic base that gives limited due consideration to differentials that may exist within and between nations insofar as the complexity and sophistication of national systems are concerned. This means that a country or economy that wishes to pursue a national innovation system-based strategy will need to gather sufficient empirical data on which to base it and from which to build a customised approach in order for the methodology to be relevantly useful (Manzini, 2012).

2.5.3. Conclusion

The issue of who should play the leading role in innovation between government, academia and industry continues to evolve (Etzkowitz & Leydesdorff, 2000). Indeed, it would be interesting to witness which of the prevailing three scenarios are in practice within the aquaculture sector – the government in its capacity to create and enforce legislation, industry in its role of a commercialisation agent or academia with its mandate of supplying human resources.

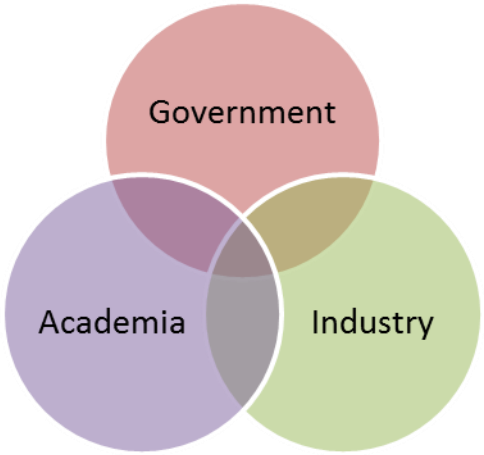
2.6. The triple helix model

2.6.1. Introduction

Etzkowitz & Leydesdorff (2000) proposed that major sources of potential innovation exist when each institutional sphere takes on the role of the other institutional sphere. This is the argument brought to the fore by the THM model, and it is made up of three basic elements: (1) a more prominent innovation role for the university given the rise of the knowledge economy; (2) a move towards more collaborative relationships among the three institutional spheres of government, academia and industry and; (3) the adoption of the roles of the other institutional

spheres, in addition to the discharge of own traditional roles, resulting in an overlap of roles amongst the otherwise independent institutional spheres (Figure 3).

Figure 3: The triple helix model



2.6.2. Evolution of theory

The question of which of the three institutional spheres should lead the innovation within the triple helix system that the spheres collectively belong to has changed over time (Sabato, 1975; Lundvall, 1988; Etzkowitz, 1995). This transformation started with the government being identified as the lead innovator as proposed by the triangle method (Sabato, 1975) to industry being proposed as the leader of innovation initiatives in the theory of national innovation system (Lundvall, 1988) to the pressure of innovation leadership being directed at academia given the increasing importance of knowledge within an economy as suggested by sub-arguments contained in the THM (Etzkowitz, 1995). This transformation process of the schools of thought has similar characteristics to the transformation process of the THM itself from its original idea of innovation leadership and power being centralised to the government (Triple Helix I) to a laissez-faire proposition requesting government to weaken this role (Triple Helix II) to the contemporary model that suggests the equal distribution of power between the three institutional spheres while at the same time challenging academia to play a more prominent role in collaboration efforts between the spheres (Etzkowitz, 1995; Etzkowitz & Leydesdorff, 1997; Etzkowitz & Leydesdorff, 2000). The outcome of the evolution is an innovation system that has changed from a rigid model that discouraged innovation to one that is fertile for the realisation of the ultimate rewards of a well-functioning triple helix system: university-led spin-off companies,

strategic alliances of firms and initiatives for knowledge-based economic development by the triad (Etzkowitz & Leydesdorff, 2000).

2.6.3. The roles of the institutional spheres

THM makes recommendations about the specific, so called "traditional", roles of the three institutional spheres. Government should facilitate contractual relationships and exchanges through policy, which somewhat supports the earlier structure of THM which suggested a more "hands-off approach" (Hira, 2013). In addition to this facilitation, government is requested to intervene only when the sector is incapable of providing the activities that are in demand (Etzkowitz, 2008).

Industry also has a part to play in the modern triple helix system. The traditional role of industry is to be the sectoral engine of production (Hira, 2013), a sentiment that links to innovation theory that stated that industry takes on the function of commercialisation of an innovation within an innovation value chain. Industry is no longer only linked competitively to other firms but is transformed into a triple helix institutional sphere that is linked to government and to academia through relationships (Etzkowitz & Leydesdorff, 2000).

Perhaps the most pronounced recommendation of the THM is arguably the higher expectations that are placed on academia. The traditional role of academia is a producer and disseminator of knowledge (Halilem, 2010). External pressures stemming from the emergence of the knowledge economy has reshaped and extended the role of academia from a firmly academic stance of knowledge production and distribution, to an entrepreneurial role (Landry, Amara & Saihi, 2005). The declining availability of research funds, along with increasing competition for this resource, is another trend that is driving the need for academia to take on an entrepreneurial role (Etzkowitz & Brisolla, 1999). In order to attain financial freedom, academia is required to willingly and ably collaborate with other organisations (Landry, Traore & Godin, 1996) including government and industry, especially given the view of the entrepreneurial academia as being key to the innovation of technology (Halilem, 2010). It can be argued that academia and its role within the triple helix is the most prominent one out of the two institutional spheres of government and industry, and this "third mission" is discussed later in this chapter.

The triple helix also dilutes the explicit boxing of the activities of the three institutional spheres during their continued interactions: research is not limited to academia and neither is policy to

government nor production to industry (Hira, 2013). The industry is no longer competitively linked to other firms through market competition but is turned into a triple helix institutional sphere that is linked to academia and to government through relationships (Etzkowitz & Leydesdorff, 2000). The triple helix can therefore be applied to different contexts, including regional and sectoral levels (Hira, 2013).

2.6.4. The "third mission"

There was a stage during the evolution of the triple helix where consensus existed about the three meta-actors, government-industry-university, influencing each other equally without acknowledgment of one actor prevailing over another (Leydesdorff & Myer, 2006). The triple helix has since moved away from the view that the triad is equally responsible for innovation stimulation to an argument that, of the three meta-actors of the triple helix model, the university should rise to the occasion as the master-actor of the model in its capacity to: (1) conduct research and reveal opportunities for innovation, and (2) teach and produce highly qualified personnel and entrepreneurs who will transform knowledge into a useable format which in turn presents another opportunity for innovation (Halilem, 2010). The pressure on the university to strengthen its role in the industry innovation processes is as a result of the emerging knowledge economy against the background of this meta-actor as a producer and disseminator of knowledge (Cooke, 2005). The decline in the availability of public research funding has also focused the spotlight increasingly on the university and created its entrepreneur-focused role, leading to the emergence of the "entrepreneurial university" and its greater responsibility in technology innovation (Halilem, 2010). The entrepreneurial university plays a central role in the theory of the triple helix, where the university proactively puts knowledge to use and creates new knowledge (Etzkowitz & Leydesdorff, 2000). As the universities create new links, they gain access to disparate pieces of intellectual property from a myriad of sources which can be exploited together to the benefit of the industry, region or nation (Halilem, 2010).

The THM calls on academia to play a third role of entrepreneurialism in addition to its traditional activities of research and teaching – a role that encompasses technology generation and transfer (Saad & Zawdie, 2011). It is proposed that the university should shift from its role of research and teaching to producing entrepreneurial talent where its students become firm founders and entrepreneurs who actively contribute to national economic growth (Ranga & Etzkowitz, 2013). Universities are, moreover, branching into educating organisations and not just individuals, and this is done through entrepreneurship, incubation and the delivery of new

training modules at venues such as science parks, incubators, venture capital firms and academic spin-offs (Hari, 2013; Ranga & Etzkowitz, 2013).

This “third mission” of the university is a viewpoint that has been slammed by Zawdie (2010) supported by the claim that this third additional role dilutes the more critical university role of being a contributor to critical thinking. While the THM asserts that universities should play a greater role in leading innovation projects given the increasing focus on the knowledge economy, this proposition is unlikely give positive results in emerging economies most of which have limited knowledge bases to begin with as compared to economies that are more advaned (Saad & Zawdie, 2011). The triple helix model should therefore be contextualized in these economies to rather focus the university on generation, application, adaptation and dissemination of knowledge in order to, in the long term, create opportunities for economic growth and social development sustainability (Zawdie, 2010). An additional concern raised against the proposition of the university as an industry innovation leader is that academia in emerging economies is often poorly integrated into the wider economy, weakening its impact therein insofar as institutional capacity building, networking, knowledge exchange and innovation is concerned (Saad & Zawdie, 2011). Considering South Africa as the context for this study, a close interrogation of the extent to the operationalisation of the “third mission” of the university in similar economies confirms would be an interesting point to observe given the arguments presented herein against the “third mission” of the university. The view of the university and its “third mission” as proposed by triple helix theory is yet to evolve in these economies and policy is needed in order to lead the operationalisation of this mission (Saad & Zawdie, 2011). The university is yet to be viewed as an active member of the economy and policy is required in order for alignment to be achieved between the university and national or regional development systems (Saad & Zawdie, 2011). Torres (2014) argues that the absence of technological and innovative efforts by a firm will weaken the firm’s propensity to establish links with institutions of higher learning. In other words, weak efforts with regard to innovation will result in no incentive from industry to partner with academia. The role of government in attempting to forge relations between academia and industry could be with regard to the role of factors relating to innovation and technology in explaining the links between academia and industry, and ensuring that any policy relating to increased collaboration takes these factors and roles into consideration (Zawdie, 2011).

2.6.5. Conclusion

The different advantages and disadvantages presented in the preceding section, the study promised to be interesting in that a determination of the extent to which the benefits and pitfalls of a triple helix system exist within the sector. For example, the study could evaluate:

- The nature and scope of active collaboration between two or more of the institutional spheres
- The extent to which academia is viewed as an active member of the economy, and to which academia is integrated into the sector
- The extent to which academia is integrated into the sector
- Whether or not the university has taken on the role of the "third mission" within the sector

By understanding the aforementioned points, it could then be determined if the perceived potential pitfalls of the THM have had a negative impact on the sector or not.

2.7. Literature review conclusion

The literature review highlighted some of the key opportunities that the South African aquaculture sector can benefit from by incorporating innovation into its mainstream business. The benefits of an innovation-led growing industry include larger revenues for government, market relevance and business sustainability for industry and, motivation to research as well as a new stream of research funding sources for academia.

The potential shortcomings of innovating alone, including lack of resources and problems of an inward-focus, paved the way for the consideration of innovation collaboration. In light of lack of resources, open innovation presented a way in which the pooling of resources for innovation could capture greater value for the group of collaborators than would the sum of the individual parts. Advantages that were highlighted included greater productivity for lower resources, a continuous stream of innovative ideas and the decentralisation of the task of innovation. The risks apparent in open innovation were also reviewed, with the most prominent of these being the risk of loss of control over intellectual capital to competitors that may form part of the group of collaborative innovators. This led to the need to explore the design of an innovation system with the aim of minimising this risk.

The THM theory provided an alternative method of innovating collaboratively by bringing together institutions that have vested interests in the growth of the sector but that do not share

the same motivations. It proposed the innovation collaboration of the three institutional spheres of government, academia and industry, all of which are driven by different motivators. Industry is motivated by the attractive returns on investment that are possible from investing in a growing industry. Academia is motivated by an industry that is willing and able to, as well as excited about, commercialising innovations that were researched and created by academia. Government is driven by the widening of its economic base by supporting the growth of industries so that these sectors can contribute to its fiscus. The ability of an industry to grow sustainably provides clear motivation for the three institutional spheres to work towards making this wish a reality. The THM theory also proposed the adoption of a role of greater prominence by the academia sphere, as well as the deliberate adoption and discharge of "roles of the other" between the institutional spheres. Institutional spheres that embrace the roles of the other spheres within a triple helix system are seen to hold great potential innovation.

The need of this study is augmented by the lack of information about the sector. New entrepreneurs with limited funding need access to reliable and cheap sources of information in order to make decisions about how to enter into a sector and what resources to acquire in order to do so. The study will also look at the propositions made by theory and match these to what is actually taking place in the sector in terms of what the theorists propose should be the case versus what is indeed the case. The study will determine whether the key attributes of the theory are as important to innovation wellbeing and activity as what the theorists claim to be the case.

3. CHAPTER THREE: RESEARCH QUESTIONS

3.1.Research Purpose

It is generally acknowledged that the building blocks of competitive advantage are science, technology and innovation (Polenakovik & Pinto, 2010). Competitiveness, economic growth and productivity are enhanced through the exploitation of science- and technology-based knowledge (Hafeez, Shariff & Lazim, 2012), and collaboration of the institutional spheres presents a major source of potential innovation (Etzkowitz, 1995). In order to ensure that mechanisms are in place at the national level to unlock innovation-based competitiveness, Hari (2013) proposes a properly designed and well-functioning triple helix system as one method of doing so. A triple helix system that functions optimally with each of the three institutional spheres being willing and open to perform the "role of the other" promotes mutual understanding as a result of the overlap and maximises collaboration within the spheres (Hari, 2013).

Aquaculture is viewed as a potential source of wealth and health for nations that embrace it (FAO, 2014). It could be set to secure its status as a mechanism with which to address chronic malnourishment and simultaneously contribute to the protection of global oceans (DAFF, 2015). Sub-Saharan Africa, with rising GDP and foreign direct investments (FDI), is the fastest growing region in the world after Asia (Urmson, 2012). The development of industries that match the growth rates of the region will further unleash the potential held by the region. Aquaculture is one such industry. However, the development of the sector requires the collaboration of the three institutional spheres so that the industry can achieve innovation-led growth. The disadvantages of the lack of innovation within the sector, such as market irrelevance and high production costs, will hamper progress in the industry in terms of production growth and employment generation (Gobble, 2012). There exist strong incentives for the institutional spheres to collaborate for innovation to the benefit of the sector as a whole.

The purpose of this study is to explore collaborative innovation activity by looking at the nature and structure of the South African aquaculture triple helix system. By understanding this structure, the study hopes to determine the readiness of the sector to not only meet the goals set for it by government (DAFF, 2015) but to also grow a sustainable aquaculture sector that is capable of diversifying the economy through the meaningful contribution by it to the GDP of the nation.

The objectives of the research are to (1) confirm the existence of a triple helix system in the sector; (2) identify the actual active parties from the institutional spheres that are actively developing the sector; (3) explore the nature of the interactions between the institutional spheres; (4) determine innovation productivity within the sector by looking at new innovations that have been produced by the sector and how these were produced (collaboratively or privately); (5) comment on the outcomes of collaborative innovation in the sector through a comparison of these against the propositions of the THM.

3.2.Research problem

The research problem is articulated as:

> *Given the goals of great contribution to GDP, production growth and generation of employment, and given its importance in Operation Phakisa, is collaborative innovation being incorporated in the South African aquaculture sector and are the three institutional spheres applying the elements of the THM and therefore enhancing their collective potential as a source of innovation that will generate growth and deliver on the goals set for the sector by government?*

3.3.Research questions

The research questions that cascade from the research problem are:

1. What is the current composition of the triple helix system in the sector?
2. Do collaborative relationships between the institutional spheres exist with innovation being the outcome of these interactions?
3. Does each of the three institutional spheres perform both its traditional roles as well as the traditional roles of the other institutional spheres?
4. Is the academia sphere performing its “third mission”, in other words, is academia entrepreneurial?
5. By comparing the aforementioned observations to THM propositions, is the current structure of the triple helix contributing to innovation that will ensure that the sector realises its goals of production growth and employment creation?

4. CHAPTER 4: RESEARCH METHODOLOGY

4.1.Introduction

At the top of good research are the characteristics of validity and reliability, and the quest for generalisability of research has led to the introduction of new challenges to the field of managerial research (Pettigrew, 1990). Various concerns directed specifically at qualitative managerial research, on which this study is based, are extracted from the aforementioned challenges including dissociative errors as a result of the convergence of the inability of qualitative research methods to disengage the researcher experiences from research analysis (Mills, 1959) and "transdisciplinary contamination" stemming from the unification of management studies to other disciplines (Tuchman, 1994). The emergence of high-tech tools that facilitates information production, distribution and acquisition, and the embracing thereof has led to contextual changes that have favored the emergence of new research methodologies and the hybridisation of old ones (Guercini, 2014). There has also been a pressing need to narrow the gap between theory and practice in managerial circles (Guercini, 2014). The emergent research methodologies are seemingly based on a combination of theoretical bases and they presented a strong undercurrent of the convergence, integration and hybridisation of traditional research theories and techniques and not so much the creation of brand new methods that question the relevance of old ones (Table 1):

Table 1: Emergent research methodologies

Research methodology	Theoretical base
Crowdsourcing	Grounded theory, Content analysis
Netnography	Listening, Participant observation
Sentiment analysis	Opinion mining, Text mining, Netnography
Hybrid textual analysis	Textual data analysis
Hybridization of netnography, personal interviews and participant observation	Netnography, Ethnography, Interview
Combination of Introspection and Observation	Guided introspection, Non-participant observation
Integration of digital ethnography and text mining	Netnography, Linguistic text, Mining techniques
Experiential testimonial research	Experiential learning, Autobiography, Auto-ethnography, Introspection

The passage of time plays an important role in all emerging theories in that such tools need to prove reliable and useful before they can be adopted widely by society in general and by academia in particular (Guercini, 2014). This reality is in itself a strong reflection of the theme of innovation which needs to follow the same process of adoption which occurs over time (Rogers, 1993). These emergent theories are also relatively new, and the lack lack in their standardisation is apparent as evidenced, for example, by the use of different terms to define a single approach such as netnography versus digital ethnography (Guercini, 2014).

The afore-listed new research methods are therefore acknowledged for their contribution towards the field of management research with simultaneous caution because they require further refinement in order for them to present a well-defined set of reliable propositions. It is with this acknowledgement in mind that the more traditional research methodologies are chosen as a foundation upon which this study will be based.

4.2.Design

4.2.1. Type of study

Saunders & Lewis (2012) asserted that research studies can be classified into three categories: exploratory, descriptive or causal studies. It is further argued that the choice of type of study depends on the ambiguity level of the problem in question, which lends itself to an idea that can be summarised as follows (Wiid & Diggines, 2009):

- Exploratory research is suitable for instances where phenomena exist but the problems behind them are unknown. An example would be the realisation that the customer attrition rate is increasing but the reasons for this observation are unknown.
- Descriptive research is best matched to situations where there is an awareness of the problem. For example, an understanding of the types of customers who would buy from a certain company versus those who buy competitor products.
- Causal research requires a clearly defined problem and an example would be questioning whether the addition of certain features to a product will result in the decline and the reversal of customer attrition.

Descriptive studies require an awareness of the problem that is creating the phenomenon (Wiid & Diggines, 2009), but the South African aquaculture industry reported a long list of often conflicting problems as to why growth was as disappointing as it was. A clearly defined problem is a pre-requisite for the employment of causal studies (Wiid & Diggines, 2009; Saunders & Lewis, 2012), making this type of study more inappropriate than a descriptive study given the aforementioned state of affairs in the South African aquaculture sector insofar as the absence of the problem linking to the phenomenon is concerned (FAO, 2014).

It is with this knowledge in mind that a choice was made for this research study to employ an exploratory study type. The phenomenon that was identified was that the aquaculture industry in South Africa was posting disappointingly low growth levels in comparison to those reported by the rest of the world, and that weak collaboration for innovation amongst the three helices was being blamed for this state of affairs (FAO, 2014). At the time of the study, there were no reports in existence that confirmed with authority that innovation was indeed to blame for the slow growth of the South African aquaculture sector (DAFF, 2014). This absence of authoritative confirmation led to the belief that perhaps the suggestion that lack of innovation collaboration between the three institutional spheres was behind sluggish aquaculture sectorial growth may have been nothing more than an untested claim. It could therefore be said that although the phenomenon of slow growth could be clearly seen and measured, the actual problem behind this occurrence was unknown.

4.2.2. Research philosophy

The assumptions and beliefs that a researcher holds about life in general affect the manner with which he or she approaches a research study, including but not limited to the research philosophy and the research strategy of his or her choice (Guercini, 2014). The research philosophy that one chooses contains important elements that illustrate the way in which the researcher views the world around him or her and although one research philosophy is not necessarily superior to another, it is important in any case to identify a research philosophy adopted for a study so that the researcher can have a conscious appreciation of the influence that the chosen philosophy will have on the study in question (Saunders & Lewis, 2012). Research scholars classify the types of research philosophies into four distinct categories: positivism, realism, idealism, interpretivism and pragmatism (Saunders & Lewis, 2012; Guercini, 2014).

The researcher believes that the role of research is to advance the knowledge of humankind towards the betterment of the lives and wellbeing of human beings, especially those at the so called base of the pyramid. The focus of any research study, the author further argues, should be on answering pertinent issues as represented by the research objectives and questions and less so on debates around which tools and methodologies will be best able to conduct the research study itself. It was against an understanding of this philosophical position that pragmatism was chosen as the research philosophy on which this research study was to be based. Unlike positivism which focuses on the creation of results that are highly replicable with the ultimate goal of the generation of "law-like" rules, pragmatism was chosen for its focus on the achievement of the research objectives and not so much the duplicable abilities of the outcomes of the research (Saunders & Lewis, 2012). Much like positivism, realism and idealism are approaches that are typically applied in scientific fields such as natural and physical sciences, whereas this research study focuses on the field of economic and management sciences (Wiid & Diggines, 2009).

In order to defend the choice of research philosophy, it is worth mentioning that the South African aquaculture industry is considered to be in its infant stages of sectorial development (FAO, 2014; DAFF, 2015). This stage is characterised by lack of industry information as the sector itself has not been in commercial existence for a long enough period to have gathered concrete industry information (DAFF, 2015). A special case that emerged is that of major policy switches which led to the change of aquaculture policy management from the Department of Environmental Affairs and Tourism (DEAT) to the DAFF (DEAT, 2015). This change saw the realisation of the importance of collecting and storing regular industry information (DAFF, 2015). Although efforts have been strengthened, the absence of policy that prescribe information disclosure by aquaculture farmers have slowed progress of information gathering (DAFF, 2015). Information asymmetries exist between farmers, and the DAFF is only able to collect information that the farmers have available and this negatively affects the richness, reliability and standardisation of information provided by farmers (DAFF, 2015). The small size and the emergent status of the aquaculture industry in South Africa, supplemented by findings of initial desktop research on the industry, led to the realisation that the industry comprises a small number of players each with disparate views, experiences and knowledge bases (FAO, 2014; DAFF, 2015). During these early stages of data collection, it was also found that the industry is unhealthily competitive and protectionist – behavior that discourages disclosure of production statistics which in turn hampers the collation of accurate industry information (DAFF, 2015)

which is needed by investors and entrepreneurs who wish to participate in the sector. This may result in the hampering of investment into the sector as investors are unlikely to enter into a market for which the profile is unknown (Drury, 2013). This also makes tracking difficult in terms of production movement and employment creation statistics (DAFF, 2015). It was also found that this state of affairs if further complicated by the existence of a number of small-scale farmers who engage in subsistence farming. These farmers produce just enough to self-sustain and their operations are typically unrecorded, which adds to the challenge of the accuracy of industry information. Although pockets of industry information are available, the pragmatist approach was employed with greater focus and emphasis placed on collating good-quality data as opposed to arguing for or against a strictly singular method to answer the research question (Saunders & Lewis, 2012). The choice of pragmatism is therefore strengthened by this reality, supported by the understanding that the research study will be guided by what is possible both from an information availability perspective and from the protectionist sentiment expressed by farmers that the author is likely to encounter in the sector during the data collection phase.

4.2.3. Research approach

It is important for any research project to link to some or other theoretical base (Chipp, 2015; Saunders & Lewis, 2012) to allow the scholar to further develop the theory in different ways such as testing it within a different setting or refining it based on the findings at the end of the research exercise (Saunders & Lewis, 2012). The testing of the proposition of a theory can be done in one of two ways: inductively or deductively (Guercini, 2014).

The theoretical base for this research project was chosen at the beginning of the study. The decision to do so was based on the importance of identifying those pockets of theory at the outset of the study that were the topic of conversation within business and academic circles (Chipp, 2014), hence the choice made to study innovation - given its prominence in the business agenda - through the triple helix framework given its eminence in the academic fraternity (Etzkowitz, 1995; Halilem, 2010; Hira, 2013). By choosing relevant theory at the beginning of the research study, the author chose deduction as a research approach for this specific research study (Saunders & Lewis, 2012).

A deductive research approach involves the clarification of a theoretical base at the beginning of the research study (Saunders & Lewis). This research study followed the choice of deduction as a research approach with the design of a research strategy whose goal was to test the

propositions of the triple helix framework within the context of the South African aquaculture sector, simultaneously seeking to understand the embracing of or detraction from innovation by the institutional actors within the industry. By determining the extent to which the propositions of the triple helix are in effect within the South African aquaculture sector, observations can then be made about the growth prospects of the industry as a whole given the health of its triple helix system and ultimately its innovation management sentiments.

The research approach of induction involves the generation of general theories following observations made during the data collection phase (Saunders & Lewis, 2012). Induction was considered at the proposal stage of the research process but was rejected in favor of the deductive approach based on the focus of the latter on the discipline associated with identifying a theoretical base on which base a research study. This level of discipline was found to be comforting given the weak experience that the author had in terms of academic research as well as the consistent message given by research lecturers of the importance of engaging in research studies that appeal to both business and academia, and that are relevant to both societies at a point in time (Chipp, 2014; Saunders & Lewis, 2012).

Deduction is helpful in identifying well-conversed theories that can be used to build a research study that will actively contribute to conversational continuity. The choice of the inductive approach links to the value that the researcher placed on contributing to a body of knowledge that was already in existence. This will provide continuation to an already vibrant conversation about innovation and the triple helix system, allowing the two interlinked topics to continue their respective evolutionary processes in the business and the academic spaces (Chipp, 2014).

4.2.4. Research strategy

The research study employed a qualitative exploratory design. Qualitative research is a process of collecting, analysing and interpreting data that cannot be quantified or expressed in numerical format (Wiid & Diggines, 2009). This type of research is best suited for cases where a detailed understanding of a problem and its resultant phenomena is sought, as is the case with the goal of this research study which is to gain insights into the possible impact of innovation on the sluggish growth of the aquaculture sector in South Africa. Qualitative research achieves this level of depth through detailed accounts given by respondents using the different qualitative research tools such as in-depth interviews, focus groups and projective techniques (Guercini, 2014, Wiid & Diggines, 2009).

The characteristics of qualitative research reverberate with the chosen research approach and philosophy. Qualitative research includes as its advantages the ability to gain an understanding of observed phenomena as it allows the use of probing as a technique of surfacing insights from respondents (Wiid & Diggines, 2009). In-depth interviewing was selected as a research strategy to be used as the author wanted to exploit the qualitative research traits of high levels of detail using a small sample size (Saunders & Lewis, 2012).

High levels of detail through the use of small samples are typical of qualitative research studies (Wiid & Diggines, 2009). A small sample is what is likely to be available given the fragmented and small size of the aquaculture industry in South Africa (DAFF, 2015), a fact that is linked to the pragmatist philosophical position that this research study has taken (Saunders & Lewis, 2012). In contrast to descriptive and causal research purposes which call for the use of a quantitative study, qualitative research resonates with the exploratory purpose of this research study (Wiid & Diggines, 2009).

Qualitative research is not without its limitations. In this case, the most prominent limitations are the inability of qualitative studies to replicate results and the stronger role played by interpretative bias on the part of the researcher. Replication is not important as the purpose of this study is to explore an observed phenomenon. To avoid researcher misinterpretation and bias, the reliability techniques of triangulation and sample diversity (Wiid & Diggines, 2009) were incorporated into the research design.

4.3.Population and sampling

4.3.1. Overview of the population

The purpose of this research study is to explore the nature and structure of the triple helix system in the South African aquaculture sector and determine if its current form is conducive for innovation to thrive. The triple helix theoretical framework asserts that innovation is enhanced at national or sectorial level when favorable cooperative linkages exist between government, industry and academia (Rodrigues & Melo, 2012). The population and unit of study was any institution or organisation with experience and insights gained from operating in the South African aquaculture sector representing any one of the three institutional spheres.

Desktop research conducted as a first step in the data collection phase suggested that an overview of the total population for this research study, classified according to each of the three helices, is presented in Table 2.

Table 2: Overview of the population

Helix 1: Government	Helix 2: Industry	Helix 3: Academia
Department of Agriculture, Forestry and Fisheries (DAFF) Department of Trade and Industry (dti) Department of Science and Technology (DST) Department of Environmental Affairs and Tourism (DEAT) Department of Public Works (DPW) Department of Rural Development and Land Affairs (DLA)	**Industry associations** • Aquaculture Association of Southern Africa (AASA) **Commercial farmers:** • Marine aquaculture – 34 • Freshwater aquaculture - 195 **Subsistence farmers:** • Undisclosed	**Universities:** • Stellenbosch University (SUN) • Rhodes University • University of Limpopo • University of Pretoria **Research agencies:** • Agriculture Research Council (ARC) • The Water Commission • Human Sciences Research Council (HSRC)
Quantity: 6	Quantity (disclosed): 230	Quantity: 8

4.3.2. Sampling methodology and sample size

The pragmatist research philosophy is guided by what is possible during a research study (Saunders & Lewis, 2012) and the aquaculture sector is an industry in its early stages of development which is characterised by lack of robust industry information (DAFF, 2015). Judgement sampling and snowball sampling techniques were used to choose samples. Judgement sampling is a non-probability sampling method where sample elements are chosen based on the researcher's judgment about the capability of the sample units to achieve the objectives of the research study (Wiid & Diggines, 2009), while snowball sampling involves a

technique where sample units refer the researcher to the acquaintances who can provide insights into the study. The use of judgement and snowball sampling, both of which are non-probability sampling techniques, will therefore allow the researcher to choose sampling units that have a well-developed sense of the operations within the otherwise small and relatively specialist aquaculture industry with focus remaining firmly on the objectives of the research study.

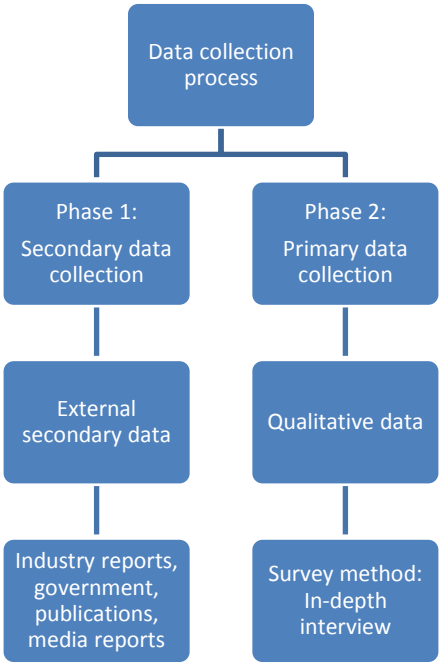
It became apparent during the early parts of the study that there was a trend within the sector of investing in aquaculture in other sub-Saharan countries. Qualitative studies are said to embrace outliers (Chipp, 2014) so a decision was made to include in the sample at least two sample units who have worked in the South African aquaculture sector in the last two years and who subsequently decided to invest in the same industry but elsewhere in sub-Saharan Africa. It was believed that the traits that motivated this action would share some light as to the inhibitors of the growth of the sector. Another reason for this decision was that an external view of an experienced aquaculturist versus the view of the same individual in a different national context would improvement areas for the sector.

Ten respondents, including two respondents who made the decision to leave the South African aquaculture sector and invest instead in the Lesotho aquaculture sector, were chosen from each one of the three institutional spheres and interviewed. Each interview took approximately an hour to be conducted.

4.4.Data collection

The data collection phase of the research study comprised the two distinct sequential sub-phases of primary data collection and secondary data collection (Figure 8).

Figure 4: Data collection overview



4.4.1. Secondary data collection

Secondary data is data that is already in existence and that was collected in the past for purposes other than the objectives of the current study (Wiid & Diggines, 2009). It was important that the research study undertook secondary data collection to gain insights into the aquaculture industry as the author had no experience at the time with the trends within this sector. Additional arguments for the collection of secondary data ahead of the primary data collection process are that secondary data is cheaper to collect and requires less effort than primary data collection, and it enriches the primary data collection phase while also providing comparative data that can be used to analyse primary data and refine the interview schedule (Wiid & Diggines, 2009). The sources of secondary data that were used were industry reports obtained from the FAO and the DAFF, government publications, and media reports from specialist agriculture and aquaculture publishers such as Farmer's Weekly magazine.

4.4.2. Primary data collection process

In contrast to secondary data, Saunders & Lewis (2012) define primary data as data that is collected to satisfy the objectives of a specific research project that is being undertaken.

Primary data can be broadly categorised into survey, documentary and multiple source (Wiid & Diggines, 2009).

This particular research study took the form of an ad-hoc or "once-off" survey where the data was collected through interviews with the sample units that were profiled before using a questionnaire as the primary and sole research instrument in the primary data collection phase. A questionnaire is a research instrument that contains a set of open-ended questions to be posed to survey respondents with the aim of answering the objectives of a research project (Wiid & Diggines, 2009). The choice to use open-ended interviews was based on the fact that the study is qualitative in nature and open-ended questions allow opportunities for further probing to take place so that the richness of information is surfaced (Saunders & Lewis, 2012).

The consent form (Appedix A), the notification of the requirement to record the session for transcription purposes (Appendix B), and the questionnaire (Appendix C) were sent out approximately a week before the day of the interview to give the participants enough time to conduct preparatory research so that high-quality data could be provided. This action was also taken to put the minds of the respondents as ease keeping in mind the potentially protectionist sentiment that some of the respondents may feel the need to uphold as indicated by the results of the secondary research phase. Since the desired sample units were based at geographically diverse locations, the in-depth interviews were facilitated via teleconference or in person. Each session began with an introductory greeting, the positioning of the study, the outline of the impact of the contribution of the participant to the study and a reminder that the session will be recorded. Semi-structured questions as outlined in the questionnaire were posed to each participant and probing techniques were used to solicit additional information from the participants based on their responses. Each session ended with a note of thanks and the reiteration of guarantee of anonymity to the participants. The recorded audio session was immediately uploaded to the cloud for secure storage for later transcription and analysis.

4.4.3. Response rates

Thirteen potential respondents were approached with requests for interviews. Agreements to be interviewed were received from 10 respondents, giving a response rate of 76%. Ten transcripts were analysed. The sample size given is an accurate representation of the respondents that were eventually interviewed: 20% of the respondents represented Government, 20% represented Academia and 60% represented Industry. One of the

advantages of using the in-depth interview method was that the author could ensure that all questions included in the questionnaire was answered, lessening the need to exclude incomplete questionnaires (Wiid & Diggines, 2009).

4.4.4. Data preparation

Data preparation is a process of reducing raw data obtained during the data collection process, which was done through in-depth interviews in this case, into a format that will accommodate data analysis (Wiid & Diggines, 2009). Following the in-depth interview data collection process, the auditory data needed to be transformed into textual data that could be used for analysis. Transcription of the audiotaped data was chosen as a pre-analysis data preparation tool.

Although generally-accepted guidelines for transcribing audiotaped data do not exist, there was an appreciation of possible delays and negative effects to the analysis process of inappropriately prepared transcripts (MacQueen & Milstein, 1999). Attempts to incorporate simple guidelines into the transcription process were made and the decision was made to use the following guidelines to base the transcription exercise on (McClennan, MacQueen & Neidig, 2003):

- The morphologic naturalness of the transcription was preserved
- The naturalness of the transcript structure was preserved
- The transcription was an accurate reproduction of the audiotaped material
- The transcribed material could be understood by third parties
- The transcription rules were kept simple, with the prevailing rule being that the text document should be an exact replica of the taped files

The transcription process was completed as soon as possible after each interview. The transcription exercise presented to the researcher the opportunity to refine her questions as the data collection phase progressed so that sharper probing could take place. The author was also worried about the specialist nature of the aquaculture sector. A transcriber with limited knowledge of the different basic concepts of aquaculture might transcribe the wrong information, negatively affecting the quality of the transcripts by creating a gap between what was said in the interview and what was actually transcribed. Further advantages of personal transcription that the researcher benefited from during the process are the ability to think through how the different elements relate to each other and the capability of engaging in the very first stages of basic data analysis.

4.4.5. Data analysis

The transcriptions produced during the data preparation stage were used as inputs into the data analysis phase of the research study (Wiid & Diggines, 2009). Data analysis was conducted using Atlas.ti as a qualitative data analysis software tool. The choice of Atlas.ti was based on the strong recommendation of the research lecturer that taught the author, and was revered for its ease of use and its friendly, effective graphic user interface (Chipp, 2015). The data analysis process using Atlas.ti employed the following steps:

- A new hermeneutic project was created and saved
- The transcriptions were added as documents to analyse in this project
- Codes were created using the theory reviewed in Chapter 2 as a basis. This reflects the deductive approach incorporated by the study that necessitated the identification of theory-based codes before analysis could be done (Saunders & Lewis, 2012) as opposed to extracting theory during the analysis process. Therefore, the functionality of creating free codes was used in this step.
- Each one of the ten transcriptions was reviewed in fine detail to determine linkages of the events recorded to the prescriptions of the triple helix model.
- Quotations found in the transcriptions were linked to the earlier-created codes.
- Once the creation of codes and the linkages of codes to quotations were completed, the codes were grouped according to the four broad sections of the theoretical bases chosen: innovation, diffusion of innovations and the triple helix model.
- A process of mapping and linking codes was undertaken to understand how each related to the other, both as explicitly proposed by theory and otherwise. This included the creation of code co-occurrences to further refine how the respondents linked the codes together.
- The analysis process continued iteratively until the author was confident of her understanding of the events that were taking place in the industry. These results are presented and discussed in finer detail in Chapter Five and Chapter Six.

4.4.6. Research limitations

A qualitative study was chosen to conduct the research and this was done through the use of interviews. Respondent and researcher biases may affect the results. The researcher held predominantly positive thoughts about the sector as well as a lack of interview skills. This

awareness led to the researcher choosing respondents that held different sentiments about the sector so that both the positive and the negative views could be considers. An online short course on interviewing skills was also taken to supplement the lack of interviewing skills held by the researcher.

The small sample size, which is a characteristic of the study type chosen, also presents the limitation in terms of generalisability of the study (Saunders & Lewis, 2012). Care was taken to ensure to attempt mitigating this by choosing respondents who are stakeholders in all three of the institutional spheres. At least two respondents from different organisations that fall within the same institutional sphere were interviewed.

5. CHAPTER 5: PRESENTATION OF RESULTS

5.1 Introduction

Interviews were conducted with ten respondents. At least two respondents were interviewed from each of the three institutional spheres but from two different organisations representing the particular sphere. Each interview lasted approximately one hour.

5.2 The role of literature

The triple helix model is encapsulated into three basic themes: (1) increasingly collaborative relationships between the three institutional spheres of government, industry and academia or university, (2) the adoption by each one of the three institutional spheres of the roles that were traditionally performed by the other institutional spheres, resulting in each sphere performing the so-called “non-traditional roles”, and (3) a call for academia or university to embrace a more prominent role in innovation driven by the increasing importance of knowledge and the rise of the knowledge economy (Etzkowitz & Leydesdorff, 2000; Lundberg, 2013). The interview schedule and the questions contained therein were designed to determine the nature and structure of the triple helix system in the South African aquaculture sector. Content analysis was conducted on the data obtained from the interviews, followed by comparative analysis the observations from the triple helix system as it exists in the sector to the proposals prescribed the theory presented in Chapter 2.

5.3 Demographics

The three institutional spheres that are identified by the triple helix framework are government, academia or university and industry (Etzkowitz, 2012). The sample was therefore chosen to reflect this proposition. At least two representatives from two different organisations representing the three institutional spheres were interviewed. This was done to ensure a balanced view of each of the spheres, reducing the type of bias that would result from interviewing a sample of one representing a helix.

The respondents had experience working in the aquaculture sector for at least a year. The respondents had collective experience of 108, 5 years in the South African aquaculture sector. Initial interviews indicated that the South African aquaculture industry has no growth prospects, and that those interested in working in the sector should look for opportunities elsewhere in the African continent where conditions are favorable. This led to a decision by the author to include

in the sample two sample units that have worked in the South African aquaculture sector but opted to invest their skills and experience in a different country in sub-Saharan Africa. The sample therefore includes two sample units that were based in South Africa and that have worked in the sector for at least two years, but that eventually decided to work in the same sector in a different sub-Saharan African country. Therefore, eight respondents in the sample were based in South Africa and the remaining two in Lesotho (Table 3). Desktop research also revealed that the sector is classified into fish farming in the ocean (marine aquaculture) and fish farming inland (freshwater aquaculture). (DAFF, 2015). The sample included respondents with knowledge of and experience with both fish farming methods, and this was done to ensure fair representation of the sector classifications.

Table 3: Demographic overview of sample

Meta-actor	Count	Years' experience in SA aquaculture industry	Base country
Government (G)	1	5	South Africa
	1	7	South Africa
Total Government	2	12	1
Academia or university (AU)	1	29	South Africa
	1	16	South Africa
Total academia or university	2	45	1
Industry (I)	1	33	South Africa
	1	2	South Africa
	1	1.5	South Africa
	1	5	South Africa
	1	4	Lesotho
	1	3	Lesotho
Total industry	6	48.5	2
Grand total	**10**	**105.5**	**3**

5.4 Analysis of results

5.4.1 Industry overview

Question: Provide an overview of the current state of the South African aquaculture sector.

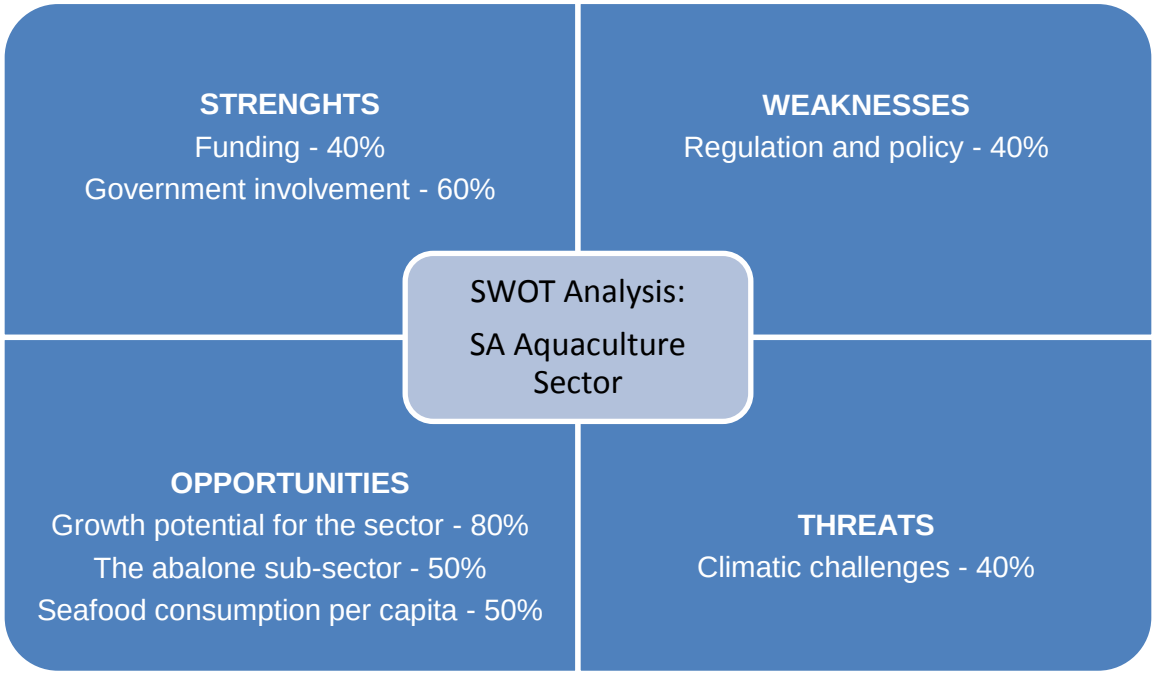
The aim of this question was to gather information from the respondents about the industry. In addition to that, the question sought to determine sentiments held by the institutional spheres about the state of the sector. The answers to the question also allowed the researcher to focus and probe on specific questions highlighted by the representatives of the institutional spheres, which enriched the depth of the interviews by allowing for probing into specific phenomena with a certain respondent on the comments made in earlier interviews about specific topics relating to a specific institutional sphere.

Interviewees were encouraged to speak openly and freely about sentiments held about the sector. As can be naturally expected, the responds representing the three helices made mostly positive remarks about their respective helix. For example, the academia helix felt that it provided robust skills and training, while the industry helix commented strongly about the lack of support given to the “farmers on the ground”.

All the distinct comments and expressions were recorded and listed, and various tools were explored as to how to succinctly present a simple overview of the sector. A decision was taken to present the sector using a SWOT analysis tool. The SWOT analysis or SWOT matrix was used based on its ability to translate observations about an entity into an evaluation of the Strengths, Weaknesses, Opportunities and Strengths of the entity (Drury, 2013). The tool also allowed for the synthesis of the data and observations into information that not only made sense but also allowed for suggestions to flow from the information at a later stage insofar as the development of the sector was concerned.

After recording observations and sentiments shared by the respondents, a list was generated and developed. The observations themselves did not communicate pertinent information about the status of the industry – they merely represented data and feelings. Observations made and sentiments shared by at least 40% of the respondents were extracted and synthesized into a SWOT analysis as presented in Figure 5. The exact percentage of respondents who verbalised each of the factors included in the SWOT is also included.

Figure 5: SWOT analysis - SA aquaculture sector



The strongest theme that came from the delivery of an overview about the sector was growth potential. Most of the respondents felt that the South African aquaculture sector had the potential for growth. This sentiment was a positive one for the study as it meant that further research could be undertaken about how, given confirmation that the respondents held a positive outlook for the sector, the three institutional spheres were interacting to make way for sectoral growth. Verbatim expressions from the respondents about the growth potential of the sector included:

> *"So there is enormous, enormous potential (for freshwater aquaculture in South Africa) but we have not scratched the surface yet".*

> *"I think the South African aquaculture sector holds significant potential".*

> *"I think that the sector is growing, definitely".*

> *"I don't know of any tilapia farmer as I speak with you now that cannot sell their product profitably".*

"There is definite demand".

"We have aspirations from 2014 to 2019 to increase production from near 5000 tons to 20 000 tons by 2019".

"I don't think that aquaculture has fully lived up to expectation".

"There are opportunities. I just don't think that we as an industry should expect them to be put on the table. You have to go and look for them".

Government involvement was the second strongest theme that emerged from the overview given about the sector, with 60% of the respondents referring to it. The sentiments shared about the involvement of government were mixed. Some respondents felt that the increasing role that government was taking was a positive thing, while others linked government to the slow growth of the sector. The fact that government was one of the first parties to be identified as players within the industry could be seen as a positive thing as at least the role of government was already present in the minds of the respondents. Some of the comments made by the respondents about government were as follows:

"You almost get the sense that the Government of South Africa has got this new toy that they have available but they don't really know how to handle it themselves".

"Government is trying to cater to everyone and keep everyone happy….I don't think that the government strategy will see an equitable split between freshwater and marine aquaculture. The split with government is not reflective of the potential"

"I really think that what is happening this time in terms of Government trying to create a platform and industry trying to utilise that is a positive thing".

An interesting dynamic that was referred to in the study when the respondents gave their respective accounts of the overview of the sector was the abalone sub-sector. The South African aquaculture sector is split into sub-sectors based on the species that is farmed. For example, the industry consists of the tilapia sector, the oyster sector, the seaweed sector and so on. The abalone sub-sector is one of these sub-sectors. The abalone sub-sector was alluded

to by half of the respondents in their overviews. The sentiments shared and the observations made were positive, and it almost felt as if those farming the other species looked in awe at the abalone sub-sectors. It felt as if the abalone sub-sector was seen as the poster child of success in an industry that is perceived to be a difficult one to succeed in. The abalone sub-sector contributes the most revenues out of the sector as a whole, with estimates stating that up to 70% of sector revenues are generated by the abalone sub-sector. Some respondents spoke highly of the successes of the sector, while some – particularly those who farm alternative species – seemingly attempted to dilute the successes achieved by the sector:

> *"The abalone industry created a single biggest and most important industry in terms of profitable and successful industry, sustaining its own growth and even competing globally in that market".*

> *"We are the third producing abalone country in the world".*

> *"In terms of the biggest contributor (to the South African aquaculture sector), it is abalone with R529 million".*

> *"It (abalone) is a very expensive commodity – I think it goes for around R350.00 per kilogram".*

> *"…Abalone represented about 76.1% of the entire (South African aquaculture) industry"*

> *"He (the consultant" showed them the abalone people, the mussels and the prawns. The politicians got very excited".*

> *"I mean, the abalone and the trout sectors are both good indicators – they have grown incredibly well over the last five or six years".*

> *"You may or may not know this but abalone can only grow in South Africa and not anywhere else in the world".*

> *"So, the abalone guys have competitive advantage that cannot be easily erased".*

The second theme that was spoken about by 50% of the respondents related to seafood consumption in South Africa. The emotional standpoint taken, and the observations made, about seafood consumption varied. Some farmers felt that the reason why aquaculture in South Africa has not grown is due to the fact that South Africans are not a traditionally fish-eating nation. Others agreed to this statement, but mentioned that foreigners who came from the northern parts of the African continent are high consumers of fish. These respondents added that South Africans may not eat fish in high volumes; but that the foreigners living in South Africa eat fish in large quantities and that they present an opportunity for new markets in the country.

> *"In South Africa, you have chicken and you have hake so the market is not very vacant. Whereas in Zambia, everyone eats tilapia".*

> *"The consumption of seafood plays a big role. Seafood consumption (in South Africa) fell from 7.1% in 2007 to 5.7% in 2011".*

> *"People there (in countries north of South Africa) earn nominal wages but they still pay for the fish".*

Climatic challenges were alluded to by 40% of the respondents. The respondents confirmed that the climate in South Africa was conducive or not based on the species in question. The climate was described as too hot in the summer for cold-water fish such as trout, and too cold in the winter for tropical and warm-water fish such as tilapia. The challenge that this raised was that the farming of certain species was cyclical unless farmers used temperature-control technology to regulate water temperatures during times when the weather was unfavorable. This was listed as a threat because climate cannot be controlled at will, so it is a threat because it cannot be manipulated – its impact, not the climate itself, can be managed.

> *"I think that we have actually been handicapped by two things: major climatic and environmental conditions"*

> *"I would say that aquaculture has underperformed due to environmental constraints and challenges"*

> *"South Africa is predominantly a semi-arid country that is cold".*

Funding within the sector was mentioned by 40% of the respondents. Respondents were in general agreement that funding for the sector was available. The concern was not so much the availability of funding, but the processes and the utilisation of the funding that is available.

The last strong theme that emerged from the overview given by the respondents related to regulation. Each and every one of the 40% of the respondents agreed that the absence of appropriate regulation for aquaculture, especially freshwater aquaculture, was an impediment to the growth of the sector. Legislation that was in place at the time was based on marine aquaculture. When freshwater emerged, with its own nuances, no policy was created to address the specific challenges faced by it. Instead, the mandate of managing aquaculture was centralised to a single department but the regulation and policies were standardised to those that were traditionally designed for marine aquaculture. The result has seemingly created a lot of frustration for the farmers operating in the freshwater section of the sector:

> *"So, the regulations are making growth quite difficult".*
>
> *"So, it is quite difficult for a start-up farmer to get going and farm. That makes it quite challenging to start up your own business as an aquaculture operation business but I think that there is huge potential".*
>
> *"What has also contributed to (the low growth of aquaculture in South Africa) is that the regulatory and statutory environment is not really conducive to entrepreneurship and innovation development".*
>
> *"They (government) are scared of being burnt by the industry so they would rather over-regulate the industry rather than under-regulate it".*
>
> *"Right now, it is difficult (for aquaculture in South Africa to grow" because of the lack of proper legislation".*

The less pronounced factors that were mentioned during the account of the sector were the fragmented structure of the industry, the need for clustering, species and genetics, the small size of the sector and low presence of large commercial farming operations in the sector.

5.4.2 Definition of roles

Question: What is the role or are the roles of your institution insofar as sectoral development is concerned?

The presence of the role as one of the three key themes of the triple helix system is highlighted by THM theory, and roles are classified into traditional roles and "the role of the other" (Etzkowitz, 2015). Each institutional sphere is assigned a set of traditional roles. This classification forms the basis on which judgment can be made about the extent to which an institutional sphere performs a role that is considered non-traditional for it. When an institutional sphere takes over the "role of the other" and results in the overlap of roles, therein exists greater potential for innovation within the triple helix (Lundberg, 2013; Etzkowitz & Leydesdorff, 2000). This overlap of roles enhances innovation

The purpose of this question was to understand the roles played the institutional spheres in the sector. Once the roles had been gathered and assigned to each institutional sphere, comparisons could then be made about the "roles of the other" that were being performed within the triple helix system. The understanding of the nature of the roles that were being discharged by the institutional spheres served an important objective of the study.

The roles of the institutional spheres were recorded verbatim into a list during the study. At total of fifteen roles were recorded. The top five roles that were being discharged, and which of the three helixes discharged them, are presented in Table 4. The five roles that were recorded as being the least performed by the triple helix as a collective are presented in Table 5.

Table 4: Highest-ranked roles

Roles	Frequency %	Government	Academia	Industry
Collaboration with government	70	√	√	√
Research and development	70	√	√	√
Infrastructure development	70	√	X	√
Advisory services	60	√	√	√
Production	60	X	√	√
Private ownership	60	X	√	√

It is comforting to see that the role that is performed the most across the institutional spheres is linked to the element of collaboration, which is one of three as proposed by the THM theory. The content of these collaborations vary from solicitation of funds from government to attempts at shaping legislation and policy. 70% of respondents across all the institutional spheres confirmed to honoring this role.

> *"We cooperate with departments of state…for the promotion and conduct of research, technology development and technology transfer".*

> *"The Department of Trade and Industry has actually been a partner for quite some time in terms of aquaculture development".*

> *"Our department is not the lead department (in aquaculture). We, through current investments, are charting the legal procedure that you have to follow in order to get aquaculture running…"*

> *"I am part of the ADEP programme….the Department of Trade and Industry is throwing money at a farmer but there is zero coordination".*

What would be of interest is the extent to which collaboration is taking place with the remaining two institutional spheres and, most importantly, the extent to which all three institutional spheres collaborate together towards innovation.

The role of research and development also emerged as highly subscribed, with 70% of the respondents across the three institutional spheres confirming to performing this task. There was a sense of exasperation from the academia sphere where one of the respondents expressed that there was no point in researching a sector that was not growing. Frustration was the prevailing sentiment from the industry sphere with regards to the need to conduct research and development when the role that industry should be playing is predominantly production. The government sphere seemed to embrace the task of research and development as part of the process of encouraging a fledgling industry.

> *"Our research team got involved in aquaculture research trying to build something where we can map technology on the value chain literally from start to end – to the consumer,*

to be able to contribute in removing obstacles and being innovative on the value chain. Then we realised at that point as to what is the point of putting out research and postgraduate degrees if the sector is not growing".

"The Department of Science and Technology and its role in aquaculture was never defined by policy. To some extent, it (our role) was to pick certain technology out of the choices that existed and only support those".

"We realised that the success and the growth of the sector to its full potential is not going to be automatic….There is also the issue of science and technology, or science and development, and we have a demonstration center. We have the Gariep technology demonstration center."

"I am doing it out of pure frustration. No one is doing the testing and the R & D which the industry the industry needs so I have taken it upon myself to do it because I am frustrated".

The fact all the institutional spheres are performing R & D, but the sense of frustration in the perception that it is a role that belongs to another sphere may affect the positive elements of innovation. For example, industry may be reluctant to share innovation results with academia because there may exist the feeling that academia was incapable hence the intervention by industry. That may lead to one sphere performing R & D on areas that the other sphere was already in the advanced stages of developing, wasting time and resources that would otherwise have been saved if there was coordination within the triple helix system in terms of the role of R & D.

Infrastructure development was confirmed to be a task performed by 70% of the respondents. The only difference between this role and the previous two was that only the government and the industry institutional spheres discharged these roles. By infrastructure development, the respondents meant the development and building of own farms as well as basic infrastructure such as water, heating and security systems. Government viewed infrastructure development as identifying areas that can be developed for aquaculture, installing water services, building roads into and out of these areas, and providing electricity so that the private farmers did not have to do this level of infrastructure themselves. The industry seemed comfortable with the

idea of infrastructure development on their privately owned farms. It appeared that the role that the farmers discharged was in the form of customising private infrastructure by extending it from what was already made available by the government sphere. For example, a farmer would install his own heating system that is powered by an electricity supply that is already made available by the government sphere in the area where the farm is based. The government sphere appeared to accepted infrastructure development as its core responsibility, and the industry sphere did not express any discontent about the type of infrastructure development that it had to do in order for operations to run optimally on a farm.

> *"Our farm is fully integrated. We have been doing this for about eighteen months and we have been doing this to prove to ourselves that we can run this farm, year-round, by heating the water so that we can have fish for sale on a weekly basis".*

> *"The government, working with sister departments, now will mobilise resources to put basic infrastructure – access to road, access to water, energy and electricity".*

Offering advisory services to the sector is a task that was confirmed as being performed by 60% of the respondents. This links to comments made by one of the respondents from Lesotho who decided to invest his resources away from the South African aquaculture sector to an aquaculture sector in another country in sub-Saharan Africa. The responded mentioned that one of the reasons behind his decision to leave the country was that the aquaculture sector in South Africa was focused on academic education and not enough practical farming. In other words, the industry was filled with professionals who possessed theoretical knowledge but not enough practical experience. Advisory services are being provided nonetheless across the three helices.

> *"We utilise the technological expertise in out possession and make it generally available".*

> *"We have normal advisory services where we get ideas on a daily basis. They work on those ideas and need advice. So those are the services that we also render".*

"I think that South Africans are already driving a lot of aquaculture projects into Africa already. The key is experience – practical experience – coupled with technological and technical knowledge. I think that this can only work for South Africa".

"I think that there is a disconnect between South African academic institutions and the industry. The guys come out with a Master's degree and they know everything so they become consultants but none of them have physically farmed a kilogram of fish in their entire lives".

This perceived movement of qualified aquaculturists towards advisory services is perhaps driven by the types of services that are demanded by the sector at any given time. The question that would have added depth to this observation would be to find out if the advisory services actually translate into value for the farmers who are the main drivers of production and growth. The utterances made by one of the respondents above regarding the need for practical, technological and technical knowledge may point to the fact that perhaps technological knowledge on its own in the absence of practical experience to determine how much of the technical knowledge works in real life may add more value to the production side of aquaculture.

Production and the private ownership of companies were the last two roles that were cited as being performed by 60% of the respondents. Naturally, the industry sphere saw this role as probably the reason for the existence of industry to begin with. One of the academia sphere respondents embraced production as a role expected of the modern university. What was interesting was the reaction of the industry sphere to the fact that the academia sphere is engaging in entrepreneurial activities within the sector. This is to be discussed in finer detail in Chapter Six. The government sphere confirmed to making a conscious decision to remove itself from the role of private ownership and production as this was not viewed as the role of government and out of fear of alienating the industry sphere by engaging in activities that would introduce conflicts of interest into the sector.

"My needs of my farm is that I need to generate around R100 000.00 per month to sustain the lifestyle that I have".

"We started this farm 18 months ago and we have doing this to prove to ourselves that we can run this farm, year-round, by heating the water so that we can have fish for sale on a weekly basis".

"The farm was a Recirculating Aquaculture System facility for farming trout where we worked on farming, producing and supply of fish throughout the year".

"We also offer mentorship or what you call incubation but there must also be an exit because government is not in the business of growing fish, otherwise it will be conflict of interest".

"I have been doing fish farming for two years and I am thinking that I will only invoice in February 2016".

"We were able to breed another 30 000 or 20 000 fingerlings from that because we had enough females to do that".

Table 5: Least ranked roles

Roles	Frequency %	Government	Academia	Industry
Development of transferable technology	20	√	X	X
Innovation stimulation and support	20	√	√	X
Perform the role of a venture capitalist	10	√	X	X
Perform the role of a public entrepreneur	10	√	X	X
Create awareness about the sector	10	√	X	X

A deliberate decision was taken to look at the lowest that were cited the least as being performed by the institutional spheres. This was done out of concern that there may be roles that are highlighted as important in THM theory that may be fall into this group of roles. Table 5 presents the five lowest-performed roles as confirmed by the respondents, and it seems that the concern mentioned above was justified.

Out of the five least-performed roles, 80% of them or four out of the five roles are core to the proposals of the THM theory. The academia sphere is the only sphere that engages in the development of transferable technology, which is perhaps linked to this role being viewed

traditionally as one “belonging” to the academia sphere. What is even more disheartening is the role of innovation stimulation and support, which is only performed by 20% of the respondents and by only the two out of the three institutional spheres. Innovation stimulation and support did not mean that innovation was not performed at all, but it meant that steps were being taken to encourage and support it within the sector.

It would be beneficial for the industry to have more entities providing venture capital, but the scope of this study is limited only to this role being the “role of the other” to be performed by the government sphere. The fact that this is indeed the case is comforting. As for the role of the public entrepreneur, this one can only be performed by government in its sole capacity as the public office so concern over its low rate of performance is unjustified.

Lastly, 40% of the respondents claimed involvement in knowledge transfer and market development. A third of the participants named fund solicitation, investor engagement, provisioning of testing facilities, networking, collaboration with NGOs and empowerment as roles that were being performed. However, 14 out of the 31 roles identified were performed by less than a third of the ten respondents interviewed.

5.4.3 Responsibility of sectoral development

Question: What institutions are tasked with the development of the South African aquaculture industry?

Government, academia and industry are the key players in any given triple helix system (Etzkowitz, 2015). Before one can expect collaboration of between these institutional spheres, it is important to gauge the knowledge that each sphere has about the existence of the other spheres. Logically, one cannot expect actors to collaborate with one another if they are do not know of each other and therein lies the importance of this research question – before collaboration can be determined, are the three institutional spheres aware of the existence of the other and the roles played by each has in the development of the sector?

During the interviews, each respondent was asked to identify institutions within the sector that are tasked with the development of the sector. This question had a dual purpose: (1) to gauge the level of knowledge that each of the respondents had about the other institutional spheres and (2) to see if the respondents viewed themselves as responsible for the development of the sector. All respondents interviewed were somehow tasked with the development of the sector:

the industry respondents for production; the academia respondents for knowledge transfer and; the government sphere for facilitation of contractual exchanges. All the respondents, except for the two respondents from Lesotho, should identify themselves as playing a role in the development of the sector. The results are presented in Table 6.

Table 6: Knowledge of the other helices

Institutions identified	G1	G2	AU1	AU2	I1	I2	I3	I4	I5	I6	Total
ARC			√	√		√					3
Ourselves	√		√	√	√	√	√	√			
SUN		√	√								2
Council for Scientific and Industrial Research	√										1
The private sector	√		√	√	√	√		√		√	7
DTI	√		√	√							3
DAFF	√	√	√	√	√		√	√	√	√	9
DST		√	√	√							3
DEA	√				√		√	√	√	√	6
Provincial government			√	√			√		√		4
Department of Rural Development and Land Reform	√										1
Rhodes University		√		√	√	√		√		√	6
University of Pretoria					√						1
University of Limpopo				√	√						2
University of Kwazulu-Natal				√							1
Department of Public Works	√										1
United Nations Food and Agriculture Organisation	√	√									2
National Regulator for Compulsory Specifications	√										1

It is not surprising that the DAFF was cited by 90% of the respondents. Being the lead government department responsible for the sector, this result is congruent with the earlier confirmation made by the respondents that most of the collaboration taking place within the sector was with government. Although specific organisations were identified as requested by

the question and since this study focuses on the institutional spheres as a whole, the additional insight of whether all three institutional spheres were identified by the respondents would indicate an existing understanding by the sector that each of the three institutional spheres have a role to play in the development of the sector. Table 7 gives this overview as summarised from Table 6.

Table 7: Cross-identification of institutional spheres

	Identified government?	Identified academia?	Identified industry?
Government	√	X	√
Academia	√	√	√
Industry	√	√	√

The results from Table 6 communicate that the academia and the industry spheres identify all three institutional spheres as having a role to play in the development of the sector. Surprisingly, the government sphere only identified the two spheres of government and industry as playing a developmental role in the sector. It must be said that a third of the industry sphere respondents made strong comments against the absent role of academia in the development of the sector. It must be appreciated that although most of the industry appreciated the role that the academia sphere played in the sector, that this sentiment was not shared by all respondents. Some shared feelings of contempt over the capability of some of the parties that are operating in the sector, indicating perhaps towards relationships that are less than favorable between the entities in question which may or may not affect collaborative efforts depending on how the entities contract with each other.

"The University of Limpopo in freshwater aquaculture and again they are working on the freshwater aquaculture for about 30 years and you ask what is the outcome of that thing".

"So it is currently Stellenbosch University, Rhodes University and Limpopo University. The ARC from an engineering point of view had an aquaculture unit before that does not exist anymore".

"The universities have all played a part and continue to do so in varying success".

"I am afraid to say this but I have not had any dealings with the universities at all".

"The DAFF alone cannot really do justice to what has to be done".

"The DTI has actually has actually been a partner for quite some time in terms of aquaculture development".

"The DST and its role in aquaculture were never defined by policy. The role stretches quite far, about 10 years back, and in the making".

"The industry has organised itself as the Aquaculture Association of Southern Africa. They are recognized because I think it makes business better for any interested party whether you are a regulator or an investor to deal with an organised industry".

"I have absolutely no idea of any university (involvement) and it is not for a lack of not knowing".

"I am not sure that I can learn anything from the universities".

The institutions that were cited the least by 10% of the respondents included governments with minor related but minor mandates in the sector and government-owned regulators. It is worrying to see that these organisations included two universities. This concern is due to the fact that the THM theory suggests a heightened role to be played by academia, and this observation seems to suggest otherwise.

5.4.4 State of innovation

Question A: Would you define the South African aquaculture sector as innovative?

Innovation policy is the desired outcome of interactions between government, industry and academia as opposed to it being a prescription from government (Etzkowitz & Leydesdorff, 2000). The question was asked to gauge innovation activity by looking at the types and quantities of new ideas that were produced by the sector. Innovation was defined as new ideas that were produced by the sector that benefit a specific sub-sector or the sector in its entirety. Innovation can be produced across many levels, from micro-level by an entrepreneur as proposed by Mode 1 innovation (Hira, 2013) to sector- or even macro-level as proposed by the THM theory (Etzkowit, 1995). Had it been found that no triple helix systems existed in the

sector, then a sense of innovation activity in the absence of the system could still be used to gauge innovation activity within the sector.

Table 8: Sentiments about innovation

Is the sector innovative?	G1	G2	AU1	AU2	I1	I2	I3	I4	I5	I6	Total
Yes	√	√	√	√	√		√	√	√	√	**9**
No											**0**
Not sure						√					**1**

90% of the respondents agreed that the sector could be defined as innovative. The element of frustration as earlier expressed with regards to the role of R & D was also detected by a respondent when answering this question. This time, the respondent indicated that the R & D operations that the academia sphere should have on its premises should look like the ones that the respondent had on his farm.

Some of the comments made in support of this claim were as follows:

"It (the South African aquaculture sector) is innovation friendly especially for the guys who are already established because there comes a time when people are fighting to break even so they do not have an appetite to experiment much".

"My sense is that there are people that have been in the system as innovators for a long time".

"Everything that I am currently doing on my farm is R & D, and my farm currently looks like what a farm at University of Stellenbosch or at Rhodes University should look like".

"Yes. I think 'innovative' in that the part of it that is operating successfully and commercially has had to be innovative because we don't locally have an industry that supports aquaculture".

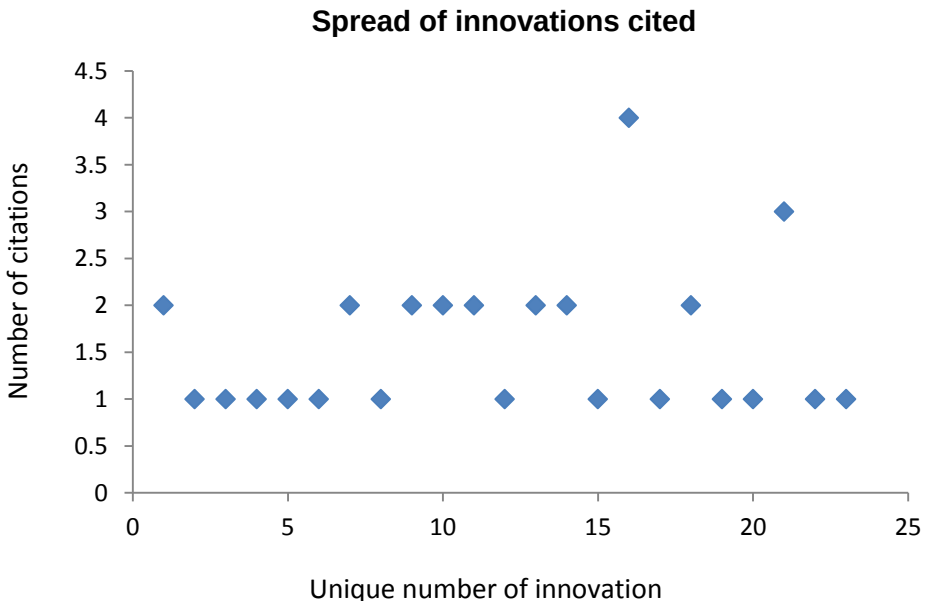
"This is innovation that is currently being tested and I think that the sector is open to innovation".

Question B: What new ideas are you aware of that were conceptualised by the South African aquaculture industry that have been successfully commercialised to the benefit of the industry as a whole?

Question A was a closed ended question. To support any confirmation of the existence of innovation, a follow-up question in the form of Question B was incorporated to gain deeper insights of the knowledge that the respondents had on any new and innovative ideas developed and incorporated within the sector. The study sought to understand if innovation was equally spread across the sector or if it occurred in certain pockets in certain sub-sectors such as the tilapia sub-sector or the oyster sub-sector.

The list of ideas and innovations were requested and recorded. Since the basic enquiry was to determine the quantity and spread of the innovations, the list was compiled to determine the spread of ideas. Each idea was given a unique number. This unique number was plotted on the X-axis of a graph, and with the corresponding count of the number of times that the idea was cited by different respondents was plotted on the Y-axis. The outcome of this exercise is graphically presented in Figure 6.

Figure 6: Spread of innovations



A total of 23 different innovations were presented by the respondents. Only one idea was identified by 30% of the respondents, and 30% of the ideas were known by a fifth of the respondents, while a staggering 65% of the remaining ideas were known to only 10% of the respondents. This shows a wide spread of knowledge about an equally long list of innovations

within the industry. Below are comments made during interviews in support of the observations graphed in Figure 6.

"So on my farm I have an aquaponics system with about 5000 plants. This is a business opportunity…but this system is very complex to run".

"The guys in abalone farming have this thing…what do they call it…they call it abalone ranching".

"In Hermanus, they have set up machines to harness energy created by the crashing waves and they have set up turbines to generate electricity out of the flow of the water. I would regard that as innovative".

"Besides the pool pump and the fly larvae feed innovations, we have attempted to get new perspectives on feed".

"We had a new project called abalone ranching which is a new process of trying to produce abalone in the sea".

Question C: How does the South African aquaculture sector generally manage innovation?

The theme of collaboration as outlined in the THM theory is the background against which this question was posed (Etzkowitz, 2015). Open innovation and THM theory both emphasise collaboration as an important golden thread in the achievement of the benefits of a decentralized approach to innovation (Chesbrough, 2003; Hari, 2013). This question was asked to gain greater insights into how each of the three institutional spheres felt about their roles relating to the task of R & D. Commentary was highlighted then about the perceived feelings of frustration that were expressed by the industry sphere in particular. The industry sphere seemed to hold the strong belief that the R & D function should be discharged by the academia sphere. Since this was not perceived by the industry sphere as being the case, this sphere seemed to have decided to take on the role out of frustration from the perception that the academia sphere was not doing what it was meant to do. The result of this feeling of being coerced to perform the "role of the other", especially in the generation of new innovation, could possibly manifest in the reluctance to share this information with the other institutional spheres.

This question about the management of innovation was asked to investigate further the possible consequence to the sector as a whole stemming from this feeling of being forced to perform the "role of the other". The results are presented in Table 8.

Table 9: General management of innovation

Answer	%
Openly	20
Protectively	60
Not sure	20
Total	**100**

It was found that 60% of the respondents believed that the sector had adopted a protectionist attitude towards innovation, with only 20% of the respondents adopting an "open door" policy and being inviting of other people to come and see own innovations in operation on own farms.

Respondents were encouraged to share their feelings about the management of innovation based on how they perceived it to be managed and, to give reasons why innovation was being managed in a particular manner. One respondent made it clear that he was not qualified to judge what other farmers were doing, opting instead to emphasise the importance of working together. One of the respondents who expressed incredible frustration over the performance of the R & D task based on the belief that it should be discharged by the academia sphere confirmed that the sector was protective of innovation. He expressed disbelief over this stance on innovation management, and continued to state that the work done on the farm could not be duplicated so no feelings of potential loss of intellectual property were held by the respondent. Further to that, the respondent expressed the wish to transform the farm into a training facility based on passion about the industry and the wish to play an instrumental role in the growth of the sector. The main reasons given for the protectionist approach to innovation management as adopted by the sector were concerns over the loss of intellectual property and fear that the return on investments made into R & D may be weakened should the R & D be shared before it can be used to capture and "lock in" market share.

"The most important thing is to start working together".

"We have platforms but we also respect the independence of the industry in terms of intellectual capital. So they are fully aware because of them have been at it for very long especially the pioneering guys so we respect that".

"Everybody is closed. I am probably the only one that says 'come and visit. You can take as many photos as you want…Why are people so protectionist?".

"We have an open door policy. We are not scared of people coming to see what we do".

"Protectionist. To answer the question 'how does the sector manage innovation', it is confidentially.

5.4.5 Collaboration

Is there collaboration within the sector between government, universities and the industry?

The triple helix model identifies collaboration as one of its three key central themes, identifying innovation policy as an outcome of these interactions instead of this policy being a prescription by the government sphere (Etzkowitz & Leydesdorff, 2000). The triple helix system is underpinned by the theme of collaboration, so it was crucial to gain perspectives from the representatives of the three spheres insofar as their perception of collaboration was concerned.

The majority of the respondents confirmed that collaboration was taking place in the sector. The results show that the majority of the respondents believed that collaboration between the three institutional spheres was absent. Only 30% of the respondents agreed that the three institutional spheres in the sector actively collaborated with one another. These respondents were from the government and academia spheres, and none of the industry sphere respondents believed that the triple helix system collaborated at all.

Table 10: Collaboration in the sector

Response	%
Yes, all three institutional spheres collaborate with each other	19
Yes, there is collaboration but not across all three institutions spheres	69
No, there is no collaboration in the sector at all	12
Total	**100**

Although the extent of collaboration seems to be clustered around interactions of only two of the three institutional spheres, it is encouraging to see the sector in active collaboration with each other although not in an ideal structure as proposed by THM theory. The observation made is that the ruling interaction setting within the sector involves exchanges between two institutional spheres instead of three. Instances of no collaboration are lower at 12% than instances of collaboration between all three the institutional spheres. What was unknown was the evolution of this observation over the years. It would be interesting to find out whether three-way collaboration has increased over the years or whether this system was being engulfed by preference for two-way collaboration.

Of the 69% instances of two-way collaboration that were given by the respondents, half of these are between the industry sphere and the government sphere. This is consistent with the two observations made earlier where respondents identified the involvement of government in the sector as a Strength as included in the SWOT analysis and, the collaboration with government as one of the strong roles that the respondents confirmed to performing. Results also showed that collaboration between certain institutional spheres occurred less than between others. Looking only at instances of two-way collaboration, it was found that the following twin sets of institutional spheres engaged in the least amount of collaboration as reported by the respondents:

- The government sphere and the academia sphere and;
- The academia sphere and the industry sphere

One will notice that the academia sphere appears in both cases. Given the task of prominence expected from this sphere, it is concerning that the presence of academia seems to have lesser presence in collaborative efforts within the sector instead of it having a stronger presence. The other set that that recorded low cases of collaboration was intergovernmental collaboration, but this would likely be the case since only the government sphere can comment on this and this sphere was only represented by 20% of the respondents interviewed. Intergovernmental collaboration, as opposed to three-way collaboration between the institutional spheres, is not highlighted as a critical component of the THM theory so its lesser impact as a result of low collaboration activity herein will not be discussed any further.

"Through Operation Phakisa, I see now that we are being pulled together – departments, universities, us and industry. I am attending a stakeholder meeting next week in East London".

"We have an aquaculture value chain roundtable, so we meet three times a year. We just had a meeting last week. This is co-chaired by the Department of Trade and Industry and the chairperson of the Aquaculture Association of Southern Africa".

"I have absolutely no idea of any university (involvement) and it is not for lack of not knowing".

"No, I am afraid not. Not at all. I have no more to say about that because there is no collaboration taking place at present".

"I am afraid to say this but I have not had any dealings with the universities at all".

"There is quite a long history of work and collaboration amongst these. There is an industry roundtable. Operation Phakisa was just an extension of an existing system that the Department of Agriculture, Forestry and Fisheries has started that brought industry and universities together".

"I think that the abalone sector is where there has been an example of success where each of the universities has found its respective place in the system".

"Certainly, we have a good working relationship with the University of Pretoria in Onderstepoort".

"(Government) has been largely absent at the national level".

"We have MOUs (memoranda of understanding) and also other collaborations in the spirit of cooperative governance with the Department of Trade and Industry".

5.4.6 Growth prospects of the sector

Question: The South African government has formulated bold growth goals for its aquaculture sector. Given the structure of the sector and the nature of innovation, is the industry primed to meet these goals in the stated timeframes?

Innovation theory identifies a positive relationship between entity growth and its level of innovation activity (Maier, Suarasan & Nicoara, 2012). The preceding section on the state of innovation showed that there existed a stream of innovation ideas within the sector. The question was asked to determine if the respondents felt that the current state of innovation and the management thereof was conducive to the growth and prosperity of the industry. In other words, the purpose of the question was to determine if the respondents viewed the current state of innovation and its management as possible to translate into growth in the sector.

Table 11: Sentiments on sectoral growth

Is the sector posed to meet its growth targets?	%
Yes	10
No	90
Not sure	0
Total	**100**

Earlier in Chapter Five, the respondents were asked to confirm if the sector was innovative. It is fascinating to see that while 90% of the respondents believed the sector to be innovative, the same percentage of respondents believed that the sector will not meet its growth targets in spite of innovation being widespread within the sector. Only one respondent, representing the industry sphere, expressed confidence that the sector would meet its growth targets. The rest of the respondents, representing the three institutional spheres, were pessimistic about the growth prospects of the sector. The following are some of the sentiments shared:

> *"No. I don't see it. I simply cannot see it".*

> *"From a tilapia perspective, yes I think that we can get to those goals but we must immediately add that DESPITE Operation Phakisa we will get to those growth goals…Operation Phakisa is involved in too much politics".*

"From a global perspective, aquaculture is promising. Using our existing technologies, aquaculture is not going to grow".

Given theoretical suggestions about a positive relationship between growth and level of innovation activity, the high number of innovation ideas communicated by the respondents in a preceding section should probably be viewed as a positive step towards growth by the respondents but that is seemingly not the case. Therefore, a level of disconnect may have existed with the respondents between the confirmed presence of innovation activity in the sector and the potential thereof to translate into sectoral growth. Another possibility was that the respondents believed that other factors, and not so much innovation, inhibited the growth prospects of the sector. In an effort to understand this, a request was made to the respondents to give factors that were inhibitors of the growth of the industry. A total of twelve growth inhibitors were identified and the top five inhibitors of sectoral growth are presented in Table 11.

Table 12: Inhibitors of growth

Top five inhibitors of sectoral growth	%
Cumbersome legislation	60
Lack of collaboration in the sector	30
Underestimation of the time it will take for the sector to grow	30
The underdevelopment of markets	20
Investment by the government sphere in slow-growth areas of the sector	20

The biggest inhibitor of growth in the aquaculture sector in South Africa was identified as cumbersome legislation that governed the industry. Cases were reported of legislation being overly regulative in processing pertaining to certain sections of the value chain, while other phases of the chain have no legislation at all where it is greatly needed. The respondents disapproved of the legislation that was in place at the time. As earlier indicated, legislation that is in place was originally designed for marine aquaculture only. When freshwater aquaculture emerged, some of the species that were best suited for this method of farming were not indigenous to the country. Current legislation did not permit non-indigenous species to be farmed. What had happened between the time the legislation was created and the present was that market preferences changed and certain species were seen as beneficial to food security in the country (DAFF, 2015) although the species were not indigenous. Some government departments have been responsive to these changes while others have not been. For example,

the DAFF governs over aquaculture as a whole and therefore promotes the farming of species that are in demand and whose production will therefore create growth within the sector. One of the species that is highly sought by the market, such as foreigners from across the continent living in South Africa, is the Nile tilapia. The industry sphere identified the farming of Nile tilapia as a good opportunity to maximise shareholder value and return on its investment. This sentiment is shared by the DAFF as driven by motivation to transform the sector into one that contributes to national income. The DEAT, on the other hand, is mandated with looking after the environment. The DEAT is therefore against the farming of the Nile tilapia because this practice threatens the integrity of the environment. This creates tension between the mandate of the DAFF and the DEAT, along with the motivation from the industry sphere to boost growth and create employment. The respondents feel that streamlined legislation that balances the two mandates while supporting the growth of the sector is desperately needed. Such policy will not only protect the environment, but provide farmers with a process to follow in order to be able to farm the Nile tilapia and therefore increase sectoral production.

Sentiments that were shared by the respondents include:

> *"Before you even start with license application, you need to get yourself an Environmental Impact Assessment but you need to know when you need one".*

> *"You cannot even show two departments together who have agreed to whether it is necessary to have an Environmental Impact Assessment done and, if so, when – which tonnes or ever?".*

> *"Whether the overall numbers are an overestimate, I am not sure in the longer term but certainly time-wise I think that implementation of Operation Phakisa relative to what they may have delivered in terms of jobs is already lagging".*

> *"I think that it will take longer than they (South African government) expect and a lot of money will be misappropriated or misspent on projects that might not even work".*

> *"The legislation is not quite in place so that means that there needs to be a lot of work done on that.*

A more detailed discussion on this finding will follow in Chapter Six, including a look at the role of policy or legislation as proposed by the THM theory. The triple helix theory appreciates the regulatory task of government, which it identifies as one of its traditional roles (Eitzkowitz, 2015).

5.4.7 Improvement of the sector

Question: What can each of the three spheres – government, industry and universities - do to improve the level of collaboration and innovation in the sector?

Lastly, the respondents were asked to give personal views on how the sector could be improved in order for it to become productive through collaboration of the three institutional spheres. Although it was unclear at the beginning of the study whether the respondents would express satisfaction about the sector as it currently was or not, it was unlikely that the respondents would not have areas of concern that would benefit from improvement given the slugging growth of the sector.

A total of 26 suggestions for improvement were given by the respondents. Using a rating scale of 50% and above, suggestions that were rated as important by 50% or more respondents was extracted from the list. The most rated improvement suggestions are presented in Table 12.

Table 13: Top rated areas of improvement

The most rated areas of improvement	%
Greater collaboration between the three institutional spheres in the sector	60
The creation of working models for aquaculture	50
The creation of a streamlined policy framework for the industry	50

The following are comments made by the respondents in support of the contents of Table 12.

> *"There needs to be coordination and working together".*

> *"Chickens have broilers. This is a working model that works for this particular function but the aquaculture does not have a working model".*

> *"I want to create a model for the farm as I did for the security company….This is what you need to build an industry".*

"There is no model that I as an interested fish farm can go and buy, learn from, plug into. There is no commercial freshwater fish farmers that I can work with".

"The pont that we looked at is that there is no model, working model. Like I said, there is beef which has a good model. It is a flying model that is working and we have many things like that in poultry".

"The most important thing, I think, is the model. It needs to be there. There needs to be a working model".

"I think we are getting to the point whereby the trust between the regulator and the regulated is now strong enough".

'Get together. Collaborate. Talk".

"Some of these protocols have been developed but you need forerunners. Whether these forerunners are prepared to share the knowledge is something else".

"Firstly, it would be legislation around the species that are allowed to be farmed. Government and the aquaculture industry need to be in agreement about exactly what is needed".

"We need a regulatory body".

"We need to move closer to the farmer on the ground. You've got a lot of obstacles to get over before you can start farming. Permitting legislation, this, than whatever else".

"The legislation is a positive thing and the Bill needs to be more focused on assisting the farmer on the ground. That is the departure point".

"South Africa has to focus more on breakthrough innovation as opposed to incremental innovation. We have to find the next big thing to make us competitive".

"You have got to fund the traditional research institutions but only if they create innovation engines".

"There is a need for a holistic approach and deliberate measures to improve. I think the industry is ready to work with us and take things further".

The results showed that collaboration was cited as the most popular intervention that the sector will benefit from the most. This is encouraging as it is in line with the propositions of the THM theory that states one of its basic elements as movement towards greater collaboration between the three institutional spheres. Although two-way collaboration was shown to be the collaboration structure that occurred the most within the sector, the aforementioned results show evidence that the respondents appreciate the importance of three-way collaboration for which the THM theory is a proponent (Etzkowitz, 1995).

The respondents placed importance on the availability of a working model in aquaculture. One of the respondents used the beef and the broiler sectors as examples of working models in animal husbandry that were created, implemented and improved upon continuously over time. The result of the availability of these models has resulted in the ability for any entrepreneur to use such models to produce a business plan and chart business success. Both these models were said to have made these two industries successful over the years. The working models have also benefited society. For example, the continuous improvement of the chicken broiler working model has reduced the cost of producing chicken which translated into chicken being cheaper for the consumer as commented earlier on by one of the respondents. The creation of a working model for the aquaculture sector requires the collaboration of a wide range of stakeholders. For example, environmental impact assessments would require input from government departments such as DEAT. The testing of the best species to farm given a certain environment would need to be done by the academia sphere in consultation with the industry sphere. The pilot testing of such innovations would need the involvement of the industry academia, with the support of the academia and the government sphere. One of the respondents told a story of how such a model could be developed and implemented:

"So the whole thing requires proper coordination. I have the whole system in my head and that is why I am so frustrated because I can visualise the whole thing. I am currently

developing a system that can be used to fish farm anywhere in the country - hot, cold, wet, dry, high, low - you must be able to farm fish anywhere. Those are the challenges that I am trying to resolve on my farm".

The importance of legislation in the sector was highlighted by the third most cited improvement suggestion given by the respondents. Lack of legislation was highlighted earlier as one of the key inhibitors of growth in the sector. It therefore comes as no surprise that the streamlining of legislation was identified as the second best intervention that is likely to benefit the sector. The THM theory seems to assume the existence of legislation or policy within a triple helix system, but a detailed overview of the role of policy or legislation in the triple helix will be provided in Chapter Six.

The lack of legislation was cited as the biggest culprit behind sluggish growth in the sector. Most of the respondents are welcoming of the Bill that was in circulation to legislate the aquaculture sector as a whole. Legislation was cited as the biggest culprit behind the lack of growth in the South African aquaculture sector. It was quite interesting to see that the second strongest reasons given for the lack of growth were lack of proactivity about innovation and the lack of facilities available to do experiential tests of what would undoubtedly be the outputs of innovation.

5.5 Conclusion

The qualitative research process produced a comprehensive set of results. An overview of the demographics of the respondents that were interviewed was given. This profile of respondents included at least one representative from an organisation that represented the three institutional spheres or helices of government, academia and industry. The presentation of results proceeded with a high-level look at the state of aquaculture as a whole using the SWOT analysis. The strongest theme that emerged from the analysis was the positive feelings that the respondents expressed about the growth potential of the sector. The study assumed that if positive sentiments were held about the prospects of the industry, then the respondents would also view it in their best interests to work towards ensuring that the sector became a success. The presentation of results continued with an investigation into the roles played by the three institutional spheres. Collaboration with government was the role that was cited the most by the institutional spheres, followed closely by the role of R & D. The least cited roles were venture capitalism, public entrepreneurship and the creation of awareness about the sector. When it

came to knowledge about the existence of other parties that formed part of the triple helix system in the South African aquaculture sector, the DAFF as a representative of the government sphere was mentioned the most. Academia was cited the least. It was encouraging to see that the majority of the industry considered the sector to be innovative. A wide range of different innovation ideas that were produced by the sector was given, with focus being on the fact that the ideas were widely spread with very few of them being mentioned repeatedly by the respondents. This was taken as evidence that innovation was alive and well in the sector. Given the possible fact that industry performed the R & D process begrudgingly due to the perception held that it was a role that industry felt should be performed by the academia sphere, the results showed that innovation was generally managed confidentially and privately within the sector and this in spite of aquaculture being widespread. The reasons for protectionism over innovation ideas were given as mentioned by the respondents. While the respondents identified many cases of collaboration in the sector, the results showed that most of these were two-way collaboration instances instead of three-way collaboration between government, academia and industry as proposed by the THM model. Three-way collaboration was present but was overshadowed by the higher incidents of two-way collaboration in the sector. While the respondents viewed the sector as one that is innovative and possessing of growth potential, these sentiments did not translate into optimism about the sector actually growing given the nature and structure of the industry in general and the triple helix system in particular. The respondents felt that improvements needed to be implemented in order for the industry to achieve its growth potential and meet its growth objectives. Although cumbersome legislation was given as the greatest inhibitor to growth, the need for greater collaboration was the highest rated suggestion for improving the sector. The need for working models in the sector and the need for a streamlined policy framework were the second highest rated improvement suggestions.

The qualitative research process produced a comprehensive set of results. Most of them could be directly linked to the initial theoretical base, while some interesting outliers emerged that generated a thought-provoking view of the South African aquaculture sector. The kaleidoscope of new and different themes that emerged from the presentation of the results offer a robust foundation on which to base what is likely to be a stimulating discussion of the state of the South African aquaculture triple helix format. Outlying and surprising themes will be incorporated which, along with the original theoretical themes, will paint a fascinating picture of the aquaculture sector and its unique emergence within the distinctive context of South Africa.

6. CHAPTER SIX: DISCUSSION OF THE RESULTS

6.1.Introduction

Chapter One introduced outlined the research background and introduced the research problem. Chapter Two provided a detailed review of the literature on innovation which provided a literature framework on which to base the study, followed by the presentation of refined research questions in Chapter Three. Chapter Four provided the research methodology followed by the study and Chapter Five presented the results of the data collection phase of the study.

The purpose of this chapter is to provide an analysis and interpretation using, as inputs, the outputs of Chapter Two and Chapter Five which were the literature review and the presentation of the results. This chapter will provide evidence that the research problem and the research purpose stated in Chapter One and the research questions outline in Chapter Three have been answered by the study.

Aquaculture is one of the fastest-growing food sectors in the world (FAO, 2014). This growth trend has not been duplicated in South Africa, and the result has been sluggish growth in the country as compared to high growth globally (DAFF, 2015). The sector needs to implement proper structures, policies and systems that are designed to support and enhance growth of the sector (Athmay, 2012). A well-designed triple helix system where the three institutional spheres pursued innovation through collaboration was identified as one such structure that could support and nurture the growth of the sector towards the achievement of its production growth and job creation goals (Operation Phakisa, 2014).

6.2.Discussion of results for Research Question 1

Question: What are the nature, make-up and scope of the triple helix system in the South African aquaculture sector?

Overview of the sector:

The first of three questions that were asked in order to answer Research Question 1 was:

Provide an overview of the current state of the South African aquaculture sector.

A snapshot of the sector as given by respondents is presented in SWOT-analysis format and is shown in Figure 5 in Chapter Five. The top rated themes that emerged from the accounts given of the overview of the sector were (1) the growth potential of the sector; (2) the involvement of government in the sector; (3) the successes gained by the abalone sub-sector; (4) the effect of seafood consumption in South Africa; (5) the availability of funding in the sector; (6) the climate in the country that was deemed to be unconducive to the farming of certain species and; (7) inappropriate regulation and policy that is currently being used to govern the sector. The SWOT-analysis was chosen for its ability to evaluate an entity, in this case the South African aquaculture sector, in a manner that allowed for the rapid synthesis of the general overview of the entity (Drury, 2013). Although this question was not driven by any propositions made by the theoretical bases that was reviewed in Chapter Two, it was important to understand the sentiments held by the different institutional spheres about the prospects of the industry. If the industry is viewed as one that is poised to grow, then investors in the industry sphere will be likely to participate in the industry in pursuit of solid returns on investments (Drury, 2013). Government stands to benefit from the tax revenues that will flow from the business activities taking place in the industry sphere (Miles, Scott & Breedon, 2012) and academia will be motivated to create information that is quickly taken up and used by the industry sphere (Halilem, 2010). The better the sentiment held about the prospects of the industry, the stronger the incentives for the three institutional spheres to perform towards the betterment of the sector.

The importance of obtaining an overview of the aquaculture sector is therefore founded on the notion that the three institutional spheres involved will have vested interests in an industry that is perceived to be growing.

The themes are now discussed in turn.

1. <u>The growth potential of the South African aquaculture sector</u>

   In Figure 5 in Chapter Five, the outcome of the research showed that the respondents had growth potential at the “top of mind” when asked to give an overview. This was shown by the high frequency rate of 80% with which growth potential was cited by the respondents. Growth potential was also the highest rated theme given by the respondents, and this theme was recognised by at least one respondent from each of the three institutional spheres. The respondents were positive about the prospects of the industry as evidenced in the positive comments given about this aspect, hence its classification in the SWOT analysis as a

Strength. It can therefore be concluded that efforts directed into the sector by the institutional spheres were viewed as likely to produce positive results and that there was a possibility of the existence of incentives from investments in the sector for the institutional spheres (Halilem, 2010; Miles, Scott & Breedon, 2012; Drury, 2013).

2. The involvement of government in the sector

The involvement of government in the sector was highlighted by 60% of the respondents. The results also showed that government was one of the highest-mentioned parties in the sector when respondents identified key players in the industry. This could have been an indication of the role that government played in the sector, except that sentiments about the role of government in the sector were inconsistent especially in the respondents from the industry sphere. Some respondents viewed government and its involvement in the sector in positive light, while others linked the involvement of government to the lack of policy in the sector. The latter respondents felt that government viewed the aquaculture sector as a "new toy" with which government did not understand the nuances of and therefore opted to overregulate due to trepidation about the sector instead of taking efforts to understand the sector and therefore deregulate it to the benefit of its growth. As was seen in Chapter Five, the industry sphere expressed concern and dissatisfaction with current policy, claiming that it was designed for only one of the two methods of fish farming. The role of policy in the triple helix system will be discussed in greater detail later in this Chapter.

3. The successes gained by the abalone sector

Half of the respondents mentioned the abalone sector when an overview of the South African aquaculture sector was given. It was confirmed early during the study that the aquaculture sector is partitioned according to the species being farmed (DAFF, 2015; FAO, 2014). Abalone is a sub-sector of the wider aquaculture sector. Abalone, also known as perlemoen in the Afrikaans language, is a high-value product that is in high demand globally (FAO, 2014). Unsurprisingly, it is the largest aquaculture sub-sector in South Africa and a major contributor to the economy of the country (DAFF, 2015). Most of the respondents who mentioned the sub-sector did so with great fondness, from the species growing only in South Africa and therefore giving competitive advantage to its farmers to the sector making enough profits to invest meaningfully in innovation. The abalone sub-sector was also said to have robust and productive collaborative efforts between government, academia and business although there was caution given against believing that this state of interactions

was the reason behind the success of the sub-sector. Various factors, the respondents commented, contribute to its success: favorable climatic conditions, inability of the other countries to artificially duplicate farm conditions within which to farm abalone, the high price commanded by abalone on international markets and limited species-related environmental regulations due to abalone is indigenous to South Africa. The respondents were seemingly in awe of the successes of the abalone sub-sector. Many conditions favor the industry, so it would have been erroneous to use the abalone sub-sector as the poster child of a well-functioning triple-helix system although temptation initially existed to do so.

4. Seafood consumption in South Africa

Seafood consumption was viewed as an important driver of market attractiveness by the respondents. It made sense – the more consumers that you have that eat fish, the bigger the market to which fish from the sector could be sold. The respondents were polarised as to whether or not South Africa had a large enough market in terms of seafood consumption. This polarisation seemed to originate from the different methods with which the respondents defined the market. The respondents that looked only at consumption of fish by South African citizens felt that the market for fish was weak as South Africans are not strong consumers of fish. The respondents that defined the market as both South African citizens and the growing community of foreigners from the African continent living in South Africa viewed were optimistic about the size of the market. Most of the foreigners come from countries where fish was consumed in large quantities such as in Zambia, Mozambique and Uganda. One respondent whose fish farm is located close to a foreigner settlement commented that he is continuously turning away foreigners wishing to buy fish from him. This linked to commentary given by another respondent who mentioned that opportunities for markets are available, but that one had to actively go out and look for them. The decision to be optimist or pessimist about seafood consumption is based on how the definition of the seafood consumption market in South Africa.

5. Availability of funding

The respondents generally viewed the availability of funding as a positive characteristic of the sector. In fact, two of the respondents from the industry sphere confirmed to being beneficiaries of government-provided funding. The issue with this benefit is that government seemed to be “throwing money at the problem” instead of requesting accountability from the farmers for the monies received by them. One of the respondents went as far as

commenting that it would be beneficial for all beneficiaries to "pay back" the grants by giving information to government that would help new farmers. This would not only enhance the performance by the government sphere of the "role of the other" of research and development, but it would also create a sense of support between the farmers who benefited from the government grants. An additional sense of dissatisfaction about the grants was that they were clustered around the expansion of existing operations and not the creation of start-up operations. This would result in production increase from current farmers instead of from both current farmers as well as new farmers that enter the market.

6. Climatic and regulatory challenges

The climate in South Africa is said to benefit some species of fish and not the others. The country is also semi-arid and although water was not an issue raised by most respondents, recent reports about a possible drought in the country are likely to negatively affect the industry.

The respondents felt that the country was too cold for the farming of warm-water fish such as tilapia and too hot for the farming of cold-water fish such as trout. The industry sphere typically the species to farm based on the species that was in demand in the market and not so much the fish that would grow best in the environment. An observation was made the best species to farm was not necessary the fish that thrived best in the environment, and that the species that were profitable were not necessarily the fish that were indigenous to the country and this is where the legislation partly clashed with the sector. With the exception of abalone, the fish that were profitable were not indigenous to South Africa and tilapia is a good example to use. Tilapia is in high demand globally (FAO, 2014) and the industry sphere are aware of this, hence the movement towards the farming of tilapia in the sector. The problem with this tropical fish is not suited to the otherwise cold climate in South Africa, so farmers have to artificially re-create tropical conditions for the fish to thrive in by using expensive thermos-control systems. An additional issue to the farming of tilapia is that it is viewed as an invasive species, so it requires special permits before it can be farmed (DAFF, 2014) but legislation regarding these permits does not exist so this adds to the frustration of the farmers.

Therefore, the issue of climatic challenges is linked to the need to balance the provision of fish that is in demand and the likelihood of such fish being non-indigenous to South Africa

which adds additional challenges to an already complex picture that is irrelevant to the abalone sub-sector as this species ticks all the right boxes: it is indigenous to the country so it requires no temperature control systems and it is a high-value and high-demand product.

Developmental institutions and their roles:

The preceding section that gave an overview of the sector did not have any linkages to the theory that was reviewed, taking on instead the purpose of gaining insights into whether or not the respondents held a positive general outlook about the sector. Since general feelings of positivity about the sector have been established, the study will now begin looking at observations made in light of the theory reviewed.

The THM model identifies three basic elements, of which the role is one of them. In a series of three questions aimed at answering Research Question 1, the second and third of these questions were:

> Which institutions are tasked with the development of the South African aquaculture industry?
>
> What is the role or what are the roles played by your institutions insofar as sectoral development is concerned?

The respondents identified a set of institutions within the sector that were tasked with development of the sector. Although most of the respondents were able to identify organisations from all three the institutional spheres, the fact that the government sphere failed to identify organisations from the academia sphere could point to lack of collaboration in this dyad. Nonetheless, the response to the question showed that the three institutional spheres knew about one another and therefore could not use lack of knowledge about each other as a basis for not collaborating.

Institutional spheres that take on the “roles of the other” institutional spheres in a given triple helix system are identified as being important sources of innovation (Etzkowitz & Leydesdorff, 2000; Hari, 2013). This question sought to identify the roles that the respondents were currently performing so that a comparison could be made between these roles and the extent to which they “cross-over” to the roles that traditionally belong to the other institutional spheres. This

would give an overview of not only the roles of the different institutional spheres within the sector, but the extent to which these roles are being taken up by institutional spheres that are not traditionally considered as custodians and performers of these roles in the triple helix system (Etzkowitz, 1995). Table 13 presents an overview of the roles that are to be performed by the institutional spheres.

Table 14: Traditional roles

Government	Academia	Industry
Provide the "rules of the game"	Source of new knowledge	Locus of production
Facilitate contractual relations	Source of human resources	Provide capital
Ease the process of doing business	Churn out entrepreneurs	Sponsor events
Improve quality of life	Forge partnerships	Generate market expertise
	Provide basic technology	

Using the traditional roles identified in Table 14 and the overview of roles given by the respondents in Table 5 and Table 6, a convergence of the two tables was created which also included a plotting of which of the institutional spheres performed which roles and to what extent were the roles belonging to the other institutional spheres. The results of exercises are presented in the next section.

6.3.Discussion of results for Research Question 2

Question: Is the aquaculture triple helix system in its current form in the South African aquaculture sector functional insofar as the theoretical propositions of a well-functioning triple helix model propose?

While Research Question 1 was used to set the scene and the foundation for the study with very little linkages to the theoretical base, Research Question 2 was presented with direct links to the theory detailed in Chapter Two. The discussion of results for Research Question 2 followed flow as Chapter Two, and were presented using the theoretical sections as subheadings in the following order: (a) Innovation; (b) Diffusion of innovations; (c) Open innovation theory; (d) Institutional social networks of innovation and; (e) The triple helix model.

5.5.1 Innovation

The understanding of innovation by the respondents interviewed was congruent in that they all believed innovation to be a concept that is new or novel, and that can occur at product or process levels (Rogers, 2003; Crumpton, 2013). The two questions that were posed to the respondents regarding innovation were "would you define the South African aquaculture sector as innovative" and "what new ideas are you aware of that were conceptualised by the South African aquaculture industry that have been successfully commercialised to the benefit of the industry as a whole?".

The results presented in Table 7 in Chapter Five showed that 90% of the respondents interviewed believed that the sector was innovative. The remaining 10% was represented by a farmer who was not sure if a straight answer to the question could be given. Given the high costs of thermo-control systems, the farmer created a system that ensured that the farm that he owned operated off the electricity grid with heat generated from a pet crematorium business that he also owned. Although the farmer seemed apprehensive to committing to an answer about whether or not the sector was innovation, it was later confirmed by him that the crematorium-heated tilapia farm was probably the first such system in the world. If that is indeed the case then the farmer may have doubts with regards to the innovativeness of the sector but innovation was practiced on his farm. It was stated by the farmer that the farm was able to generate tilapia fish throughout the year as a result of the heat from the crematorium, which was not the case with other operations that depended on nature where tilapia fish was a seasonal product that could only be farmed during the summer season. The direct result of the crematorium heat innovation was the ability by the farmer to generate revenues throughout the year. This linked to the central concept of innovation being the ability to commercialise an invention (Aulet, 2013) Did the farmer believe that the sector was innovative? This was not stated explicitly, but one must conclude that the farmer was able to conceptualise an idea, test it, commercialise it and successfully exploit it (Ismail, 2015).

The second question, which requested that the respondents list innovative ideas that the sector has successfully commercialised, was posed because of concerns around differences that existed amongst the respondents of the extent of disruption an idea should be before it is defined as innovative. Commercialisation is an important element of an innovation as the lack thereof relegates a potential innovation to nothing more than an invention (Aulet, 2013; Ismail, 2015). The respondents gave a list consisting of 23 items that represented new innovations

within the sector as perceived by the respondents. The aim of the question was to quantify the innovations, based on the assumption that a high number of innovations identified were an indication of activity in the sector in terms of innovation. The focus was therefore on the number of ideas identified and the frequency with which any of the ideas were repeated by different respondents. The quantity of the ideas and the citation frequency of these ideas are plotted on a scatter diagram as represented by Figure 6 in Chapter Five.

The most cited idea was repeated by only four respondents, while the second most cited idea was repeated by three respondents. Eight of the ideas were mentioned by a maximum of two respondents, while the remaining 13 innovations were mentioned only once. Figure 6 showed that there was a level of dispersion in terms of new innovations. In other words, there innovations given were diverse. Although this could prove that innovations were widely available and were sourced from many different areas. This wide range of innovations, in light of the small sample that was used during the study, is an indication of an active innovation landscape (Aulet, 2013).

The question that could be posed at this point in time was, if innovation is as vibrant as the results in Figure 6 show then why is it that the industry continued to post comparatively low sectoral growth rates (DAFF, 2015; FAO; 2014)? The key to this question could be found in the responses given with regards to the management of innovation in the sector. It was possible that innovation in the sector was driven by the need to survive in the context of a restrictive environment (Amabile & Kramer, 2010) as a result of the cumbersome legislation or it could be that innovation efforts in the environment were wild, unfocused and unbridled – that the innovations were as a result of a state of chaos in the sector where innovations abound but the management thereof is weak (Gobble, 2010; Knowledge@Whatron, 2012).

This section answered the first part of Research Question 2. Given the quantity and dispersion rate of the ideas, it could be confirmed that innovation activity was evident in the aquaculture sector. Innovation was the outcome of interactions of the institutional spheres within a triple helix system (Etzkowitz & Leydesdorff, 2000; Hari, 2013). It must be concluded then that a triple helix system is present in the sector given the outcome of innovation in the sector.

5.5.2 Diffusion of innovations

Rogers (1995) proposed that new ideas were communicated for either adoption or rejection when (a) the ideas or innovations themselves; (b) communicated through channels by (c) members of a social system, which referred to the institutions that represented the three institutional spheres in the South African aquaculture sector, (d) over a period of time. These four factors along with an evaluation of their prevalence in the South African aquaculture sector are presented below:

(a) Awareness of innovations or ideas

The preceding section which profiled the innovations given by the respondents is evidence of the availability of innovations for diffusion. The innovation-decision process presented in graphic format in Chapter Two presupposes that the first step to diffusing an innovation is awareness by the audience of the innovation or idea (Shimp & Andrews, 2014). Although the large repository of innovations as given by the respondents is a positive signal in terms of the existence of innovation in the South African aquaculture sector, it could be questioned if this sentiment of positivity is the same for awareness. The range of innovations given during the study, coupled with the low rate of repetition of the similar innovations, could point to lack of focus on a handful of innovations that will have the biggest impact on the industry. Utterances by some of the respondents could be in support of this observation:

> *"South Africa as a whole has to focus more on breakthrough as opposed to incremental innovation".*

> *"We need a working model in the South African aquaculture sector".*

Assuming that the large repository of new ideas or innovations is as a result of lack of focus by the South African aquaculture sector, it can be judged that the innovation will fail to reach the confirmation stage of the innovation-decision process (Shimp & Andres, 2014). This can be explained using the idea that was repeated the most by the respondents, which was abalone ranching. Abalone ranching was an innovative abalone farming technique in the South African aquaculture sector (DAFF, 2015). The idea was conceptualised by the abalone sub-sector in 1996 and the call for applications for the right to ranch were released by the government in the same year (DAFF, 2015). Ten abalone ranching pilot projects were in operation in 2011 (SUN, 2011). Respondents agreed that abalone ranching was one of the innovation success stories to

come from the aquaculture sector. This example illustrates the importance of awareness about innovation and focus on its commercialisation in order for the innovation to progress through the innovation-decision process. The low repetition rate of the innovations could be viewed positively as evidence of innovation activity and negatively as lack of knowledge or awareness about the innovations, the latter of which could place the innovations at risk of falling short of the successful diffusion based on the stages given of the innovation-decision process (Rogers, 2003).

(b) Communication through channels

The channels of communication are used to share information about an innovation, the absence of which will impair the diffusion process (Rogers, 1995). It was mentioned in Chapter Two that the focus of the literature review and therefore the study would be on the members of the social system. The element of communicating through channels will therefore not be explored further.

(c) Institutional members of a social system

The role of the members of the social system is to both adopt the innovation, or reject, an innovation (Shimp & Andres, 2014). As mentioned earlier in this report, members of a social system can be individuals or organisations (Rogers, 1995). The focus of the study was specifically on this particular element of the diffusion process as alluded to in Chapter Two. It was mentioned earlier that the THM would be used to explore the nature and structure of the South African triple helix system and compare observations taken from the fieldwork completed in the study to elements proposed by the THM theory. Using the information gathered thus far, focus is redirected back to the knowledge of innovations demonstrated by the respondents as discussed in the preceding question. One wonders if the low levels of knowledge about the various innovations were an indication of the failure of the institutional spheres to bring awareness about the innovations (Shimp & Andres, 2014).

(d) The passage of time

It is rare for innovations to be adopted immediately, so the passage of time is an important element in the diffusion process (Rogers, 1995). Knowledge of the average time it took for an innovation to be adopted would have allowed the study to delve deeper into this element as it applied to the South African aquaculture sector. However, like the element of communication through channels, the element of the passage of time fell outside the ambits of this study and would therefore not be discussed further in this section.

5.5.3 Open innovation

Central to the concept of open innovation is a collaborative process of idea generation and management between members of different institutions driven by the notion that the rewards of the collective are greater than the sum of the units which comprise the collective (Chesbrough, 2003; Bank & Raza, 2014). Although open innovation was not the core theme of this study, it formed part of the study nonetheless. The request during the interviews made to the respondents to give insights into how innovation was being managed in the South African aquaculture sector served the dual purposes of understanding the intricacies of innovation diffusion, as well as gaining insights into the appetite held by the different institutional spheres for innovating together. A strong theme that emerged from the interviews related to protectionism. In economics theory, protectionism refers to the attempts made by an economy to protect the jobs and businesses of its citizens from international competition and trade (Miles, Scott & Breedon, 2012). The same concept was adopted to define protectionism in this context as the attempt by industry players to self-protect from competition, in whichever way. The study showed that while 20% of the respondents viewed themselves as being open to other parties coming in and witnessing the intellectual property that they practiced at their respective farms, 60% of the respondents confirmed that the industry as a whole managed innovation "privately" or "confidentially". Some of the iterations expressed by the respondents in support of this observation include:

> *"Everybody is closed. I am probably the only one that says 'come and visit'".*
> *"Innovation in the sector is managed confidentially".*

It appeared therefore that while the South African aquaculture sector may be open to innovation and innovative, there seemed to be a weak appetite for sharing ideas and knowledge. The low incidence of three-way collaboration (Table 9) that was viewed in theory as a potential source of innovation (Hari, 2013) could be linked to the protectionist sentiment shared by the respondents. Without collaboration, innovation information cannot be communicated and shared (Rogers, 2003; Etzkowitz & Leydesdorff, 2000). The fear of for relinquishing control over intellectual property, introduction of opportunistic external parties, the need to share resources that were previously fought over and loss of control over staff are some of the risks that open innovation presents (Jarvenpaa & Wernick, 2011) and the same risks could be to blame for the reluctance to embrace open innovation by the South African aquaculture sector players. Apprehension

towards open innovation could be understandable in light of the limited number of successful cases that resulted directly from the application of open innovation (Hoosain, 2013). An additional dimension that seemed to be strengthening this status quote was from one of the respondents from the government sphere commented that this sphere respected the independence of the industry in terms of intellectual property. This commentary linked to the propositions made by theory of the Triple Helix II was focused on a laisse-faire approach from the government sphere (Hari, 2013), an attempt from to dilute the state-led triple helix system proposed by Triple Helix I (Etzkowitz & Leydesdorff, 2000).

The theory on open innovation partly contributed to the answering of Research Question 2. Table 9 confirmed the existence of a triple helix system as the respondents confirmed instances of collaboration between government, academia and industry spheres. The incidences of three-way collaboration in this triple helix system remained low at a comparative percentage of 19% versus the 69% incident percentage of two-way collaboration.

5.5.4 Institutional social networks of innovation

This section in Chapter Two was included to show the evolution of social networks of innovation so that greater appreciation was held of the triple helix model. In-depth evaluation of this social network of innovation was therefore reserved for the following section which discussed in greater detail the triple helix model and its application within the South African aquaculture sector.

5.5.5 Triple helix model

The essence of the triple helix model was based on the notion that the three institutional spheres of government, academia and industry should engage in greater collaborative efforts and blur the traditional roles of each of other by actively engaging in the roles of each other while the university engages in a more prominent role in the context of the knowledge economy (Eitzkowitz & Leydesdorff, 2000). Before analysis of the overlap of roles could be attempted, it was important to understand the scope of traditional roles as proposed by the THM (Table 14). By understanding what the traditional roles are, an analysis of which of the roles overlapped as proposed by the theory could be attempted.

The respondents were asked to define their roles in the sector insofar as development was. This served as a mechanism with which insights could be gained into the nature and scope of

the roles of each of the three helices, including the identification of any "roles of the other" that were being performed – intentionally or not – by the helices (Hira, 2013). Probing questions about the perceived role of and contribution made by the university were also incorporated into the interviews. This was done in support of the need to understand whether or not the "third mission" of the university as proposed by the theory (Halilem, 2010; Landry, Amara & Saihi, 2005) was in existence or not, or was known by the other helices or not. The last question that was asked by the author related to the request for an account to be given about any known instances of collaboration known to the respondents between the three helices within the South African aquaculture sector.

As a reiteration, the THM model is comprised of three basic elements: (1) Movement towards collaborative relationships, (2) the need for the academia sphere to adopt a more prominent role given the knowledge-intensive modern economy and; (3) the adoption by each of the institutional spheres of the "role of the other" institutional spheres. For the purpose of discussing the results of Research Question 2 using the triple helix model as a lens, the elements of the model were isolated to allow for the separate discussion and evaluation of both as they apply in the South African aquaculture sector.

(a) Movement towards collaborative relationships

Triple helix theory proposes that the outcome of interaction that takes place during collaboration between the three helixes should be innovation policy, the opposite of which is innovation policy that is prescribed by government (Etzkowitz & Leydesdorff, 2000). Table 9 in Chapter Five gives an overview of both knowledge of the existence of any collaboration between any of the three institutional spheres in the South African aquaculture sector, as well as the parties which actively collaborate. A third of the respondents who represented the industry helix believed that there was no collaboration at all within the sector, while 100% and 50% of the respondents represented the government and the academia spheres respectively believed that a triple helix system existed in the South African aquaculture sector. The rest of the respondents believed that instances of collaboration were apparent but that they involved either interactions between two helices as opposed to three or interactions between the members of the same helix, for example, independent farmers interacting with each other or with the trade association. Focusing on the double helix, it came as a surprise that none of respondents reported interactions between universities and government as well as between universities and industry.

This somewhat brings to question the prevalence of the "third mission" of the university (Halilem, 2010) but this analysis will be discussed later on in this section.

The issue of legislation presented itself as an unexpected but nonetheless strong theme during the interviews, and this theme was unexpected because the THM theory assumes the existence of legislation within a triple helix system (Hari, 2013). "Government acts as a public entrepreneur and venture capitalist, in addition to its regulatory role in setting the rules of the game" (Etzkowitz & Leydesdorff, 2000). Legislation was fingered as the biggest impediment to the realisation of the growth goals set by the government for the South African aquaculture, represented by sentiments shared by 60% of the respondents including the two farmers who exited the sector in favor of another in a different African country. The traditional role of government in the triple helix is to facilitate contractual relations that guarantee stability of interactions and exchanges (Etzkowitz, 1995). What was found during the study is a complete absence of a dedicated policy framework governing the relations of the all the players, both from marine aquaculture and freshwater aquaculture farming methods, within the South African aquaculture sector. These absent "rules of the game" made it difficult for farmers to negotiate the regulatory environment within the sector. It could be concluded that the absence of legislation or the rules of the game made it difficult for the different industry actors to improve contractual relations when there was no awareness as to what these were in the first place. This area of greyness has increased the difficulty of doing business within the sector. "The regulations that are coming in are making growth quite difficult. That makes it quite challenging to start up your own business as an aquaculture operation", one of the respondents said. "I think that the legislation around aquaculture is very difficult. It is quite a minefield to negotiate, so I think that there is not any growth per se", said another respondent. The study revealed that regulation to a certain extent was in existence, but it only covered one portion of the South African aquaculture sector. The frustration raised by the respondents were based on the fact that the regulation in place was outdated as it covered old methods of farming and did not take into consideration the rapid changes within the sector that have since taken place (DAFF, 2015), such as the emergence of new types of fish that the market demanded including tilapia. It was found that the legislation was not only inappropriate but also included gaps that led to confusion about how to comply with the regulation as a farmer which government responded to by enforcing related legislation from other policy frameworks.. For example, a prospective farmer needs to conduct an environmental impact assessment (EIA) on the piece of land on which he or she is considering setting up an aquaculture operation. Legislation, on the other

hand, is unclear as to when an EIA is required. The Department of Environmental Affairs and Tourism states that an EIA is only required when a farmer produces a certain level of tonnage. The exact tonnage is unclear, so the farmer can decide on a certain tonnage only to be deemed to be running an illegal operation later on by a public official who believes that an EIA should be granted at a different level of production. This makes both starting a business and maintaining it quite difficult because the farmers stated that they needed consultants to help them apply for EIAs in the absence of firm legislation around this, and that these consultants can cost upwards of R500-million, which is a significant cost to carry considering that one may, or may not, actually need an EIA to begin with.

Saad & Zawdie (2011) affirmed that the role of government in the triple helix should focus on the provisioning of policies that not only governed the relations within the South African aquaculture sector but, most importantly, provided a hospitable environment on which relations between the three helices thrive. The issue was not just the lack of a policy framework for aquaculture. The bigger problem was the continued insistence by government compelling farmers to comply with a policy framework that was rendered irrelevant, outdated and inadequate by changes in the industry. This state of affairs seems to lower the spirit of collaboration as proposed by the triple helix (Etzkowitz & Leydesdorff, 2000; Hari, 2013) and also created an environment that was unwelcoming to new farmers and investors seeking to enter the industry.

The literature review presented in Chapter Two was not explicit in terms of the impact of weak or absent policy on the health of a triple helix system. It seemed to assume the existence of policy or the rules of the game that government could use to discharge its role in the triple helix system. It would seem that the setting of growth targets by the government for the sector was unfair and presumptuous given the absence of the rules of the game to govern the sector as it grew and to guide the operations of the sector.

It can be concluded that collaboration within the sector occurs in both a dyad and a triad, the latter of which is proposed by the THM theory (Etzkowitz & Leydesdorff, 2000). Triad collaboration was occurring in approximately 20% of the reported cases of collaboration and this further confirms the existence of a triple helix system that could be communicating predominantly in a series of dyads and less so in triads.

(b) The adoption of the "role of the other" as well as one's own traditional roles

The sample responded to a question posed to them requesting an overview of the roles that each of them played insofar as sectoral development is concerned. The roles were captured and presented in Table 4 and Table 5 in Chapter Five. The greater the overlap of the roles, the more enhanced the innovation within the triple helix. In other words, innovation is improved when all three the institutional spheres blur the boundaries of their respective traditional roles and venture into the performance of the "role of the other" (Etzkowitz & Leydesdorff, 2000). The roles that were given by the respondents were recorded and listed under the institutional sphere that indicated them during the interviews. A comparison of the traditional roles proposed by the THM theory to the actual roles performed by the respective institutional spheres as indicated by them was completed. To ensure ease of information dissemination, a colour-doing scheme was used to differentiate between the three institutional spheres as follows: the government sphere was allocated a red colour, the industry sphere was allocated a green colour and the academia sphere was allocated a purple colour.

Table 15: Traditional roles versus the "role of the other"

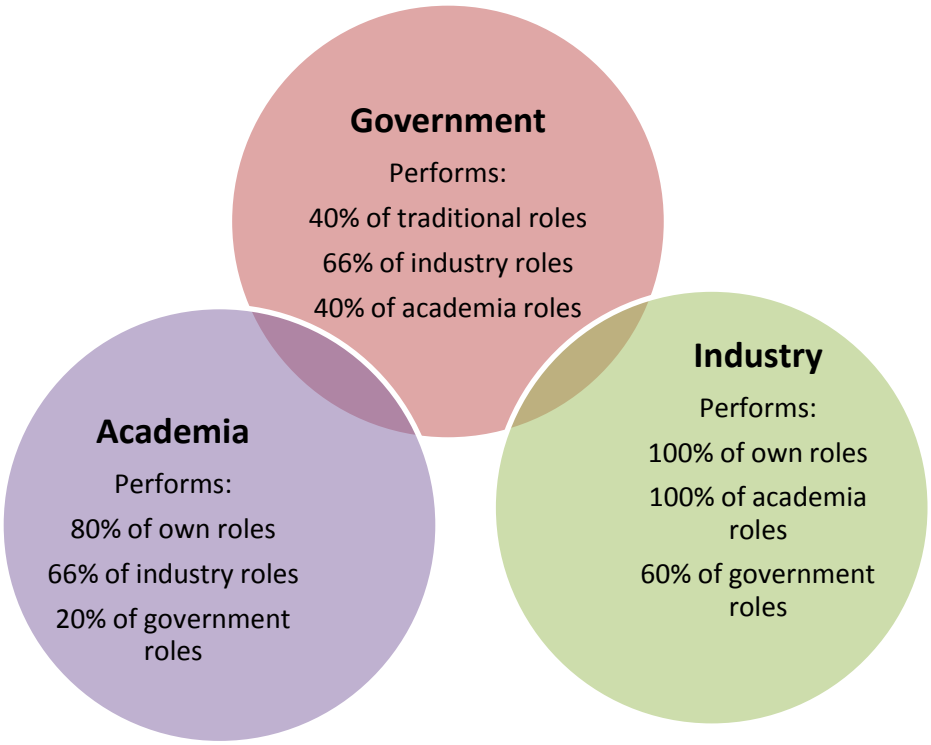
	Roles	Government	Academia	Industry
Government	Basic R & D funding	√	√	√
	State incentive programmes			
	Quality of life			√
	Ease of business			√
	Grants	√		
Industry	Capital	√		√
	Event sponsorship	√	√	√
	Market expertise		√	√
Academia	Basic technology		√	√
	Technical assistance and education	√	√	√
	Human capital supply		√	√
	Partnership forging	√	√	√
	Churns out entrepreneurs			√

Each role was given a weighting based on the number of roles for a given sphere. For example, the industry sphere had three roles so each role weighted 33.3%. If academia sphere

confirmed that it performed two out of the three industry roles, then the percentage of industry roles performed by the academia sphere was calculated to be 67%. The results of this exercise are presented in Table 15, featuring the traditional roles on the left and the spheres that perform the roles in actuality on the last three columns.

The results as presented in Table 15 were reproduced in graphical format to illustrate the level of overlap that was in place at the time of the study within the South African aquaculture sector. This graphical representation is presented in Figure 7. Figure 7 is an "infographic" that gives an overview of the extent to which each of the institutional spheres performs the roles of the other institutional spheres. This extent is expressed in percentage form. The actual overlapping of the circles in Figure 7 are only for visual purposes and do not represent the extent of the overlapping of the roles.

Figure 7: Overview of the overlap of roles



The results indicated that all three helices within the South African aquaculture sector perform the "roles of the other" in varying degrees. Although a historical analysis of the evolution of the

triple helix structure in the sector fell outside of the borders of this study, the existence of role overlaps serves as evidence of Triple Helix III being at play (Etzkowitz & Leydesdorff, 1997). It can be concluded that the triple helix system that was in place within the sector met the THM theory element of the performance of the "role of the other" (Hari, 2013).

It is said that most contexts, be it regions or countries, are currently attempting to put Triple Helix III into place in some form or the other (Etzkowitz & Leydesdorff, 2000). The drive behind this initiative is eagerness to create an innovative environment comprising strategic alliances in the industry sphere, spin-off companies created by the academia sphere, government laboratories and academic research groups (Hari, 2013). It can therefore be said that the existence of these components can be used as criteria to determine whether or not an innovative environment exists as a result of the presence of Triple Helix III. The question to ask, then, is to what extent is there a presence of these components within the South African aquaculture sector, which has already been deemed to have taken the form of Triple Helix III based on the existence of the overlap of roles between the three helices? Each component will be looked at in turn based on evidence obtained by the author during the primary data collection stage which was in the form of interviews:

Strategic alliances in the industry sphere:

A strategic alliance is an agreement between two or more organisations or entities to work towards common objectives while maintaining independence (Drury, 2013). Table 3 indicated that 60% of the respondents mentioned collaboration with industry as some of the roles played by them, while Table 10 highlighted that 40% and 50% of respondents confirmed to be in collaboration with companies within the industry and with government and industry respectively. What is not clear is whether these instances of collaboration could be defined as strategic alliances or not.

Based on the afore-described definition of strategic alliance, the interview transcripts were analysed for evidence of the presence or absence of strategic alliances within the South African aquaculture sector. The findings of this exercise were as follows:

- The Tilapia Association of Southern Africa is a member-funded trade association made up of tilapia fish farmers. The association started as a strategic alliance formed by the farmers to lobby for the right to farm a certain species of tilapia. Once the rights were issued, the alliance members realised that the tilapia sub-sector faced more challenges.

This realisation evolved from a “loose” alliance to a trade association that represents its members on many different platforms including engagements with government and customers.

- One of the farmers mentioned that the Association is now involved in numerous initiatives that are aimed at the betterment of the sector. These include alliances with:
    - Retail chains, where discussions are in place to help farmers package their fish in a manner that is acceptable to the consumers to which the retailers sell. This alliance benefits the retailers because they will have access to fresh tilapia fish instead of frozen fillets that are of inferior quality that are imported from China and that have been, up until recently, the only source of product supply that the retailers had.
    - Fish feed suppliers, where technology was being created by the suppliers and the farmers give input as part of the creative process of innovation in fish feed.
    - Veterinary students, where farmers provide the scholars with live fish that can be used to test new types of inoculations.

Based on the above observations, one can confidently confirm that strategic alliances existed at the time of the study within the South African aquaculture sector.

Spin-off companies created by the academia sphere:

Only one of the two respondents that represented the academia sphere confirmed the creation of a spin-off company by academia. Stellenbosch University confirmed to have co-created a company called Diamond Coast Abalone Farm in partnership with a labour trust and a private company. One of the innovations identified earlier, abalone ranching was incorporated as part of the operations of the farm in partnership with the University. The private company eventually acquired a majority state in the business in 2011. Although confirmation cannot be given as to the number of spin-off companies such as these, one can confirm the existence of such based on this evidence.

Government laboratories:

30% of the respondents confirmed the existence of two state-owned laboratories that were dedicated to the aquaculture sector. The first laboratory, Jonkershoek Hatchery, was said to be located in the Western Cape and was said to be owned by the Department of Agriculture, Forestry and Fisheries. The second laboratory that was identified was Turfloop Hatchery in

Limpopo which is a facility that was built by the previous government and which was being rehabilitated under the leadership of the Department of Agriculture, Forestry and Fisheries. These two facilities are by no means exhaustive, but the provide evidence of the presence of government-owned laboratories that service the South African aquaculture industry.

Academic research groups:

One of the respondents strongly suggested the creation of academic research groups by bringing together communities that are closely related for the purpose of research. "I thought that if you could bring together the water community with the oceanographic community and the aquaculture research community – all of them slightly closer together – you would get better identification of ideas and problem solving and you could maximise what one could get out of this system", the respondent commented. A suggestion was made to create an incentive-based research strategy for the industry. The closest to evidence of the existence of academic research groups was confirmation by the respondents representing the academia sphere of their direct involvement in research. Whether or not these constitute academic research groups as dictated by Triple Helix III (Etzkowitz & Leydesdorff, 2000) was unclear from the results of the study.

(c) The "third mission" of the university

Triple helix theory suggests that the university should adopt a more prominent role by adopting the "third mission" role of entrepreneurialism in addition to its traditional roles (Halilem, 2010; Etzkowitz & Leydesdorff, 2000). It is said that the entrepreneurial university basically (1) conducts research and reveals opportunities for innovation and (2) teaches and produces highly qualified personnel and entrepreneurs who will transform knowledge into a useable format (Halilem, 2010). These two criteria will now be used to determine the extent to which each were discharged based on data received during the interviews:

Conduct research:

The two respondents who were interviewed who represented the academia sphere both confirmed that their respective institutions were actively engaged in research. Research forms part of the traditional roles of the academia sphere (Etzkowitz, 1995), so the fact that research is being undertaken is not considered a groundbreaking finding. Research alone is insufficient insofar as the propositions of the triple helix theory are concerned – instead, research should lead to the revelation of innovation opportunities (Etzkowitz & Leydesdorff, 2000).

Reveal opportunities for innovation:

Evidence of the revelation of opportunities for innovation was found in only one of the two organisations that represented the academia sphere in the sample. This particular university communicated that the institution was actively involved in the both research and commercialisation of abalone ranching, leading to the eventual creation of a spin-off company as previously discussed. A disturbing observation that was made during the study relates to the strength of collaboration with the academia sphere as it applies to the South African aquaculture sector. Table 10 shows that industry-academia collaboration occurred in only 10% of the reviewed cases, while government-academia collaboration did not exist at all. Why?

It is said that the absence or weak presence of efforts towards innovation carry no incentive for industry to partner with academia (Torres, 2014). Earlier discussions confirmed that innovation efforts within the South African aquaculture sector were alive and well. If innovation efforts are a prerequisite for collaboration between industry and academia, then there should surely be evidence of such collaboration in the study but there is not.

The profile of roles performed by the three helices revealed that the Industry sphere performed 100% of the traditional duties of the Academia sphere. A closer examination of the sentiments around this reality reveals frustration from the Industry sphere. “I am doing it out of pure frustration”, confirmed one of the respondents from the Industry sphere when he was asked to provide reasons for his decision to set up full-scale Research and Development (R & D) facilities on his commercial farm. His frustration, he confirmed, stemmed from the fact that no one in the industry was conducting tests or R & D that the sector that was much needed, and that he had taken it upon himself to do this. Another respondent from the Industry sphere who has also taken it upon himself to test out new ideas confirmed that he had never, up to that point in time, collaborated with any parties from the Academia sphere. When probed further, he gave a dismissive answer: “I am afraid to say this but I have not had any dealings with the universities at all. No one has ever been here”, he discoursed. The Industry sphere representatives that confirmed the lack of participation in innovation within the South African aquaculture sector represented 33% of the Industry sphere respondents. There was only one Industry sphere representative who confirmed positive collaborative relationships with a party from Academia, but this relationship was based on veterinary-based knowledge exchange and not knowledge relating specifically to aquaculture.

Teaches and produces highly qualified personnel and produces highly qualified entrepreneurs:

There was general sentiment that the universities that offered Aquaculture course delivered high-quality educational interventions. Evidence of this was given by 30% of the respondents who articulated that the South African education system produced high-caliber aquaculture specialists, with one of the respondents being in possession of a Master's degree in aquaculture obtained from a South African university. One of the respondents concurred that the sector had a robust pool of specialists with technological and technical knowledge, but went further by adding that practical experience was lacking. This observation was shared by another respondent who linked this state of affairs to the large number of consultants who operate in the South African aquaculture sector. He went on to say that this was one of the reasons why he chose to work in another African country although his degree was obtained in South Africa. "The guys finish Masters Degrees and know everything about aquaculture so they become consultants, although none of them have physically farmed a kilogram of fish in their entire lives". The respondent closed his statement by stating that he was the only one out of his Masters class to have successfully pursued a career in aquaculture, although outside of South Africa. The rest of his class could not work on an aquaculture farm so they followed alternative careers in the fields of research, academia, financial services and sheep farming. It can be said that the Academia sphere in the South African aquaculture sector produces highly qualified personnel. The limited opportunities that are made available for new graduates to pursue a career in aquaculture, coupled with the difficulty of starting an entrepreneurial aquaculture operation, make it difficult for these graduates to either work as an employee or establish a new venture within the aquaculture sector. It cannot be said that the low entrepreneurial activity in the South African aquaculture sector is driven solely by the inability of Academia to produce entrepreneurs – there are other dynamics at play that also contribute to low appetite for entrepreneurship within the sector.

Conclusion:

The triple helix system in the South African aquaculture sector was found to be in seemingly good health in terms of its structure as compared to the propositions made by the triple helix theory. The existence of the system itself was confirmed. The three institutional spheres confirmed that collaboration was occurring and an appetite for greater collaboration was expressed. The academia was meeting some of the tasks required to be performed as proposed by the "third mission", and the overlapping of roles was determined. It can be concluded that Research Question 2 has been answered.

6.4.Discussion of results for Research Question 3

Question: Does the current form of the aquaculture triple helix promote or discourage sectorial growth?

The triple helix model suggests that the traditional roles of each of the three helices should not be limited to each one; that the university should play a more prominent innovation role in the context of the knowledge economy; that there should be movement towards greater collaboration between the three helices; and that government should engage in a larger role only when the market is unable to provide an activity while at the same time ensuring that the environment sustains stable interactions and exchange between the helices (Etzkowitz, 2008; Etzkowitz & Leydesdorff, 2000).

Table 16: Evaluation of the triple helix system

Triple helix element	Evidence of the existence of the element established during research
Role overlap between the three helices	Yes
Movement towards greater collaboration between the three helices	Yes
Role prominence played by Academia	Yes
Government policy apt for the facilitation of stable interactions and exchange amongst the three helices	No

A comparison of the proposals made by the triple helix theory to the evidence obtained from the results of the study shows that the triple helix system in the South African aquaculture sector satisfies all three the basic elements of the theory. The strong theme of policy that emerged during the study could not be ignored given the fact that the inability to grow the sector meaningfully so far can be attributed to it as so believed by 60% of the respondents. Triple helix theory asserts that government should engage in a larger role only when the market is unable to provide an activity (Etzkowitz, 2008), but what happens in the case where policy is absent and the roles of the three helices is unclear?

A review of the literature made no reference to the value of a triple helix system in the absence of policy as is the case in the South African aquaculture sector. What has been found to be the case is the emergence of behavior that is unconducive to the processes of innovation:

- Protectionism, with industry undertaking its own R & D on its own cost when Academia should be doing this task. To earn a return on R & D effort, the industry resorts to being protective over its intellectual property in an attempt to extract from it as much as it can and gain competitive edge before the property is eroded over time.
- Reluctance to engage with government. This trend was quite pronounced during the study. Although half of all collaboration efforts recorded was between industry and government, the goal of these interactions was to lobby for laws that are favorable to the industry and not so much the intent to actively and collectively innovate.
- A choice by educated aquaculturists to become consultants instead of start new aquaculture operations. This is evidenced by the high number of consultants in the sector when new farmers are required to grow the sector.

The structure of the triple helix system in the aquaculture sector in South Africa looks good on the surface. There is evidence of a strong repository of innovations, but there is lack of focus on which innovations to invest time and effort based on strong likelihood of them delivering the greatest value to the industry. The quality of the relationships between the three helices vary, but the most concerning of these are the extremely weak relations between Academia and the other two helices. The lack of policy that is designed to give direction in terms of the types of interactions that are to take place only makes matters worse.

Conclusion:

In summary, all three basic elements of the triple helix system were evident in the aquaculture sector in South Africa. The triple helix system in the South African aquaculture sector seemed to be mostly structured in a manner that promoted innovation. The lack of policy designed to facilitate interactions between the three helices was impacting the functioning of a seemingly robust triple helix in a negative manner as the respondents seemed likely to be protective over intellectual property in the absence of rules around the protection thereof as outlined by policy governing collaborative interactions within the sector. The theory that has been reviewed so far seems to assume the presence of policy, the opposite of which holds true in the South African aquaculture triple helix. It can therefore be concluded that Research Question 3 was answered.

6.5.Discussion of results for Research Question 4

In comparing the theoretical propositions of a good-quality triple helix system, what recommendations can be made to improve the innovative productivity of the South African aquaculture sector?

An overview of the top-rated improvement suggestions as given by the respondents with regards to enhancing collaborative innovation in the sector were presented in Table 12 in Chapter 5.

The results of the study showed that 60% of the respondents identified greater collaboration as the most important manner with which to improve collaboration for innovation in the South African aquaculture sector. This result aligned with one of the propositions of the THM theory that identified movement towards greater collaboration as a basic element of a triple helix system (Etzkowitz, 1995).

The second most-rated improvement suggestion given by the respondents to improve collaborative innovation was to streamline legislation – a suggestion given by half of the respondents. Triple helix theory seems to base its proposals on an already existing government policy. The literature that was reviewed seemed to not consider the implications of the functioning of the triple helix system in the absence of legislation, as was seen to be the case in the South African aquaculture sector. Another suggestion that was given by the respondents was the need for the sector to develop a working model for aquaculture. This was reiterated by half of the respondents who were seemingly convinced that a model, once proven to work, could be applied to various contexts with greater likelihood that it would lead to success. It was believed that the creation of a working model was in itself an opportunity for collaborative innovation as one of the respondents confirmed that the creation of a working model required collaboration from the three institutional spheres.

Conclusion:

The South African aquaculture triple helix is aligned to the theoretical propositions of what such a helix should be. However, triple helix theory seems to be based on the assumption of the presence of solid legislation within the given context. It is believed that this is so based on the proposition that the traditional role of government being the source of contact-based relations that promote stability of interactions and exchange. The author assumes that the term

"contract" alludes to the need for legislation on which to base the "contract". If there is no legislation, it is difficult to see how the government will be able to discharge this traditional role. The rule of law gives comfort to citizens in that protection of property, amongst other things, is upheld. The absence of this rule of law as outlined in government policy means that the relationships between the industry players are to be self-governed, and this introduces an element of trust – trust that the one party will not disadvantage the other. This brings forth the topics of trust-based relationships as well as the theme of social capital in the absence of governing policy.

7. CHAPTER SEVEN: CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

The purpose of this Chapter is to bring together the outcomes of the study as aligned to the objectives of the study. An overview of the research background and the principal findings make up the first section of the chapter, followed by the implications of the findings to management and a proposed model of improving the triple helix system in the South African aquaculture sector. Limitations of the research are presented before areas of future research are given.

7.2 Research context

The literature review showcased the importance of a well-structured and managed innovation programme for the very survival of an organisation (Porter, 1985; Scherer, 1986; Kanter, 1990; Hamel, 2006; Yalabik, Howard & Roden, 2012). The decentralisation of globalisation has introduced the need for developing nations to form pockets of regional development processes aimed at capturing innovation value and realising economic growth, through the completion of the "business as usual" transactions and relationships that are based on power, trust and loyalty (Lundvall, 1992). Economic diversification, especially in the context of resource-dependent nations, is a compelling proposition that can be used to overcome the risks of overdependence on natural resources and unlock of the benefits of a widened economic base (Miles, Scott & Breedon, 2012). Investment into high-potential alternative industries using innovation as a mechanism with which to ramp up, maintain and manage sectoral growth stands to benefit the business organisation in as much as it stands to benefit the nation and its citizens (Porter, 1985; Kanter, 1990; Hamel, 2006; Yalabik, Howard & Roden, 2012; Crumpton, 2012).

The shifts in power bases insofar as the lead role for innovation has been evident in recent years, with the power settling ever so temporarily on government, industry and academia (Etzkowitz & Leydesdorff, 2000). This model, albeit in continued evolution, brings with it unique opportunities and challenges to contexts that choose to implement it.

Current literature rests the success of government-academia-industry relations on the elements of a continued appetite to increasingly collaborate, willingness to perform additional duties which are traditionally discharged by the other parties and, preparedness by academia to step into a

role of heightened prominence in the context of the increasingly important knowledge base. This so-called triple helix model promises a wide range of innovation-based opportunities.

A review of the triple helix model as it applies to the South African aquaculture sector has highlighted the need for certain contextual factors to be in place in order for it to be successful. The study confirmed that the mere existence of a triple helix system, regardless of the wellness of its construction, does not guarantee the delivery of the benefits that are promised. This research sought to explore the sectoral-level innovation system as it applied in the South African aquaculture sector, with the aim of determining whether the system promoted or inhibited sectoral growth. The outcome of this process is hereby presented in accompaniment of its implications to management and recommendations to each of the three helices.

7.3 Principal findings

The results of the research revealed two major findings insofar as the triple helix system of innovation approach and application in the South African aquaculture industry.

7.3.1 The health of the triple helix system

The research study used the triple helix model to attempt to understand innovation activity within the South African aquaculture sector. This was done to determine the structural elements within the system that may be inhibiting the growth of the sector through innovation, therefore contributing to the observed low sectoral growth. The study looked at the presence within the sector of the three basic elements of a well-functioning triple helix system: appetite for increased collaboration, a heightened role played by the university as a member of an innovation system and, efforts from the three helices to take over “the role of the other”. The outcome of the study showed that the three elements as proposed by current literature were present in the South African aquaculture sector, and that the likelihood of success stemming from the presence thereof was possibly reduced in the absence of the rules of the game or policy. It was concluded that the mere existence of a triple helix system was unlikely to guarantee innovation success if the context within which the system is embedded is out of kilter. This finding both supports and refutes the literature. The number of innovations that came from the sector supported the proposition by the theory that a triple helix system enhances innovation activity. The low level of innovation-led growth, on the other hand, refutes the idea held by theory that innovation results in growth and prosperity as other related dynamics may be at play. This realisation created a need for an enhanced triple helix model incorporating context that will

assist other emerging industries in creating and managing effective triple helix systems in the absence of policy as was found to be the case in the South African aquaculture sector.

7.3.2 The absence of policy

Prevailing literature makes the assumption about the context within which a triple helix system exists or is implemented. This assumption relates to the idea that government already has a policy in place which it uses as a tool for facilitating contractual relations and exchanges between the helices.

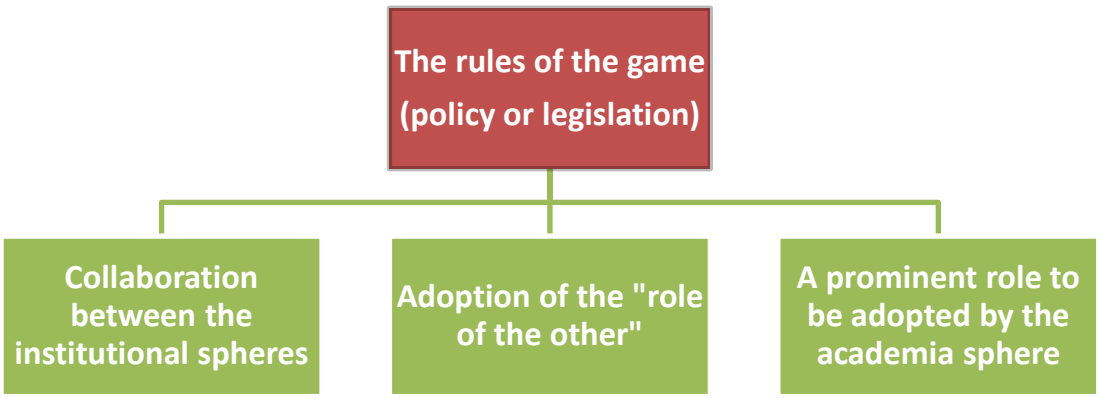
A second key finding that the study revealed was the need for effective policy to be in place in order for the proposed collaborative exchanges to take place productively and healthily. The absence of policy seems to have led to a set of behaviors amongst the triple helix that were driven by the need for self-protection in the absence of policy that governs this need. Although the triple helix system in the South African aquaculture system possessed the three basic elements of such a system that is deemed to be well-functioning, the absence of the rule of law to serve as a comforting mechanism to support increased collaboration dampened the very same spirit of innovation that the triple helix strives for. One might suggest that policy be put into place by government before the industry moves ahead but it is a well-known fact that globalisation has brought with it an increasingly rapid speed of change. The rapidity and speed of change is likely to be closely matched by Industry than by the other two helices of Government and Academia. This reality was indeed matched by the outcome of the study in that Industry went ahead in any case, with or without the much-needed policy. Industry agreed that policy is important and that it would facilitate the ease of doing business in the South African aquaculture sector, but that policy was not a pre-requisite for progress to be made within the sector by Industry. The result of this acceptance of the state of affairs bred a host of behaviors that benefited disparate areas of the industry, as was evidenced in the abalone sector, and served to fragment the industry even further.

It is therefore concluded that context, specifically context as it relates to policy, is an important pre-requisite for a triple helix system to survive and thrive. It is reiterated that a reviewed model that proposes different approaches to the creation and management of a triple helix model both in the presence of effective policy and its absence is required.

7.4 Proposed model

The triple helix model of innovation on which the study was based seemed to assume that policy was already established within the context in which the triple helix system existed. The outcome of the study suggested that the absence of policy was likely to dilute the impact of the positive outcome of a well-structured triple helix system. An updated model that considered a well-structured triple helix system that exists in a context without policy would be useful.

Figure 8: Proposed triple helix model where policy is absent



Based on the findings of the study, the proposed model in Figure 8 prioritises the implementation of policy to govern all aspects of the elements of the THM theory. Using the South African aquaculture sector as an example, it can be concluded that clarification of the rules of the game and the rules of engagement in terms of collaboration between the three institutional spheres is likely to result in greater willingness from the spheres to collaborate. The respondents have already expressed the willingness to collaborate in the absence of the rules of the game so the implementation thereof may bring comfort to the players in the industry who felt protective over intellectual property if these sphere representatives felt that the rules were to their own benefit.

Adoption of the role of the other could also benefit from the implementation of the rules of the game. It is believed that clarification over the traditional roles of the institutional spheres could help with the organisation of the innovation collaboration activities in the sector. The institutional spheres were found to be adoptive of the roles of the other so coordination of these activities as outlined in the rules of the game is likely to result in the productive structuring of innovation activities to the benefit of the sector as a whole. Lastly, the role of the academia in the sector – which the study showed to be seemingly fading into the background – could be incorporated in the rules of the game or in legislation. This action is viewed as being likely to help the academia sphere re-position itself within the triple helix. Once the academia sphere re-establishes its role more strongly within the triple helix, the rules of the game or legislation could be used to increase its prominence within the sector as leaving the academia to do so on its own given could result in resistance from the industry sphere in particular whose comments highlighted the possible irrelevance of the academia sphere in the sector.

In conclusion, the model suggests the prioritisation of policy before the basic elements of the triple helix system are organised. The presence of a triple helix system implemented within a context where the rules of the game are absent could provide a positive environment where the institutional spheres could be encouraged to collaborate towards the creation of a policy or the rules of the game that benefits the helix as a whole.

7.5 Implications of the study

The triple helix model was used in the research study as a means by which to promote innovation-led growth of a sector. Management was not the only stakeholder in the study, so the implications of the outcomes of the study are equally split between all three stakeholders that were under the research study: Government, Academia and Industry.

7.5.1 Government

The role of government within the ambits of the triple helix system is to use policy to facilitate contractual relations and exchanges between the three institutional spheres (Etzkowitz, 1995; Etzkowitz & Leydesdorff, 2000; Hira, 2013). While collaboration is at the top of the wish list for respondents as a mechanism by which to improve the triple helix system in the South African aquaculture sector, the introduction of policy by government will create a favorable foundation for greater collaboration between the parties. If parties understand the scope of their basic roles

and spheres of influence, they will be better positioned to design an approach for venturing into the "role of the other" in a manner that enhances instead of inhibits work already completed by the party for which the role is being adopted. In other words, collaboration that is based on mutual respect and the intention to maximise effort as governed by policy is likely to result in coherent action as the parties engage each other meaningfully as to how roles may be adopted.

Although the mandate to oversee aquaculture in South Africa has been consolidated over the last few years to the mandate of a single department, the activities performed within the industry activate legislation from other departments. For example, the decision to farm a certain species of aquatic organism triggers legal implications relating to environmental management which is mandated by a different department. The study found that a simple decision to start an aquaculture operation triggers legislation that is foreseen by at least four different departments. This was one of the reasons given by the government sphere regarding the slow process of implementing the policy – there are simply too many "sister departments" whose viewpoints and permissions are sought. In cases such as this where policy creation is slowed down, government should accommodate an adoption of Triple Helix I, an earlier version of the triple helix model that emphasised the centralisation of innovation influence and leadership to the government (Etzkowitz & Leydesdorff, 1997; Etzkowitz & Leydesdorff, 2000). This could be done until such a time that policy is introduced and deemed to be robust enough to transition to Triple Helix II and then finally to Triple Helix III.

7.5.2 Industry

It is indeed true that, given its primary motivation of maximising shareholder value, that the industry is unable to exercise patience in the absence of certain factors that support the ease of doing business (Drury, 2013). Given the fact that government typically follows in the footsteps of industry, it goes without saying that lack of action from industry will greatly hamper the development of a sector. The study showed that industry possesses the appetite, inclination and motivation to invest in high-growth sectors and find ways to survive given difficult circumstances. The study showed that trade associations with strong leadership at the helm have a firm role to play in engaging government and in smoothing out hurdles in the environment that negatively impact the process of business. Trade associations also represent an opportunity for greater collaboration – a wish expressed by many of the respondents in the quest for the improvement of innovation efforts in the South African aquaculture sector.

The absence of policy, coupled with strong interest from government to both collaborate and to prescribe a policy framework, is an opportunity for industry to shape the very same policy that will be used by government to govern industry. Industry, perhaps strengthened by high numbers in the form of a trade association, could relinquish the position of finger-pointing for the absence of policy and instead adopt a position of power in realising that the absence of policy is an opportunity to shape future policy. Such an action will resonate with the idea that policy, in whatever form it takes, should be the outcome of interactions between the three helices instead of a prescription from government (Etzkowitz, 1995).

7.5.3 Academia

Academia is faced with the boldest role of all in the face of the rising importance of knowledge within an economy. The research study showed that just because academia has embraced both its traditional as well as its "higher" roles as prescribed by the triple helix theory, does not mean that the respondents representing the other helices are ready to view academia in its new role. In fact, some of the respondents express contempt over the attempt by academia to become more entrepreneur-driven. This obviously creates friction, especially between the industry and the academia relationship sphere. There emerges a need, then, for clear lines of communication to be established and the "new age" role of the university to be highlighted especially to industry. Perhaps this is another opportunity for academia to establish its presence within a triple helix system and finely tune its portfolio of tasks so that industry is aware of these activities and, most importantly, sees value in them. This will not only streamline the value chain but also create a favorable environment on which industry and academia can establish connections.

7.5.4 Conclusion

The combination of a well-established triple helix system and a guiding policy framework results in an increased ability for the institutional spheres to engage in a manner that improves and nurtures innovation. On the other hand, the absence of a guiding policy presents opportunities for the institutional spheres to use the triple helix system to shape policy – policy that will entrench the profiles and areas of responsibility of the institutional spheres, saving the institutional spheres the challenge of trying to change that which is already ingrained in an existing policy.

7.6 Limitations of the research

The limitations of the research originate from the research methodology used, the contextual limitations as a result of the geographical scope of study and the dynamics that were at play within the industry. Each will be discussed in turn:

7.6.1 Methodology limitations

A qualitative research strategy that was chosen to guide this study presents challenges that are typical of such a strategy. The study could have benefited from a larger sample size, but a qualitative research study proposes the collection of data that is highly detailed extracted from a small sample size (Wiid & Diggines, 2009). The study was also completed under intense time pressures, and the author feels that this fact reduced the deep analysis of data that would have been possible in the absence of time pressures. This was also the first attempt from the author to undertake a detailed research study, so the sophistication of task that is evident in more experienced researchers might not be the same as the one demonstrated by the author.

7.6.2 Geographical limitations

The study was undertaken in the context of a specific industry in a specific country. This limits the generalisability of the study in other contexts, for example, in a different country. A qualitative study is, generally, weak in terms of generalisability of results (Wiid & Diggines, 2009).

7.6.3 Contextual limitations

Current literature assumes the existence of policy, but policy was non-existent in the context chosen. The limitation introduced by this is that perhaps the results of the study would have been more classical within a context that had all the theoretical assumptions in place. Since policy affects the manner with which government is able to facilitate exchanges, the results would have been different in a setting where the institutional spheres had direction on what their respective roles and responsibilities within the South African aquaculture sector.

7.7 Suggestions for future research

Suggestions for future research are extracted from the limitations presented in the preceding section as well as from observations made during the interviewing process. Further research should be conducted to address the following points:

- What is the effect on innovation activity does the presence versus the absence of policy in an otherwise well-constructed triple helix system?
- Given the negative sentiment that environment-conscious consumers may have about aquaculture, is the South African aquaculture industry ready to attempt transitioning into the quadruple helix system?
- The South African aquaculture sector has limited case study information available. The abalone sub-sector is said to be the most successful sub-section of the aquaculture sector. A comparative study between the abalone sub-sector and another, less successful sector such as tilapia could help gain an understanding of how the former has gained success while the latter has not.
- The leadership within the South African government office is in a constant state of flux. What impact does this have on the wellbeing of the industries affected by consistent change in public office leadership?
- What comprises the entrepreneurial consideration set of an entrepreneur-driven investor who is interested in entering the industry, and to what extent is information available to supplement and guide his or her thought processes favorably?
- What drives investment into the aquaculture sector and who is responsible for ensuring that these drivers align to what is being offered by the sector to the investment community?

7.8 Conclusion

The objective of the study was to explore innovation activity between the three institutional spheres of government, academia and industry in the South African aquaculture sector with the aim of establishing if such activity is likely to support the growth of the sector. The tripe helix model of innovation was used to evaluate the triple helix system as it was currently structured in the sector. While it was encouraging to see that the system was seemingly in good condition as compared to the propositions of the triple helix theory, the absence of the rules of the game that the theory assumes to be in place was seemingly inhibitive of the triple helix system. A proposed model for overcoming this was tabled with the suggestion that the absence of the policy and the presence of a triple helix system was not necessarily a negative phenomenon. The triple helix system could be encouraged to collaboratively work towards the rules of the game. This action would likely result in the appropriate balancing of the interests of the institutional spheres, which may lead to a stronger incentive to comply to the rules.

8 APPENDICES

8.1 Appendix A – Consent Form

Gordon Institute of Business Science
University of Pretoria

Department of Social Wildlife Hunting
178 Plein Avenue
Cape City
7155

14 September 2015

Consent for an interview

Dear Sir or Madam,

I am conducting research on the role of innovation in the South African aquaculture sector. I am attempting to find out more about how innovation practices are applied at institutional level within the industry. The study is expected to shed some light on how institutional innovation networks can support industry development by creating an environment that nourishes new ideas, processes and products.

Our interview is expected to last between one and two hours, and will help us understand how emerging industries can use innovation to achieve sectorial growth and sustainability.

Your participation is voluntary and you are welcome to withdraw at any time without penalty or recourse. Although the interview will be recorded, you are given unconditional assurance that all data and identities will be kept confidential.

If you have any concerns at any given point during the course of the study, you may contact me or my supervisor. Our contact details are as follows:

Researcher name: Tumi Nkosi
Email address: tumi.nkosi@me.com
Telephone number: 072 953 9978

Researcher name: Bev Waugh
Email address: bev.waugh2@gmail.com
Telephone number: 011 771 4000

Signature of researcher:

_____
Date:

Signature of respondent:

_____
Date:

Thank you for your willingness to participate in the study. I look forward to meeting with you on the date and time as discussed.

Yours sincerely,
Tumi Nkosi

Gordon Institute of Business Science
Reg. No. 99/19816/08
26 Melville Road, Illovo, Johannesburg
PO Box 787602, Sandton, 2146, South Africa
telephone **(+27) 11 771 4000**
fax **(+27) 11 771 4177**
website **gibs.co.za**
University of Pretoria

8.2 Appendix B – Introductory Email

Dear Mr. Smith,

I hope that you are doing well.

This email is confirmation of our interview by teleconference at 11:00 CAT this morning. I enclose a copy of the list of questions that I will be asking for your information. In line with the GIBS ethics research practices, I will need you to please sign the attached consent form.

The interview will be recorded for transcription purposes. The confidentiality of your identity as a participant in my study is guaranteed in that the units of analysis will be based on the three helices (i.e. government, industry or academia) and not the actual people or names of institutions themselves.

If there is anything else that you need, let me know. I am excited about the interview and look forward to it.

Warm regards,

Tumi.

8.3 Appendix C - Questionnaire

List of questions

1. Provide an overview of the current state of the South African aquaculture sector.
2. What is the role or what are the roles played by your institution insofar as sectoral development is concerned?
3. Which institutions are tasked with the development of the South African aquaculture industry?
4. (a) Would you define the South African aquaculture sector as innovative?
   (b) What new ideas are you aware of that were conceptualised by the South African aquaculture industry that have been successfully commercialised to the benefit of the industry as a whole?
5. Is there collaboration within the sector between government, universities and the industry?
6. How does the South African aquaculture sector generally manage innovation?
7. The South African government has formulated bold growth goals for its aquaculture sector. Given the structure of the sector and the nature of innovation within it, is the industry primed to meet these goals?
8. What can each of the three spheres – government, industry and universities – do to improve the level of collaboration and innovation in the South African aquaculture sector?

8.4 Appendix D – Code Book

All current codes

HU: The triple helix in South African aquaculture
File: [Y:\04_PROGRAMMES\2015\150038 - Standard Bank CACP 2015 - Kat...\The triple helix in South African aquaculture.hpr7]
Edited by: Super
Date/Time: 2015-11-09 06:43:52

Abalone industry
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-28 07:06:17

Quotations: 22
Comment:
A sub-sector of the industry meta-actor.

Academia or universities
Created: 2015-10-10 07:25:44 by Super
Modified: 2015-10-28 06:51:50

Quotations: 24
Comment:
Meta-actor in the triple helix system

Additional roles
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-27 14:18:49

Quotations: 3
Comment:
Non-traditional role of the university or academia meta-actor.

All these institutions playing..
Created: 2015-10-10 10:16:01 by Super
Modified: 2015-10-10 10:18:03

Quotations: 0

Aquaculture sectoral growth
Created: 2015-10-10 07:54:33 by Super
Modified: 2015-10-28 07:04:51

Quotations: 29

Aquaculture value chain
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-28 06:25:59

Quotations: 13

Comment:
The evolution of innovation - could tie into open innovation, national innovation systems and the triple helix model.

Clusters
Created: 2015-10-10 08:28:46 by Super
Modified: 2015-10-27 21:45:04

Quotations: 10

Collaboration
Created: 2015-10-10 07:31:29 by Super
Modified: 2015-10-28 07:10:07

Quotations: 85
Comment:
Main activity in the triple helix model.

Competitive advantages
Created: 2015-10-10 09:50:30 by Super
Modified: 2015-10-27 17:27:48

Quotations: 6

Cross-border opportunities
Created: 2015-10-10 07:25:44 by Super
Modified: 2015-10-28 07:09:03

Quotations: 13
Comment:
An opportunity to consider in the quest to grow the South African aquaculture sector in light of the limiting factors faced by the industry.

Development of industry
Created: 2015-10-10 10:15:53 by Super
Modified: 2015-10-28 07:02:17

Quotations: 57

Empowerment
Created: 2015-10-10 09:44:55 by Super
Modified: 2015-10-28 06:57:31

Quotations: 7

Environment
Created: 2015-10-27 14:30:13 by Super
Modified: 2015-10-28 06:41:04

Quotations: 9

Example of best practices
Created: 2015-10-27 13:28:41 by Super
Modified: 2015-10-27 16:49:22

Quotations: 6

Frustration
Created: 2015-10-10 09:41:57 by Super
Modified: 2015-10-28 06:43:28

Quotations: 16

Fulfillment of non-traditional roles
Created: 2015-10-10 07:31:29 by Super
Modified: 2015-10-28 06:53:22

Quotations: 68
Comment:
The challenge put forth by triple-helix theory or model.

Fulfillment of tradtional functions and roles
Created: 2015-10-10 07:31:29 by Super
Modified: 2015-10-28 06:50:48

Quotations: 17
Comment:
From what I can see here, the University of Stellenbosch is falling short of its traditional roles, let alone the non-traditional ones. No research, only teaching. ARC is an academia, chosen because of this idea too.

Funding
Created: 2015-10-10 08:22:51 by Super
Modified: 2015-10-28 07:04:39

Quotations: 62
Comment:
The fact that we have these limiting factors means that we are also unable to compete for international funding that we need to experiment with new species locally. The NRF is giving funding but is that enough to fund the universities sufficiently?

Globalisation decentralisation
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-10 07:42:55

Quotations: 0
Comment:
The outcome of the triple helix system that "splits up" globalisation into regions.

Globalisation in regional networks
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-10 07:42:35

Quotations: 0
Comment:
An outcome of the decentralisation of globalisation from a context of "the globe" to a regional context.

Government
Created: 2015-10-10 07:25:44 by Super
Modified: 2015-10-28 06:57:04

Quotations: 19
Comment:
One of the three-part triple helix meta-actors

Increased importance of knowledge
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-10 07:41:59

Quotations: 0
Comment:
Linked to the prominent role of the university or academia.

Incubators, science parks and networks
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-28 06:52:26

Quotations: 2
Comment:
Part of what the non-traditional role of the university or academia should be responsible for.

Industry
Created: 2015-10-10 07:25:44 by Super
Modified: 2015-10-28 06:36:35

Quotations: 17
Comment:
Responsible for production.

Innovation
Created: 2015-10-10 07:25:44 by Super
Modified: 2015-10-28 07:06:37

Quotations: 70
Comment:
The outcome of the collaboration between government, industry and academia or university.

Innovation is not a prescription from government
Created: 2015-10-10 07:31:29 by Super
Modified: 2015-10-10 07:40:29

Quotations: 0
Comment:
What innovation should not be.

Investors
Created: 2015-10-27 13:37:12 by Super
Modified: 2015-10-28 07:08:03

Quotations: 22

Key success factors in aquaculture for industry
Created: 2015-10-10 07:58:39 by Super
Modified: 2015-10-27 14:18:08

Quotations: 2

Knowledge-based economy
Created: 2015-10-10 07:31:29 by Super
Modified: 2015-10-10 07:40:17

Quotations: 0
Comment:
The reason for the increasing prominence of the role of the university.

Leadership
Created: 2015-10-10 07:25:44 by Super
Modified: 2015-10-28 06:50:12

Quotations: 6
Comment:
Strong leadership needed to drive development?

Legislation
Created: 2015-10-10 07:25:44 by Super
Modified: 2015-10-28 07:07:36

Quotations: 58
Comment:
An output of the role of government as a regulator.

Limiting factors in SA aquaculture
Created: 2015-10-10 07:31:29 by Super
Modified: 2015-10-28 07:02:11

Quotations: 35
Comment:
Limiting factor in the growth of the South African aquaculture sector.

Locus of production
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-10 07:39:11

Quotations: 0
Comment:

290 Traditional role of industry
291 _____
292
293 Market limitations
294 Created: 2015-10-10 07:31:29 by Super
295 Modified: 2015-10-28 07:08:37
296
297 Quotations: 10
298 Comment:
299 South Africans are not fish eaters.
300 _____
301
302 Operation Phakisa
303 Created: 2015-10-10 08:00:22 by Super
304 Modified: 2015-10-28 06:49:16
305
306 Quotations: 20
307 _____
308
309 Players in the industry
310 Created: 2015-10-27 16:36:21 by Super
311 Modified: 2015-10-28 06:20:09
312
313 Quotations: 8
314 _____
315
316 Politics
317 Created: 2015-10-10 07:25:44 by Super
318 Modified: 2015-10-28 06:41:20
319
320 Quotations: 24
321 Comment:
322 Inter-relations in the triple helix system of innovation in the South African aquaculture sector
323 _____
324
325 Potential of aquaculture in South Africa
326 Created: 2015-10-10 07:54:33 by Super
327 Modified: 2015-10-28 06:46:15
328
329 Quotations: 14
330 _____
331
332 Prominent role for the university
333 Created: 2015-10-10 07:29:43 by Super
334 Modified: 2015-10-28 06:28:35
335
336 Quotations: 7
337 Comment:
338 Non-traditional view of the university or academia
339 _____
340
341 Protectionism
342 Created: 2015-10-27 13:27:13 by Super
343 Modified: 2015-10-28 07:08:48
344
345 Quotations: 24
346 _____

Public entrepreneur
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-10 07:38:04

Quotations: 0
Comment:
Non-traditional role of government

Reaction to non-traditional roleplaying
Created: 2015-10-27 13:15:42 by Super
Modified: 2015-10-28 06:53:37

Quotations: 11

Regulatory role
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-27 12:55:29

Quotations: 1
Comment:
Traditional role of government

Research
Created: 2015-10-27 12:55:44 by Super
Modified: 2015-10-27 21:55:12

Quotations: 10

Return on investment
Created: 2015-10-27 17:46:28 by Super
Modified: 2015-10-28 06:25:06

Quotations: 10

Risk
Created: 2015-10-27 17:13:17 by Super
Modified: 2015-10-28 06:55:24

Quotations: 7

Roles
Created: 2015-10-10 07:25:44 by Super
Modified: 2015-10-10 07:32:14

Quotations: 0
Comment:
Traditional roles are being fulfilled as well as non-traditional roles by the three spheres

---

Skills - industry specific

Created: 2015-10-27 17:48:26 by Super
Modified: 2015-10-28 07:10:17

Quotations: 14

Social capital

Created: 2015-10-10 09:37:37 by Super
Modified: 2015-10-28 06:31:47

Quotations: 6
Comment:
The pattern and intensity of networks amongst a group of people.

Source of contractual relations that guarantee stable interactions

Created: 2015-10-10 07:25:44 by Super
Modified: 2015-10-10 07:32:27

Quotations: 0
Comment:
The master role of government

Source of human resources and knowledge

Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-10 07:33:17

Quotations: 0
Comment:
Traditional role of university or academia

Source of regional economic development

Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-10 07:33:07

Quotations: 0
Comment:
Traditional role of academia or university

Species

Created: 2015-10-10 07:31:29 by Super
Modified: 2015-10-10 09:52:14

Quotations: 4
Comment:
Legislation determines which species are allowed to be farmed in South Africa

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Technology transfer

Created: 2015-10-27 13:39:13 by Super
Modified: 2015-10-27 21:30:39

Quotations: 4

Themes
Created: 2015-10-10 07:25:44 by Super
Modified: 2015-10-10 07:35:41

Quotations: 0
Comment:
Themes of the triple helix theory: 1. More prominent role for the university or academia in innovation, 2. Movement towards a collaboration between the three spheres, 3. Innovation is an outcome of these interactions, 4. Innovation is not a prescription from government, 5. Fulfillment of traditional roles or functions, 6. Fulfillment of non-traditional roles or functions, 7. Knowledge-based economy as the context

---

Tilapia industry
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-27 21:26:04

Quotations: 10
Comment:
Sub-industry of aquaculture in South Africa

Too important to be left to an individual firm or researcher or group of firms or researchers
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-10 09:50:19

Quotations: 0
Comment:
The duty of innovating.

Traditional role
Created: 2015-10-27 12:56:40 by Super
Modified: 2015-10-27 12:57:34

Quotations: 2

Trout industry
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-10 07:36:46

Quotations: 0
Comment:
A sub-sector of the aquaculture sector in South Africa

Trust
Created: 2015-10-27 16:22:12 by Super
Modified: 2015-10-28 06:31:42

Quotations: 5

Venture capitalist
Created: 2015-10-10 07:29:43 by Super
Modified: 2015-10-10 10:07:28

515
516 Quotations: 2
517 Comment:
518 Non-traditional role of government
519 _____
520
521 Working model of aquaculture
522 Created: 2015-10-10 07:57:58 by Super
523 Modified: 2015-10-27 21:54:10
524
525 Quotations: 8
526 _____

8.5 Appendix E – TurnItIn Report

turnitin

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This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

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Gordon Institute of Business Science

Aquaculture in South Africa:

Using the triple helix model to explain innovative activity in institutional spheres

8.6 Appendix F – Ethical clearance letter

Gordon Institute of Business Science
University of Pretoria

Dear Tumishang Nkosi

Protocol Number: **Temp2015-01971**

Title: **Aquaculture: an exploration of the productivity of innovation networks as accelerators of diffusion**

Please be advised that your application for Ethical Clearance has been APPROVED.

You are therefore allowed to continue collecting your data.

We wish you everything of the best for the rest of the project.

Kind Regards,

Adele Bekker

8.7 Copyright declaration form

Gordon Institute of Business Science
University of Pretoria

COPYRIGHT DECLARATION FORM

Student details			
Surname:	**Nkosi**	**Initials:**	**TN**
Student number:	14452953		
Email:	Tumi.nkosi@me.com		
Cell :	**072 953 9978**	**Landline:**	**078 389 4789**
Course details			
Degree:	**MBA**	**Year completed:**	**2015**
Department:	**GIBS**		
Supervisor:	**Beverly Waugh**		
Supervisor email:	Bev.waugh1@gmail.com		
Confidentiality / Embargo			
Do you need to have your report embargoed? If so, write a letter of motivation to substantiate (please attach letter to this form). Without a letter this will not be granted.			
Yes		**No**	**X**
If yes, please indicate period requested			
Two years		****Permanent**	
****Please attach a copy of the letter of permission from the Vice-Principal: Research and Postgraduate Studies, if indicated, permanent. Without a letter this will not be granted.**			
A copy of your research report will be uploaded to UPetd/UPSpace Can the Information Centre add your email address to the UPetd/UPSpace web site?			
Yes	**X**	**No**	
If no, please motivate (ignore if report is to be embargoed)			
Copyright declaration			

I hereby certify that, where appropriate, I have obtained and attached hereto a written permission statement from the owner(s) of each third-party copyrighted matter to be included in my research report ("the work"), allowing distribution as specified below. I certify that the version of the work I submitted is the same as that, which was approved by my examiners and that all the changes to the document, as requested by the examiners, have been included.

I understand that all rights with regard to intellectual property in the work vest in the University who has the right to reproduce, distribute and/or publish the work in any manner it may deem fit.

I agree that, a hardcopy of the abovementioned work be placed in the Gordon Institute of Business Science Information Centre and worldwide electronic access be given to the softcopy on UPetd and UPSpace.

Signature:	Date: 9 November 2015

8.8 Appendix G - References

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