Survival, R&D propensity and technological capability: Factors impacting the innovation performance of new technology-based firms in South Africa.

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ABSTRACT

New technology-based firms (NTBFs) or technopreneurs are assumed to be one of the most important sources of economic value creation and development. Apart from bringing innovation with high growth and impact potential, NTBFs are faced with high uncertainty and demand a supporting environment that enhances firm's performance. It can be concluded that new firms or new incubatees operate in competitive settings and demand systems that aid them to realize sustainable growth. Globally, there is a well-established body of knowledge that scrutinizes factors and relationships between factors that enhance NTBFs innovation performance. Majority of existing literature concurs that there are numerous variables of factors that can influence the product or service performance in respect to turnover. Within sub-Saharan Africa, technology incubation support programmes are seen as factors that affect a firm's performance. However, the rise of NTBFs, the startups concept and technology incubator practices are all very much in their infancy in South Africa.

From this point of view, it is significant to qualify the existing global body of knowledge to Gauteng's context in order to identify the right mix factors impacting innovation performance of new technology-based firms. Factors such as survival, research and development (i.e. R&D propensity) and technological capability are seen as levers that impact new technology-based firm's innovation performance. In a narrow sense, in this study, we aim to extend existing research by identifying determinant factors related to survival, R&D propensity and technological capability as independent variables; and analyse the nexus of these factors and innovation performance, the independent variable.

We prudently identify startup firms that are in technology and embrace innovations while most of these new startups are still in an early development stage and receive comprehensive investment from university or government innovation in Gauteng. A total of 206 NTBFs were surveyed. Initially, the study employs exploratory factor analysis to first estimate the underlying variables and estimate of latent loadings. Subsequently, the correlations between survival, technological capability, R&D propensity and innovation performance measurements were tested.

The findings suggest that there is no relationship between the number of years under the incubation management and producing new products and services that firms can launch to new market to gain profits in order to survive. Particular, in South Africa, the technology incubator movement is still in an infancy stage; hence for firms starting new ventures and producing products, it is difficult. The evidence from this study also found no relationship between survival (i.e. access to knowledge and collaboration) and innovation performance i.e. turnover. On the other hand, it was expected that investing vigorously in R&D would create patents, publications, products and services which would impact turnover. In opposition, the empirical results found no statistical relationship between R&D propensity and turnover. Our results should also be interpreted in the broad sense; measuring R&D propensity should be viewed with the understanding of complexity in measuring R&D impact to turnover. The study also found no relationship between marketing and firm turnover. Although theoretical studies suggest applying marketing capability is a key in launching and commercialising innovations, these firms tend to place more focus on product developments and pay less attention to marketing capabilities.

Consistent with existing literature, the study found that there is a positive relationship between technological capability - innovativeness and innovation performance i.e. turnover. This is in line with the researcher's position that generation, developing and implementation of new ideas leads successful performance of innovation, while we have contended that adapting or modifying existing technologies, emphasising introduction of new products, marketing of tried and true technologies and using previous research to implement technologies as determinant factors to technological capability (i.e. Technology Adaptation) impacts innovation performance. The results of the study concluded that there is a relationship between Technology Adaptation and innovation performance. In regards, competitive environment, the study found that no relationship between introducing innovation ahead of competitors and innovation performance. It was expected that these firms would avoid taking risks, these firms are not equipped with resources to experiment innovation methods or lead in new market identification.

The empirical evidence generated from this study is significant and contributes to the existing body of knowledge for this reason: the study advances literature of measurements of innovation performance which varies from one study to the other.

DECLARATION

I, Wonder Ndlovu, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in Entrepreneurship and New Venture Creation (MMENVC), Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Wonder Ndlovu

Signed at …………………………………………………

On the …………………………….. Day of ………………………… 2016

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"Izandla ziyagezana", Zulu proverb. A direct translation to English means, "It is all about working together "

Having said that, I would not have been able to produce this research report without the following people:

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To all the entrepreneurs, startups, technology incubators, technology transfer offices, incubator managers in Gauteng, I would like to thank you for taking time to complete the and/ or distributing survey questionnaires.

Finally, I would like to specially, thank my little sister for bearing with me during my research process and continuing doing your part to ensure you do well at school and looking after yourself.

DEDICATION

I dedicate this research report to my late mother Thabisile Queen Ndlovu, my granny mother Xoshiwe Ndlovu, sisters, brothers and uncles, aunts and my entire family. Thanks for putting my education first and always emphasizing that education is a key to unlock opportunities.

Mother, aunts and granny, friends, without your commitment to education, all the support and sacrifice you made, I would not be where I am today.

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1. INTRODUCTION

New technology-based firms (NTBFs) or technopreneurs are assumed to be one of the most important sources of economic value creation and development (Thérin, 2007). Apart from bringing innovation with high growth and impact potential, NBTFs are faced with high uncertainty and demand supporting environment that enhance firm’s performance (Chan, 2005). It can be concluded that new firms or new incubatees operate in competitive settings and demand systems that aid them to realize sustainable growth. The idea of the technology incubator is regularly utilized as an overall denomination for institutions or environment that constitutes or provide a backing that is definitive to the "incubating" and the development of the NTBFs (Bergek, 2008).

Technology incubators can play a key role in supporting NTBFs by betting on innovation as a way to help the creation and development of these firms (Grilo, 2015). NTBFs are therefore exposed to the technological entrepreneurship ecosystem to access critical resources provided by a set of science parks or technology hubs, i.e. national- or provincial-, university- and private-run technology incubators. However, the incentive of NTBFs in technological entrepreneurship ecosystems are subjected to survival, growth and R&D outputs that lead to firms’ innovation performance i.e. the proportion of revenue from products and services added to NTBFs market (Colombo, 2002).

Globally, there is a well-established body of knowledge that scrutinizes factors and relationships between factors that enhance NTBFs innovation performance. Westhead (1996) found that a technically qualified spin-off founder directly affects firm’s survival and growth; Tidd (2001) suggested that internal and external organization factors (i.e. collaboration, networks, organization structure) affect the capability to develop and launch new innovation, while Lofsten (2003) measured innovation performance in relation to job creation and sales. Furthermore, Kim (2010) identified funding and “physical space” as factors that enhance a firm’s performance, while Grilo (2015) argued that a firm’s performance is caused by its degree of R&D efforts. Within sub-Saharan Africa, grant funding and physical space are factors that affect a firm’s performance in relation to access to expertise, business opportunities and external funding that lead to self-sustainability (InfoDev, 2010). However, the rise of NTBFs, the startups concept and technology incubator practices are all very much in their infancy in South Africa.

This situation negatively affects the survival, R&D output and technological capability of NTBFs in SA. Considered antecedent factors that affect firms' performances in developed economies do not necessarily have similar applicability to South Africa (SA) (InfoDev, 2010). Some of the existing literature analysed technology incubators and firm's performance in SA by measuring the performance of policy implementation (Ndabeni, 2008). Alessandrini (2013) and Ndabeni (2008) examined the role of technology incubators to firms' growth and assessed the firms' structures and key factors of the status quo of technology transfer at university-run incubators respectively. A recent study by (Masutha, 2015) extended the existing literature to investigate business and technology in SA during the past 15 years in regards to challenges to the activities of incubators, level of commitment by government and variances amongst incubators functioning under state-run as opposed to private-run. Their studies highlighted the progress of technology and policy implementation and linked it with firm growth.

Despite the extent of recent literature, there has been little analysis of determinant factors that impact the innovation performance of NTBFs. Much more work is done on descriptions of start-up policy effectiveness and formalization of technology incubators than empirical investigations of underlying factors impacting innovation performance. This presents an opportunity for this academic work to extend the existing body of knowledge by identifying determinant factors impacting the innovation performance of NTBFs. In this study, we aim to extend existing research by identifying determinant factors related to survival, R&D propensity and technological capability; and analyse the nexus of these factors and innovation performance of NTBFs as opposed to a descriptive analysis of technology incubators in university-run and government-run technology incubators. By examining innovation performance rather than overall firm performance, we avoid an excessively broad measure of innovation performance.

The study will contribute to knowledge in three ways. Firstly, the study aims to shed a light on NTBF's innovation performance in Gauteng, South Africa. Secondly, it seeks to identify the determinant factors of technology-based firm's survival, R&D propensity and technological capability. Thirdly, investors, fund managers, technology incubator managers, start-ups and policy-makers involved technological entrepreneurship will derive a better understanding of relationship between survival, R&D propensity, technological capability and innovation performance.

1.1. Context of the study

Industrialising economies are recognizing the role played by NTBFs to produce technological ventures by creating conditions that foster new technologies. Globally, national and local governments are creating environments for technological entrepreneurship to flourish in the form of national innovation systems. The introduction of technology incubators often referred to as science parks encourage and support the majority of NTBFs to undertake R&D, with an objective of launching of new products and markets (Lofsten, 2002). In the past 15 years, South Africa has formed technology incubators to strengthen and accelerate activities that include development of new technology (Ndabeni, 2008). At a national level, a number of policies and acts to coordinate and manage country's NIS exist. The DST, at a national level has developed a number of policies and acts to coordinate and manage the country's NIS. In SA, the Department of Science & Technology (DST) continues to bring interventions other than technology incubators to provide support for technological entrepreneurship through policies to aid NTBFs to translate innovation into significant products or services.

At the heart of the innovation process, successfully bringing and commercializing innovations is key to the growth of NTBFs, but some startup firms nevertheless fail despite being innovative. According to (InfoDev, 2010), the startup community in SA has been increasingly expanding over the years with lots of painful growth, extraordinary successes, shattered dreams and ruined credit records. Gauteng's provincial government took a bold step by establishing The Innovation Hub in 2000 to encourage R&D activities, technology transfer and providing support to startups (InfoDev, 2010). The environment in Gauteng is set up in a way that there are private or university technology incubators providing funding, space, coaching, technical and commercial support to startups or NTBFs to achieve the sustainable growth of start-ups. In the province, technology incubators including The Innovation Hub, SoftStart, Resolution circle and others provide support to entrepreneurs and start-ups to prototype R&D and commercialize it, amongst other things (Ndabeni, 2008).

In the light of the above, there is no uniquely accepted approach for support of NTBFs' survival, R&D propensity and the successful launching of new products and services. It is significant to qualify the existing global body of knowledge to Gauteng's context in order to identify factors impacting innovation performance. Lofsten (2003) study in Sweden analyzed the effects of new product versus process innovation, the findings settled on existence of financial markets and exploiting an invention or technological innovation as factors that can impact the product innovation performance of NTBFs. Based on the above context, the present study analyzes three dimensions: survival, R&D propensity and growth as factors that can impact NTBFs innovation performance which are located in, or recently graduated from the technology incubators (i.e. university or government technology incubators). For instance, Westhead (1996) study of high-technology firms in Great Britain based at the Science Park identifies "space" as affecting firms' survival which directly affects innovation performance during the early development stage. Furthermore, existing literature suggests that although Science Parks or technology incubators supply critical key resources to NTBFs, nevertheless it is important to understand how the combination of various other factors such as adapting new technology and a strong focus on R&D activities encourage a firm's innovation performance (Coad, 2008).

1.2. Purpose

The purpose of this study is to examine the innovation performance of NTBFs located at government-run and university-run technology incubators in relation to survival, R&D propensity and technological capability.

1.3. Study Aims

To identify the determinant factors for survival, R&D propensity and technological capability of NTBFs in government-run and university-run technology incubators and identify factors related to innovation performance.

1.3.1. Secondary aims

1.3.1.1. Survival

To determine the determinant factors for the survival of NTBFs in government-run and university-run technology incubators.

1.3.1.2. R&D propensity

To determine the determinant factors for R&D propensity of NTBFs in government-run and university-run technology incubators.

1.3.1.3. Technological capability (non- R&D activities)

To determine the determinant factors for technological capability and identify factors related to NTBFs' innovation performance in both government-run and university-run technology incubators.

1.4. Research questions

According to Ndabeni (2008); Masutha (2015) technology entrepreneurial startup practices are very much in their infancy in SA. Nevertheless, the Gauteng province has made significant progress in formalizing the technology incubators to support NTBFs during the early development stage. Despite the supporting environment, there is a poor rate of survival of NTBFs which affect firms' innovation performance. Thus, prompting the following research questions:

1) What are determinants factors related to the survival of nascent firms?
2) What is the relationship between R&D propensity and NTBF's innovation performance?
3) Does technological capability (non-R&D activities) of a NTBF lead to innovation performance? If so, under what conditions?

1.5. Definition of terms

1.5.1. Technological entrepreneurship

Technological entrepreneurship is defined as a form of leadership that comprises of exploring high-potential, technology-intense commercial profitable opportunities, gathering resources such as talent and capital, and managing rapid growth and significant risk using principled decision-making skills (Therin, 2007).

1.5.2. New technology-based firms

New technology-based firms (NTBFs) are a key element in technological entrepreneurship to assure innovation and the creation of new jobs in an economic system (Colombo, 2002). Chea (2008) defined NTBFs as a venture that conducts a detailed assessment of the attainability and potential financial value of identified opportunities, and from dynamic strides, creates them through new ventures.

1.5.3. Innovation performance

Commonly, there are twofold methods to assessing level of innovation performance. For example, one explores indicators in the public domain such as Research and Development (R&D) expenses, intellectual property IP output and innovation launches; whereas other utilizes internal measures, for example the percentage of personnel with practical expertise or the percentage turnover from new products launched in the past years (Tidd, 2001). There are no homogeneously accepted determinant factors for NTBFs' innovation performance.

1.5.4. Technology incubators

The main objective has been and still is, to nurture entrepreneurial start-ups that will grow rapidly, create wealth and employment and contribute to local and regional economic development (Abetti, 2004). A typical incubator includes services such as capital access, business coaching, legal services and networking, while technology-based incubators also include support related to technology transfer and intellectual property guidance (Ndabeni, 2008).

1.6. Contribution of the study

The study will contribute to existing knowledge in three ways. In a broad sense, it has been advocated that science parks [either university-run or government-run technology incubators] facilitate the growth and performance of the NTBFs (Chan, 2005). However, the evidence is not conclusive; Tidd (2001) highlighted the difficulty in concluding the relationship between a set of factors and firm's innovation performance due to a country's unique environment.

Firstly, according to Grilo (2015) the main measure of NTBFs' performance is the introduction of new products or services to new market. Thus, the present study seeks to identify the relationship between survival, R&D propensity, technological capability and innovation performance. A better understanding of the relationship among these factors may provide finer-grained theories to guide innovation management research and clearer and more consistent advice for management practice.

Secondly, Lau (2015) suggested that the problem of studying innovation and effectiveness at the regional level has not yet been completely resolved. Despite the number of policy regimes seeking to support technological entrepreneurship and fostering a favorable environment for NTBFs, evidence accumulated suggests that a high number of new ventures fail and only a few survive and grow (Ndabeni, 2008). Therefore, in order to improve innovation and technological capabilities; efficient regional innovation systems are important to build innovation capacity in a country (Zhao, Cacciolatti, Lee & Song, 2015). This study will attempt to offer an academic understanding to policymakers and technology incubator' managers to understand the provision of resources such as "space", funding, duration, R&D activities or technological capability whether or not to assist NTBFs attain a high level of success with regard to innovation performance during the early start to development stages of NTBFs.

2. LITERATURE REVIEW

2.1. Introduction

This chapter provides an academic context of the study and locates a theoretical background related to the research problems and hypothesis. The literature review has an official account of about 350 years and denotes to the most significant part of the quantitative research approach (Onwuegbuzie, Leech & Collins, 2012). Reviewing of literature provides context for the research framework and innovation studies. An existing body of knowledge of innovation is embedded in a wide-range of disciplines, including management science, economics, geography, and consequently assumes different approaches, and definitions (Tidd, 2001). In this context, innovation is theoretically rooted in technological entrepreneurship theories.

To contextualize the study, this chapter reviews the existing body of innovation management, national innovation systems, technology incubators and technology-based firms. This is followed by outlining innovation management, research and development, technological capabilities and the innovation performance of NTBFs. The literature review then explores three factors – survival, research and development (R&D) and technological capabilities, whether do these factors impact new technology-based firm's innovation performance. Based on the existing theories and models, a theoretical model of the study is presented.

Furthermore, construct variables or underlying variables of the above-mentioned factors are rigorously discussed to link the theoretical lens to the research problem. Each sub-literature review section concludes with a summary and the formulation of each hypothesis for this study.

2.2. Theoretical background to technological entrepreneurship in the context of new technology-based firm

This section review existing literature of this study.

2.2.1. Conceptualizing entrepreneur, entrepreneurship and Technopreneurship

The importance of technological entrepreneurship in a developing economy such as South Africa, it is significant as it creates wealth for individuals, contributes to economic development through job creation and at a macro level, contributes to regional development. It is a common understanding that a new-technology-based firm (NTBF) plays a critical role in bringing new technology and creating new employment in the economic system.

There are many definitions of entrepreneurship and it covers multiple disciplines and industries. Moreover, entrepreneurship is broadly outlined by tracing its evolution through academic theories and its practices. First of all, let us explore the definitions of an entrepreneur. What is an **entrepreneur**? The entrepreneur paradigm can be followed back to the 1930s when Schumpeter initially endeavored to build up a hypothetical association between a business person and innovator (Barreira, Carmichael, Dagada, Duneas, Marcelle, Smith & Urban, 2011). Diverse researchers had characterized an entrepreneur in distinctive context. The majority of the researchers concur that there is a need to comprehend what an entrepreneur does and how. According to Filion (1998) people tend to perceive and define entrepreneurs using the premise of their own background or disciplines, but similarities do emerge within each discipline. Schumpeter simplifies the definition of an entrepreneur by emphasizing that is an individual who accomplishes new things and not necessarily the individual who invents (Schumpeter, 1989).

However, this definition of an entrepreneur who accomplishes new things is an issue as the definition do not account for the nature of commercial opportunity. As indicated by Moroz (2012), an entrepreneur seeks opportunities that are seen to be gainful or profitable; combined with the command to make new means-end relationship for exploiting them. We endeavor to discover shared understanding from diverse researchers that may serve as foundational to the comprehension of the meaning of an entrepreneur. The paramount qualities of the entrepreneur are distinguished, one of which is the capacity to consolidate effectively existing assets in inventive ways (Schumpeter, 2000). This study embraces the meaning of an entrepreneur by Venter, Urban & Rwigema (2008); entrepreneur is the electrifying power behind the new venture, mixing opportunity, resources, and the team to deliver something new or particular, commercially; to add value in the face of dynamic competition and an unstable environment.

Moreover, there is a relationship between entrepreneur and entrepreneurship. An entrepreneur is the agent of change and facilitates the process of entrepreneurship. In the accompanying section, diverse conception of entrepreneurship is reviewed to illustrate a more extensive meaning of entrepreneurship. Differing researchers have introduced various entrepreneurship process models and contend that these models are profoundly divided in their cases and emphases and are deficient for building up a framework whereupon to combine and comprehend the entrepreneurial process that is both generic and distinct (Moroz, 2012).

Entrepreneurship may be, in large measure, a function of an institutional sociopolitical structure which allows protection to the innovator in the era of financial benefits (Schumpeter, 1983). Venkataraman (1997) highlighted that entrepreneurship is a process of making new markets, new commercial ventures, new innovation, new institutional structures, new employments, and net expansions and generate profitability. According to Venter, et al. (2008) it is the process of creating something new with value by devoting the necessary time and efforts assuming the accompanying financial, psychic and social risks and receiving the resulting rewards of monetary and personal satisfaction and independence. Although one may stumbled across several definitions of entrepreneurship, it is noted that there are cases of similarities in defining entrepreneurship - some of the key terms associated with entrepreneurship - innovation (Schumpeter, 2000); revolutionary Urban (2008); creativity (Kuratko, 2004); value creation (Bruyat, 2000); pillar of innovation (Hindle, 2004), human urgency Urban (2006), resourceful (Covin, 1991; Urban, 2006). Bygrave (1989) concluded that entrepreneurship is a process that evolves with time. Similarly, Shane (2004) attempted to converge what is distinct and generic by considering the connection between individual and opportunity; and considers generic process as potentially overlapping and recursive i.e. entrepreneurial -, discover- and exploit-opportunity.

While there is a diverse explanation of entrepreneurship, in view of general theory of entrepreneurship, the process is characterized by activities that include the discovery, evaluation and exploitation of opportunities to present new products and services, methods for organizing, procedures, and raw materials through sorting out endeavors that had not existed (Shane, 2004). Shane's model of explaining entrepreneurship offers an elaboration of factors, environment and activities of the entrepreneurial process. There is no convergence definition for an entrepreneurship process as sometime depends on the nature of entrepreneurs or selected sample (Urban, 2006). However, from these definitional points of views it is clear that entrepreneurship has common attributes: discovery, evaluation and exploitation of opportunities. Creating something new with value, exist in all level; entrepreneurs recognize opportunity, evaluate and use various means to exploit it to create value [for profit or social benefits] and this involves integration with individual and environment. See Figure 1.

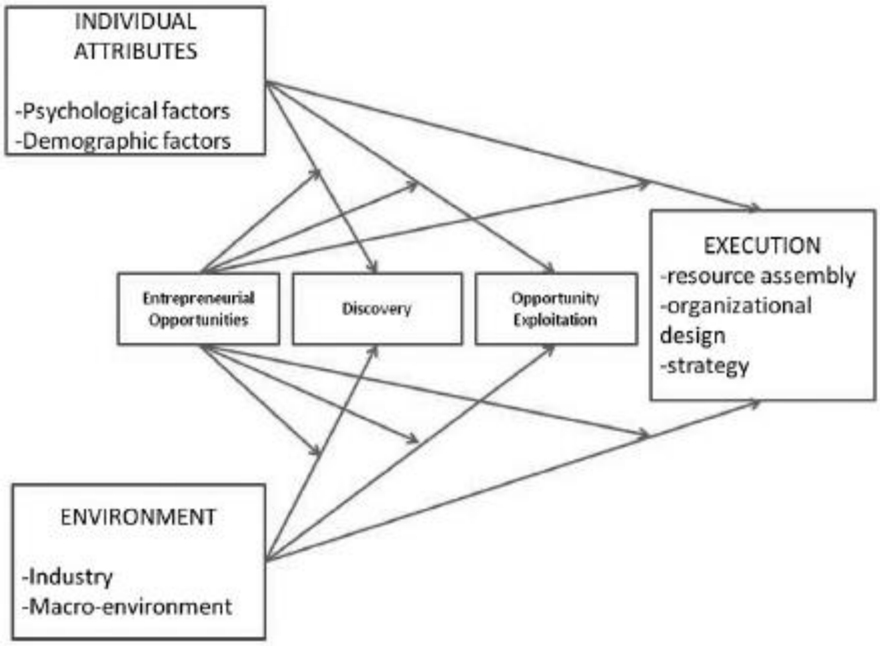

Figure 1: Shane's Model of the Entrepreneurial Process Source: Moroz (2012)

2.2.2. Technological innovation and technology-based firms

Schumpeterian entrepreneurship, involves attempting "new" things and taking risk by betting on the nonexistent (Venkataraman, 2004). To introduce the concept of technological entrepreneurship, we describe the connection between entrepreneurship and techno-entrepreneurship. The definition of an entrepreneur in a technology-driven opportunity often referred to techno-entrepreneur, technopreneur, and technology-based entrepreneur. Technology-based entrepreneur can produces new technology i.e. products, services, processes, business models, etc. and can be propelled as new technology-based venture which require solid experimental information and social capital (Barreira, et al. 2011). These individuals are vital components for the creation of ventures that may expand into big businesses such as Apple, Microsoft and many other technology-based firms. Technopreneurs - are then seen as the catalysts in the process as they access and marshal these critical resources to bring new technologies to new markets.

In addition, technopreneurs, often referred to as technological entrepreneurs, have practical knowledge and have capabilities that comprise proficient knowledge of appropriate technological advancement composed with innovative expertise (Venter, et al., 2008). The technology-based entrepreneur is often associated with technopreneur with technology human capital and know-how to exploit those opportunities by understanding the technologies, platforms and future anticipation of technology use (Wright, Hmieleski, Siegel & Ensley, 2007; Venter, et al., 2008). Both emerging and developed markets acknowledge that technology brings value creation in a form of innovation. Hence, technology and innovation are at the center of technological entrepreneurship.

What is technology and innovation? Tidd (2001) gave an account of various types of innovation:

- Disruptive - Re-writing the rules of the competitive game, creating a new `value proposition'
- Radical - Offering a highly novel or unique product or service, premium pricing
- Complex - Difficulty of learning about the technology keeps entry barriers high
- Continuous incremental innovation - Continuous movement of the cost/performance frontier.

‘**Innovation’** is an iterative procedure started by the view of a new market and/or new service opportunity for a technology based innovation which prompts improvement, production, and launching activities toward the commercial success of the invention (Garcia, 2002). **Innovation** is defined as taking up and converting new ideas into a commercial market success (Hindle, 2004); implies the generation and implementation of new ideas, processes or products (Alegre, 2008). The explanation by Tidd, Hindle, and Garcia highlighted two key perspectives of innovation, one being generation and converting new ideas and the other tuning the idea into commercial value. Schumpeterian definition of innovation is the generation of items already in use, the opening up of new markets or of new sources of supply, enhanced handling of material, the setting up of new enterprises associations such as department stores— to put it plainly, any "doing things differently" in the realm of economic life— in the domain of financial life—all these are occasions of what we might allude to by the term “Innovation” (Schumpeter, 1939). The emphasis on the definition of innovation from various scholars is generating new ideas and successful converting into value [i.e. for profit or social gains] rather than ideas with no value. This is evident in Garcia (2002) clarification of innovativeness terminology literature review that an invention does not turn into an innovation until it has set through development and marketing undertakings and is diffused commercially. Indeed these two key terms – innovation and innovativeness are operationalized in development and commercialization of technology.

Technologies have a deeply strong impact on our lives; for example the use of internet via wired network has changed the way of delivering information and it has become effective and easy for people to communicate (Jaradat, 2013). A broadest conceivable clarification of **technology** is learning of how to do things and accomplish human objectives (Narayanan, 2010); application of science to solving problems or enhancing operation (Venter, et al., 2008). There are varieties of technology-based innovation that have the potential to have a significant impact on regional economies and development; including electronics, information and communication, biotechnology, etc. Technology does not only represent the firm’s technology offering, it also serves as a measure for competitive advantage. Technology now represents one of the bases of strategic planning, guiding the fundamental question of how to establish a competitive advantage and how to guarantee the survival of the firm (Moraes, Melo, Oliveira & Cabral, 2010). The impact of technology is not only on firm's productivity, operation and scalability, but also broader society (White, 2011).

Technological innovation is characterized as the generation of new products, processes or significant technological improvement in the current products or processes (Galende, 2006).

This definition of technological innovation addresses 'what constitutes a technological innovation'. According to Moraes et al. (2010) we distinguish the technology-based innovation into two subjects:

- process or product that outcomes from scientific exploration and whose total quality originates from the areas of advanced technology, for example: personal computer, biotechnology, fine chemicals, new materials, mechanics of precision, among others;
- use of experimental learning on complex strategies and on the high specialized capability work

The conclusive understanding of technological innovation is inherited from definitions by Schumpeter (1937), Moraes et al. (2010) and Galende (2006) that it is driven by research, techno-based entrepreneurs with in-depth technical knowledge and capabilities of use usage of investigative research and applying this information to develop new technologies. Although prior or depth technical knowledge may trigger technopreneurs to discovery opportunity, various scholars have attributed different cases of opportunity discovery.

Ventakaraman (1997) differed and argued that the key is that this information is diffused in the economy and is not a "given" or available to everybody; and that this information is normally unusual in light of the fact that it is gained through every individual's own circumstances including occupation, at work schedules, social connections, and day by day life. In addition, the technical knowledge may be simpler to find on account of new technologies, however they do not need to be limited to mechanical improvements, but diffuses to other sector that can copy the innovation and implement it appropriately (Shane, 2000).

2.2.3. Technological entrepreneurship

In the 21st century, technology has become a fundamental component as a driver of economies or firms' competitiveness. To stimulate further diffusion of technological innovation and the growth of entrepreneurial firms require the capacity of entrepreneurs to successfully match resources and opportunities in order to mobilize and promote the innovation (Hung, 2006). Technopreneurs identify technological opportunities and organize resources to exploit new technologies and new market. Despite the technological opportunities, it is important to understand the technology innovation and how technology ventures navigate in the entrepreneurship process to achieve sustainability and perform better in regards to innovation performance. Therefore, we explore the technological entrepreneurship model that provides supporting environment for new technology-based firm to transfer technology and diffuse it into industry or market.

Beyond the encouraging culture of entrepreneurship, Schumpeter further emphasizes that regional economies are developed through technological entrepreneurship. Technological entrepreneurship indeed assumes a focal part in regional and economic development and transformation (Shane, 2000; Venkataraman, 2004; Song, Podoynitsyna, van der Bij, & Halman, 2008). Technology venture have appeared to create jobs and to reinvent developed sectors through launching of radical technological innovation (Barreira, et al., 2011).

According to Shane (2004), **technological entrepreneurship (TE)** is a process whereby technopreneurs (or technology-based entrepreneurs) assemble resources, technical systems and strategies to pursue opportunities. The effort of TE is often facilitated by government in an attempt to create new industries and grow economies by setting up policies to support new technology-based startup. Technological entrepreneurship occurs at many levels of analysis. Thérin (2007) identified seven key elements of technological entrepreneurship that are linked to a new technology-based firm, namely the technological entrepreneur, universities, corporations, capital, market/customers, government and advisors, *see Figure 2*. Based on the above definition of technological entrepreneurship, in this study, we review key elements from the perspectives of new technology-based firm, supporting environment and exploring factors related to innovation performance, i.e. percentage of total turnover from products and services that were new to the market.

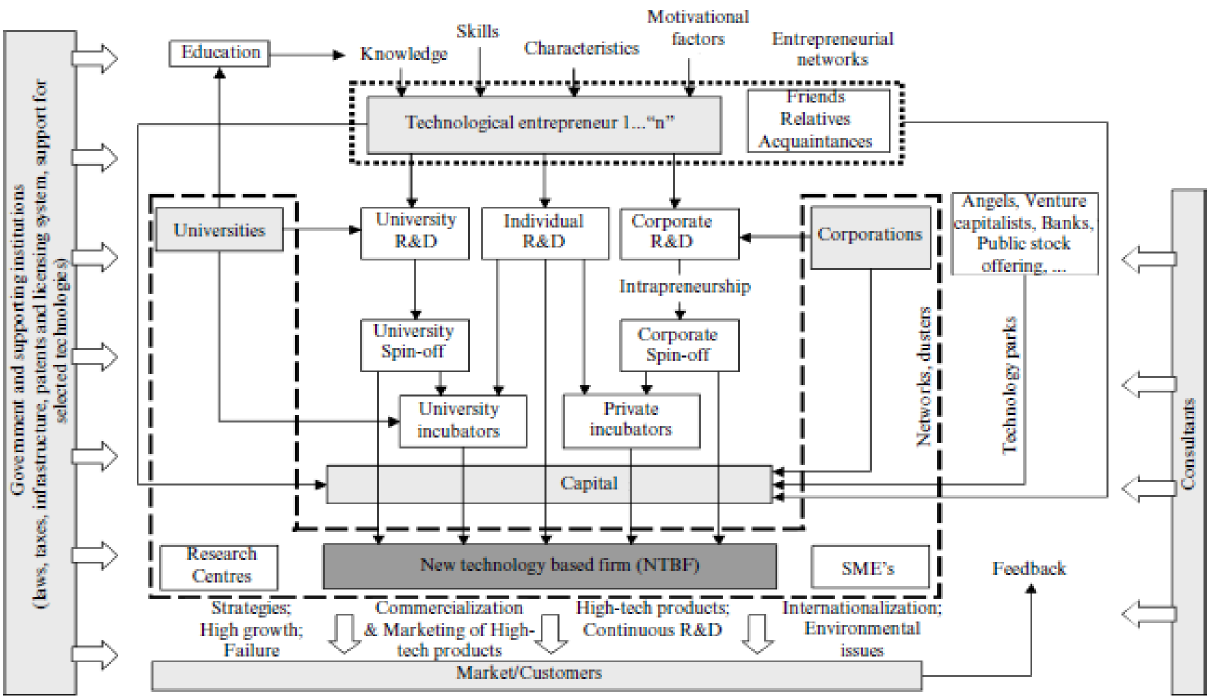

Figure 2: Model of technological entrepreneurship Source: Therin (2007)

As argued by Shane (2000) a major aspect of entrepreneurship [technological innovation in this context] lies in the way technology-based firm recognize opportunities for business creation. New technology-based firms' creation and development are not self-governing, isolated procedures but rather include the foundation and managing of a system of connections between the new firm and different parties in its surroundings (Thérin, 2007).

Technology-based firms (NTBFs) exploit technological opportunities through establishment of new firms, organization resources and market mechanisms. However, a new technology opportunity can also occur within an existing organization or technology opportunity may be sold to an individual or other entity (Shane, 2000). Chea (2008) defined NTBF as a venture that conducts detailed assessment of the attainability and potential financial value of identified opportunities from dynamic strides to create them through new ventures. It should be said this definition does not explain the surrounding environment of NTBF and that these ventures operate in uncertain environment. This view is general supported by Cooper (1985) and Mian (1996b)'s work that NTBF might be less prepared to start new venture, thus demanding critical resources for the establishment and development of new venture. Therefore, the development of NTBFs has become increasingly important in today's competitive economies (Mian, 1996c; Lofsten, 2003).

From an entrepreneurship perspective, the innovation performance of new technology-based firm is facilitated by tapping into the **technological entrepreneurship** system at different levels of effects and actions such as government, universities' knowledge, corporations, capital, market or customers, advisors and technology incubators (Thérin, 2007). In technological entrepreneurship, the **government** plays an important part in supporting NTBFs through laws, legislation, protection of intellectual property, patenting and licensing systems. According to Zhao, et al. (2015) in knowledge-based economies the associations amongst various players within the innovation system are significant to (i) create, (ii) gather and (iii) diffuse learning, to advance technological development and innovations. The government combines three aspects which are crucial if the support for technological entrepreneurship is to be successful: (1) unity of strategy (policies), (2) institutions (organizations) and (3) service programs (Thérin, 2007). However, Venkataraman (2004) warned that although many efforts are done to promote technological entrepreneurship, low culture and quality entrepreneurship has led to many regions stuck in vicious circles and are finding it increasingly hard to overcome. This is further confirmed by Hung (2006) that figuring out how to encourage new technology-based ventures has been a noteworthy challenge for both industrialized economies and developing economies, particularly on the most adequate policies to effect in launching or accelerating the development of technology-based startup. In opposition to Venkaraman (2004); Hung (2006); Zhao, et al. (2015) argued that the combination of resources (innovation input) and know-how within collaboration frames that allow innovation actors to benefit from innovation outputs is a complex process.

In respect to supporting new technology-based firms, government uses policies as mechanism to enabling effective cooperation to happen among science, innovation, creation and the market. Turning to the relationship between new technology-based firm and enabling environment, Freeman (1995) gave a recollection of enabling environment referred to as the national innovation system that uphold policies not only to cushion new ventures but a broad range of policies intended to speed up or to make conceivable, industrialisation and economic growth. What is national innovation system?

2.2.4. National Innovation System

Most nations or regions adopt the National Innovation System (NIS) to highlight the growing need to encourage and develop the interactions among those participating in the innovation process. However, Intarakumnerd, Chairatanab & Tangchitpiboo (2002) highlighted that many researchers have contributed in defining the NIS concept from different contexts and according to the country's economies. The National Innovation System (NIS) concept can be tracked back to work done by List and Lundvall in 1992 and 1841 respectively (Freeman, 1995). NIS recognizes that innovation and technology are major performance drivers of a national economy, especially through the emergence of the knowledge-based economy (Lundvall, Johnson, Andersen & Dalum, 2002; Rooney, Hearn & Ninan, 2005). Public authorities and policymakers continue to investigate and draw up policies to support technological innovation through encouraging R&D, venture capital and the creation of sustainable new ventures (M'Chirgui, 2012).

According to Intarakumnerd et al. (2002) NIS is the cooperation of existing institutions, market, institution of learning and research and public entities, with an aim of production of science and technology within country's borders. Etzkowitz (2000) considers NIS as generic interrelated components including varying public institutional entities, academia and industries also referred to as the Triple Helix III, where the common goal is to realize an innovative environment comprising of academia, state and industry which is a tri-lateral network and hybrid organization. NIS model such as university technology incubator, government agencies or science parks are established to foster support of new technology-based firms, however these institutions are not isolated establishments rather connected establishment supported by policies and regulatory framework. The Triple Helix as a logical model adds to the description of the variety of institutional setting and policy models of NIS (Etzkowitz, 2000).

From an interaction point of view of the national innovation system's entities and networked agents are positioned with the aim of creating, inside of national boundaries a mechanism of economic development through technological advancement (Arranz, 2009). Fostering innovation and technological advancement for many countries, relies on formulation and implementation of policies. The significance of effectively implementing policies to gradually conduct R&D and produce innovative success is confirmed by Freeman (1995) as vital for any firm to innovate. In some instance, depending on economic structures, NIS is typically achieved through the establishment of technology incubator institutions which support entrepreneurial startups across industries, for instance pharmaceutical (Abetti, 2004).

To summarize the concept of "National Innovation System", we unpacked each term. Each of the terms can be defined differently; however, we adopt the interpretation from various scholars. As defined by Hindle (2004); Tidd (2001) *"innovation"* is a process of bringing new products and services to new market. The orientation of innovation is not limited to corporate firm, within the NIS it broadly includes, university spin-offs, individuals and industries. Nelson (1993), *"System"* is a set of institutional factors that, together assume a significant role in influencing innovative performance, help innovation dissemination and advance human asset improvement (Nelson, 1993; Lau, 2015). Even though different systems may have similar components, they may function in a completely different way. The terms *"national"* refers to collaborating private and open firms or institution (learning institutions, and government offices) aiming for the generation of science and innovation inside of national boarders Feinson (2003), In this study, we are concerned with the unique set of factors that are intermediates between NTBFs and innovation performance within NIS i.e. the technological entrepreneurship ecosystem. Identifying factors that influence firms' innovation performance will help guide stakeholders (e.g. start-ups, incubators, investors, etc.) involved in technological entrepreneurship to allocate specific resources and processes for firms to enhance innovation performance.

2.2.5. Technological Capability of new technology-based firm within NIS

According to Sobankea, Adegbite, Ilori, and Egbetokun (2014) innovation performance at the country- and firm-level is assumed to depend on (at least) four interlinked factors (not put in order of importance) (i) geographical structure, (i) political, sociodemographic and institutional factors, (iii) market and public economic incentives, and (iv) technological capabilities. From the above-mentioned dependences, we consider technological capabilities as one of the factors that lead to NTBFs innovation performance. There are various ways to categorize technological capabilities at a firm level. Diez (2003) described technological capabilities as the development of new markets, the organisation of knowledge, the ability to develop and introduce new products, organisational arrangements either in-house or in cooperation with customers, continuous improvement, adaptation and incremental innovation. Technological capability building is a learning process which involves absorptive capacity drawn from two forms of learning modes i.e. the Science, Technology and Innovation (STI) mode and the Doing, Using and Interacting (DUI) mode. According to Lundvall (2010) STI learning links science and technology to innovation using codified knowledge, while DUI relies on informal process of learning and experience based on know-how to bring innovation to market. Gaining technological capabilities can assist in converting R&D output into marketable products and taking them to the market (Haeussler, Patzelt & Zahra, 2012).

2.2.6. Innovation performance

In management research, there are generally two approaches used to measure the level of innovation performance. One explores indicators from freely available information such as Research and Development (R&D) spending, quantity of patents and innovation launches; whereas other utilizes internal measures, for example, the percentage of personnel with practical expertise or the percentage turnover from new products launched in the past years (Tidd, 2001). Measuring NTBFs’ innovation performance is often associated with the relationship between input, i.e. firm’s size, R&D efforts and capital, and output (financial performance, new products and services) which have been investigated by many researchers. It is noted by many researchers that there is no unique set of factors impacting NTBFs innovation performance. Various factors are applicable to certain industries, for example, R&D efforts for electrical firms; and patents and product launches for software and services industries (Tidd, 2001).

However, in an environment characterized by exploring new innovation and bringing new technologies, NTBFs are faced with challenges to flourish, thus most do not survive or grow, consequently affecting innovation performance. According to Feinson (2003) bringing new products and services, requires firms to navigate within the technological entrepreneurship ecosystem in order to introduce new technologies.

2.2.7. Measuring innovation performance

For NTBFs to be competitive in their innovation performance, successfully exploiting new ideas means navigating through the innovation process that includes new ideas, R&D effort and commercial activities (Ferreras-Méndez, Newell, Fernández-Mesa & Alegre, 2015). Innovation is crucial for survival and firm's performance as this tends to assists NTBFs to discover opportunities to differentiate itself from competitors (Alegre, 2008). In this context, the innovation process is based on entrepreneurial orientation (EO) dimensions (i.e. innovativeness and proactiveness) of a NTBF. For example, proactively accessing critical resources for sustainability, R&D propensity and introducing new products to new market. However, the innovation is not a linear process due to the fact that the business environment is always changing which can significantly impact the NTBFs innovation performance. Tidd (2001) found that identifying factors that impact on innovation performance is difficult and establishing a correlation between factors and innovation performance is problematic.

In this study, we focus on survival, R&D propensity and technological capability as factors that impact innovation performance (Alegre, 2008). We define product and service innovation performance as the positive exploitation of new ideas which denotes two criteria: novelty and the use (Ferreras-Méndez, et al., 2015). In accordance with the above arguments, this study is centered on theories that identify determinant factors and measure firms' innovation performance with respect to the percentage of turnover from products and services and that are consistent with previous literature (Westhead, 1996; Tidd, 2001; Phillips, 2002; Lofsten, 2003; Ar, 2015). We examine the relationship between three factors: survival (i.e. existence at the incubator, space and funding, R&D propensity and technological capability (i.e. adapting existing technology, introduction of product and services to new market) in order to explore whether these factors impact firms innovation performance (i.e. turnover) (See Figure 3).

2.3. Summary of theoretical background

A general conclusion of literature on entrepreneurship is that it is a process of creating new venture and new innovations to generate commercial gains. Entrepreneurship is a process that is facilitated by and entrepreneur whose motive is to marshal resources and organize interrelated activities to exploit and execute the formation of new ventures. Others scholars have argued various entrepreneurship process differ, however Shane's model combines and comprehends an entrepreneurial process that is both generic and unique. The connection between technology and innovation introduces the concept of technological innovation which is characterized as the generation of innovation i.e. new products, processes or significant technological improvement in the current products or processes.

A major aspect of entrepreneurship [technological innovation in this context] lies in the way technology-based firms recognize opportunities for business creation (Shane, 2000). Various perspectives on what enables NTBFs to flourish are directed to the national innovation system of a country. Governments can intervene by implementing policies through NIS to new technologies through various programs, protect intellectual property, learning and helping create a new market. However, it should be said that the enabling environment do not guarantee the success of NTBFs and that these ventures operate in an uncertain environment. In terms of innovation performance of new technology-based firms, performance measures fall into various categories including patents, product launches and financial performance. Despite the fact that there is an absence of conformance in characterizing innovation, it has been perceived, that there has been no embracement of any dependable measurement. This may be because of the way that innovation is exploration from numerous academic backgrounds and every background addresses each audience (Garcia, 2002).

2.4. New technology-based firms innovation performance

This section review existing literature that relates to sub-problem and formulation of hypothesis

2.4.1. Determinant factors for innovation performance

Barbero (2012) argued that innovation performance of firms is broadly defined and varies from one sector to the other. The study is centered on three independent variables (IV) and one dependent variable (DV) to identify determinant factors and measure their impact on firms' product innovation performance. For instance, Lofsten's (2003) study in Sweden assessed R&D propensity as an IV (based on determinant (construct) factors such as: R&D expenditure, radical new research, patents, copyrights, new products) and product innovation performance.

The body of literature agrees that there are many factors that can affect the product innovation performance. Bergek (2008) argued that there is a lack of a theoretical base for technology-based firms' evaluation in general and the identification of best practices, in particular. Due to the fact that there is a broad way of identifying determinant factors, this study adapts the previous work of measuring performance and identifying determinant factors namely, Westhead (1996) with respect to survival and growth, Rubin (2015) with respect to technological capability e.g. introduction of new products to new market and commercialization and Grilo (2015) with respect to the measurement of firms' performance based on R&D outcomes such as patents, invention & innovation. Figure 3 shows the model that will be used to develop three hypotheses.

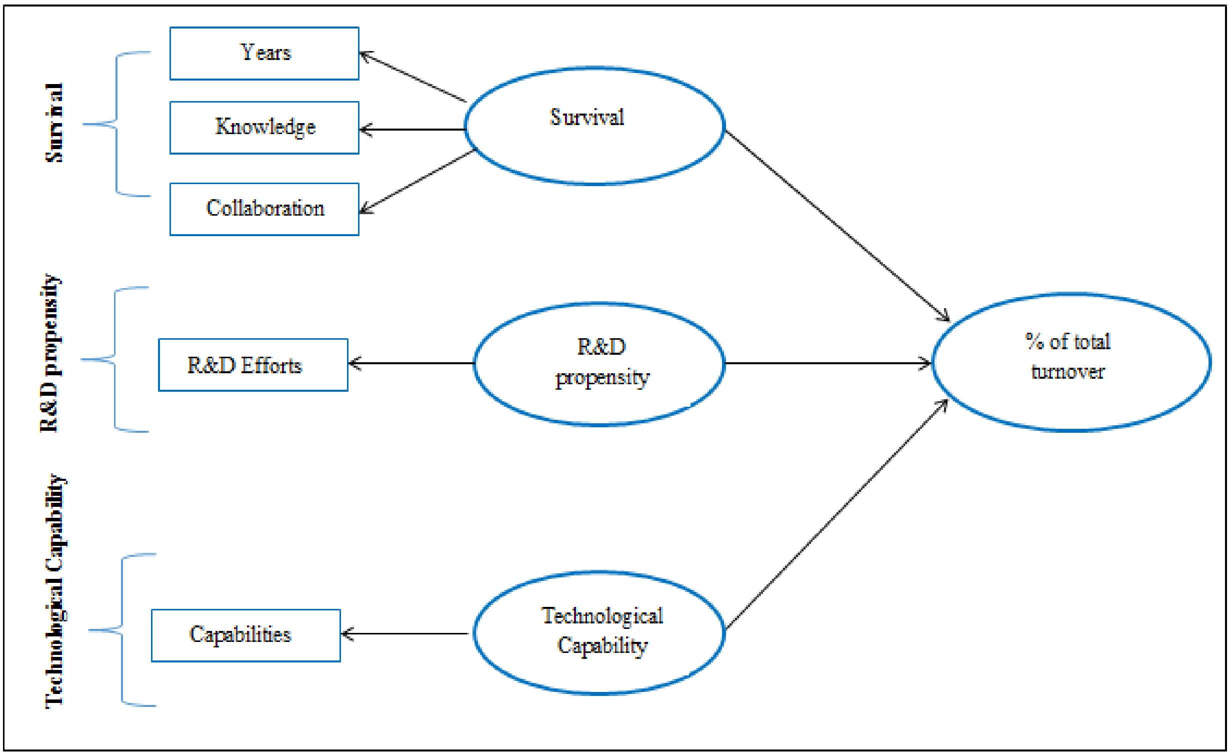

Figure 3 – High-level research model

2.4.2. The survival of technology-based firms

2.4.2.1. Access to knowledge and collaboration

Technology-based firms, during the early development stage, face obstacles to the performance of innovation such as technology development and marketing. In response to removing these obstacles, the government has several lines of dedicated funds to support incubation by providing funding for a certain period (Aruna, 2012). Agencies are located at multiple levels of government and have been set up to provide funding or seed capital at the national, provincial and local levels to assist with incubation efforts in assisting firms to survive. What many governments want is to replicate Silicon Valley and the formation and growth of what have been described as "entrepreneurial ecosystems". However, despite significant investments by governments into such initiatives, their overall success rate is mixed (Mazzarol, 2014). According to Rubin (2015), government incubators (GR) are oriented to the provision of capital during the incubation programme to assist firms to survive. Since the government incubator operates with the goal of funding, the financial intervention enhances the survival of a NTBF (Aruna, 2012). While university-run technology incubators (UR) may have technology transfer as their primary goal. Both technology incubators focus on providing typical services such as space, funding among other things to their tenants. In accessing these services, NTBFs must be resourceful by utilizing resources to develop and produce products and services and also to reduce the costs. Given the nature of product development, new technology-based firms are faced with scarce resources, therefore unable to finish product development. A view offered by Hanna (2002) and Rubin (2015) suggested that it is unrealistic to have enough abundant resource to reduce innovation risks and costs; thus, clearly collaboration by networks can significantly affect capacity of NTBF to finish prototypes or products and be ready to compete in the market. Furthermore, Díez-Vial (2015); Bergek (2008) argued that firms with previous cooperation agreements (with universities, research institutions and other startups) would benefit most from as they can more easily incorporate existing knowledge from networks and improve their product innovation.

One of the roles for technology incubator is to offer networking opportunities where firms may establish new co-operation or partnership with other firms. Thus, in general the significance of networking, collaboration and access to knowledge with external partners is progressively recognized both in the entrepreneurship body of knowledge (Chan, 2005; Rubin, 2015).

To develop this argument, if partner's specialized knowledge overlaps, sharing of those common resources and jointly develop innovation would greatly reduce risks and costs. Having said that, effective learning in partnership seems possible when new technology-based firms have adequate absorptive ability to capture and apply the knowledge made through common R&D efforts (Haeussler, et al., 2012; Rubin, 2015). However, other scholars challenges this argument, on the contrary, there is a limitation of formation collaboration and knowledge sharing amongst startup located at the technology incubator; specifically at university-run incubator. Technology incubator are unlikely are unlikely to deliver collaborations of any significant (Chan, 2005); there are couple of startup firms that form collaboration with other incubatees (competition), and these partnership are regularly identified with supply of services instead of joint R&D (Hanna, 2002).

2.4.2.2. Duration of incubation

According to Grilo (2015), free rental and other types of available funding for the duration of the program, as most incubation programmes would offer in the first year, become a great help for start-up firms to survive. At the same, firms are expected to proactively secure these critical resources to continue with the development of the new venture and technology. Most science parks (either UR or GR) accommodate firms and that ultimately leads to the development and survival of these NTBFs (Chan, 2005). However, depending on the type of incubator, the duration of the funding enables firms to survive. Rubin (2015) argues that GR incubators are oriented to the provision of capital (including finance) to assist firms to survive, although the lack of efficiency can compromise the survival of incubated firms, regardless of their business area or programme offer on-site or off-site. Therefore, we hypothesise that:

H1. The greater the number of years in the technology incubator, the higher the probability of new technology-based firms to produce new products or services and survive.

2.4.3. R&D propensity of technology-based firm

Value-added services provided by technology incubators such as the establishment of new venture entities, business support and advisory, and access to capital are supposed to assist nascent technology-based firms to have positive R&D output. The literature on innovation and firm innovation performance (in particular, product innovation) identified that there is a relationship between R&D, new products and market book value i.e. in this study referred to percentage total turnover from products and services that were new to the market in the past (3) three years (Tidd, 2001). R&D propensity can be divided into two groups: input measurements for high-technology activity, such as the number of qualified employees, time allocated for R&D and budget, while output measurements include the number of patents and technological innovations (i.e. new products and services) (Grilo, 2015). Ar (2011) argued that a strong R&D effort has a significant impact on firms' product innovation performance. On the other hand, returns on R&D propensity heavily depend on the sector; for example, ICT and pharmaceuticals are found to have the highest return from R&D (Tidd, 2001).

Also, there are environmental factors other than R&D budget and resources used to measure R&D input that can be put forward as influences for R&D propensity. Location of NTBFs, such as in universities are considered as convenient in order for firms to access higher-learning knowledge capital and academic experts that are essential to the innovation process i.e. intellectual property and technology transfer (Rothaermel, 2005). Research conducted by Campbell (1987) and (Ndabeni, 2008) indicated that university incubators are more likely to have firms which are likely to perform positively in R&D output. Kim (2010) highlighted that firms at UR incubators are more likely to promote interactions with Higher Education Institutions (HEIs) and hence improve innovation output: patents, publications, technology transfer.

Therefore, we hypothesise that:

H2. The higher the R&D output (patents, invention) of technology-based firms, the better their innovation performance.

2.4.4. Technological capability (Non-R&D activities)

The realization and commercialisation of product launches is crucial to self-sustainability of NTBF. The output of R&D is general intended to contribute to the business/innovation performance of NTBF. Essentially, NTBFs should produce new innovations and commercialise them in order to exploit potential market opportunities, generate needed cash flows, and make a profit (Haeussler, et al., 2012). In contrast, drawing upon existing literature, the inexperience of NTBFs and limited resources ultimately lead to a costly exercise to commercialise and outcomes are uncertain. NTBFs are often unable to pull together the right mix of capabilities needed for introducing innovations to the market (Haeussler, et al., 2012). The technological capability of an NTBF is considered to be one of the key factors that lead to NTBFs innovation performance. However, accumulating technological capabilities are considered to be a learning process. Oyelaran-Oyeyinka (2006) further emphasised that technological learning is the way organizations such as firms accumulate technological capability.

According to Jensen, Johnson, Lorenz & Lundvall (2007), learning contributes to innovation performance. In this context, learning processes and technological capability in relation to innovativeness and proactiveness of NTBFs. Based on theoretical models explaining the growth of NTBFs, the connection between innovation and turnover growth stress the imperative role that innovation plays in expanding market share. According to Kuratko, Covin & Morris (2011) innovation manifests itself in various ways, whereby with respect to product innovation as an example, NTBFs can dramatically improve existing technology, enhance existing technology with new features or adapt or imitate innovation of other technology firms. These R&D results are then used to create a new product and/or service that are introduced to the new market leading to a firm's new channel of revenue stream (Rubin, 2015). However, many firms do not have immediate sales from products new to the markets.

Kuratko, et al. (2011) argued that the proactiveness (in regards to innovativeness) of firms means accessing critical resources in pursuit of seeking new opportunities and introducing new products. In order to enhance firm's innovation performance, NTBFs have to proactively assess whether technology can be developed or acquired and if the product or process developed by means of the technology can be marketed and accepted by the potential clients. For example, the impact of technology incubator facilities on small firms result in access to new knowledge, expertise, networks and cost effective access to leading edge research; which consequently enables firms to adapt existing innovations and commence trading quickly without large overheads while also offering credibility to the enterprise along with opportunities for networking (McAdam, 2008). The capabilities to proactively utilize available resources enable technology-based firms to perform with regard to launching new products and services. Over and above, innovativeness of NTBF is characterized here as the capability to present of some new process, item, or thought in the firm (Hult, 2004). Critics of innovation management settled on the empirical evident that there is no agreement of factors of new technology-based firm innovation performance. A different point of view of innovativeness impacting innovation performance is to consider marketing strategies. Hult (2004) argued that decisions in regards to introduction of technology to new market have a tendency to be taken at more strategic levels inside of divisions included with marketing and operations. Since, new technology-based firms are faced with uncertain market environment and this may require highly level of aggressiveness, proactiveness to development market by introducing innovation that already exists in firm's portfolio. Marketing involves distribution channels, packaging, promotional and pricing techniques. It is a reason in this study we consider marketing as close related to technological capability to impact innovation performance. Here, technological capability as a term is identified with products and service, but also related to marketing techniques.

Therefore, we hypothesise that:

H3: The greater the level of technology capability (non R&D activities) of NTBFs, the higher their innovation performance.

2.5. Conclusion of Literature Review

In response to the demands and needs of a supporting environment for NTBFs to survive, grow and perform, technology incubators play a critical role in supporting these firms during the start-up stage by providing unique resources to avoid untimely death. However, it is critical for both the technology incubator and NTBFs to use existing theories and models to explore the determinant factors that influence new firms' innovation performance.

Existing literature on innovation performance has presented various ways to clarify the set of factors that impact the measurement of firms' innovation performance. Growth in turnover and R&D output (i.e. patents and publications) are generally considered as the main measures for firms' innovation performance. However, in emerging and advanced markets, the majority of start-ups does not survive or grow and few succeed (Ndabeni, 2008). Particular attention is needed to examine three main dimensions: survival, R&D

propensity and growth of NTBFs and to identify the determinant factors that enable these firms to perform with respect to product innovation.

Tidd (2001) argued that there is no conclusive measure of innovation performance and that it is difficult to establish a correlation between its factors and the measurement of NTBFs' innovation performance. However, there are broad approaches of measuring innovation performance. Based on previous studies, this study firstly, identifies determinant factors for (1) survival, (2) R&D propensity and (3) growth; and secondly determines the correlation factors between them, and on innovation performance. In conclusion, based on empirical studies, firstly, it can be argued that the duration of funding enables the firm to survive during the start-up or development stage; secondly, the higher the R&D output (patents, invention) of technology-based firms, the better their innovation performance; and thirdly, the greater the level of technology capability (non R&D activities) of NTBF, the greater the NTBF will experience higher innovation performance.

Hence, in concluding the literature review, the following research questions arise:

1) What are determinants factors related to survival of nascent firm?
2) What is the relationship between R&D propensity and NTBF's innovation performance?
3) Does technological capability (non-R&D activities) of a NTBF leads to innovation performance? If so, under what conditions?

3. RESEARCH METHODOLOGY

3.1. Introduction

In this chapter, we outline the details of the research design and methodology to provide a logical framework that delivers the evidence to provide answers to each research question. This chapter is organized as follows:

- research approach and paradigm
- research design and instrument
- population and sample
- research instruments
- data collection and analysis
- validity and reliability

3.2. Research Design – Quantitative approach

Selecting a study approach is a vital phase in any literature work as it is seldom applied, resourceful or ethical to do academic work on entire populations (Marshall, 1996). Hence, the objective of survey (quantitative) methods is to generalize a conclusion from a sample population back to the entire population. The study adopts a quantitative method to draw insights from the sample population gathered through survey instruments and to generalize findings about the NTBFs (Bartlett, 2001).

The quantitative approach has some challenges which can be experienced during the survey data collection phase, including misinterpretation of survey questions, and the lack of an opportunity to ask follow-up questions for clarity. However, one of the advantages of the quantitative method is its ability to use a smaller group of people to make inferences about larger group (Bartlett, 2001). The quantitative approach is suitable to test pre-determined hypotheses and produce generalisable results about factors that impact the innovation performance of NTBFs. This approach is appropriate for this study to understand the determinant factors for survival, R&D propensity, growth, and the correlation between these factors and innovation performance of NTBFs in Gauteng.

3.3. Research paradigm

There are two main paradigms that form the basis of research. This study is rooted in the paradigm called the positivist approach (Kumar, 2011). The research problem in this study was argued and concluded using a quantitative approach. The positivist approach is typically based on the belief that facts and feelings can be separated, and that the world exists as a single reality; composed of facts that can be discovered through observation or measurement (Mertler, 2015). Since the study utilized self-administered questions on technology-firm's innovation performance at a single point in time, the study assumes a cross-sectional approach. The advantage of cross-sectional studies is that they are quick and cheap. Cross-sectional studies are primarily used to determine prevalence. Prevalence in this study refers to the number of NTBFs in a population at a given point in time, as advanced by Mann (2003). Since the study assumed a cross-sectional approach, the ideal form of collecting data is a survey instrument. The purpose of the survey is to produce statistics, that is, quantitative or numerical descriptions about some aspect of the study population (Fowler, 2014).

3.4. NTBFs Population and sample

The national audit of the evolution of incubators in SA suggests that there are a growing number of NTBFs and technology incubators. These NTBFs spread across a number of economic sectors including renewable energy, the automotive industry, life sciences, biotech, small-scale mining, agriculture (floriculture) and agro-processing, information and communications technology (ICT), construction, chemicals and manufacturing (Masutha, 2015). This section describes the population and sample characteristics.

3.4.1. Population

NTBFs and entrepreneurship in ICT, biotechnology and energy sectors are rapidly gaining momentum, but on the other hand these practices are very much in their infancy in SA (Alessandrini, 2013). The study surveyed firms linked to university and government technology incubators in Gauteng. The nature of the study population was made up of startup firms which are either on-site or off-site, as long as the startup has some form of interaction with the technology incubators in Gauteng.

The study assumed a judgmental sampling technique. Judgment sampling is a common sampling strategy where a researcher actively elects the most useful sample to respond the research questionnaires (Marshall, 1996). We prudently identified startup firms that are in technology and embrace innovations with the following profile: (a) has and/or engages with university or government innovation hubs (b) that are in ICT, and biotechnology, energy, pharmaceuticals and embrace innovation. Most of these new startups were still in an early development stage and receive comprehensive investment from university or government innovation programmes (Alegre, 2006).

3.4.2. NTBF Sample

Selecting a study sample is a vital phase of any research project as it is rarely practical, efficient or ethical to study whole populations (Marshall, 1996). The sampling population comprises of start-ups based at the technology incubators around the City of Tshwane and City of Johannesburg area.

Out of the 51 incubators nationally, the study is focusing on NTBFs located in the Gauteng province. The majority of these technology incubators were located in two metropolitan areas in Gauteng; hence, the City of Johannesburg and City of Tshwane are selected. Four (4) government-run technology incubators and four (4) university-run technology incubators were identified as the startups located in these incubators meet the sampling criteria. Although NTBFs are made up of automotive, pharmaceutical, agriculture, this study was more inclined to the ICT sector as the nature of technopreneurs in South Africa is dominated by ICT.

Determining a sample size is one of the key research design features as inadequate or excessive sample size influence the quality and accuracy of research (Bartlett, 2001). The sample size was determined using Cochran's (1977) method by specifying margins of error for items. The formula takes into account two factors: marginal error which is the risk a researcher is willing to accept at a given alpha level. Bartlett (2001) suggested that the alpha level used in determining sample size is either .05 or .01. The following formula was calculated to determine the sample size:

T= value of alpha the research is willing to accept which is 95% level of significance to a Z score of 1.96.

S= estimate of standard deviation of 1.167.

Marginal error = 0.025

Sample size = [(Z– s)2 x StdDev x (1 – StdDev)] / Marginal error

= (3.8416 x 0.25) /0.025

= .9604/0.025

= 385

However, due to the fact that there are no available statistics for the number of NTBFs firms in Gauteng, the study relies on technology incubators to provide a list of NTBFs that are currently active and available for the study. Hence, the research considered Bentler and Chou's suggestions as well to determine the sample size of five to ten respondents per research instrument variable. Based on the number of research variables for this study, which is 40; the formula is calculated as follows:

40 research variables multiplied by 5 respondents = 200. The study aimed for 280 respondents. *See Table 1.*

Table 1: List of technology incubators and sample of startup in City of Johannes burg

City of Johannesburg		
Type of incubator	**Incubator**	**No. of firms**
University	Wits Enterprise	10
University	University of Johannesburg (UJ)	10
University	Resolution Circle – UJ aligned	10
University	JSCE/CoachLab	20
Government	SoftStart	40

Table 2: List of technology incubators and sample of startup in City of Tshwane

City of Tshwane		
Type of incubator	**Incubator**	**No. of firms**
Government	Innovation Hub	100
Government	Mlab aligned to DST and World Bank	80
Government	Technology Innovation Agency	10
	TOTAL	280

3.5. The research instrument

As far as the research instrument is concerned, the Entrepreneurial Orientation (EO) survey and the Community Innovation Survey (CIS) are adapted and utilized for this study. The EO research instrument is widely used in several studies with equally great reliabilities to measure innovation performance. EO instrument commonly measure the autonomy, innovativeness, and proactiveness of NTBF to determine connection between entrepreneurial posture and firm's performance (Covin, 1991). On the other hand, the CIS is designed to focus on product and process innovation, the source of information about innovation activities, intellectual property and other common indicators such as R&D, patents and number of innovations produced and the demographic about NTBFs including, employee size, existence of the firm (Vásquez-Urriago, Barge-Gil, Rico & Paraskevopoulou, 2014).

Drawing from existing literature, the EO research instrument is widely used in several other studies with equally great reliabilities (Miller, 1983; Lumpkin, 2001). According to Knight (1997) the most popular method for assessing the measure of reliability is the Cronbach's alpha. Validity and reliability of EO instrument conducted by (Knight, 1997) recorded a score of Cronbach's alpha = 0834. α=0.74. According to Gliem (2003), the Cronbach's alpha reliability is ordinarily between 0 and 1, though, the limit of the coefficient depends on the researcher. However, the closer the alpha value is to 1.0, the higher the internal consistency of the research instrument scales. With regard to the CIS, the approach of this study is similar to (Vásquez-Urriago, et al., 2014) which analyses the effect of funding subsidy, patents, and new innovation in the past three years on NTBFs' innovation performance. A test reliability of coefficient was run on SAS *(using proc corr alpha)* to compute individual variables for scale reliability. Construct reliability ranged between 0.69 and 0.78 and the Cronbach's α coefficient standardized record was 0.74 which is closer to 1

3.5.1. Instrumental variables

To test the afore-mentioned hypotheses, a field study using questionnaires was conducted and this approach is advantageous in the settings where it naturally occurs with minimal intrusiveness by the researcher (Limpkin, 2001).

The research instruments collect data about the location of NTBFs, R&D propensity and growth in the form Furthermore, the instrument gathers firms' information regarding the construct variables [determinant factors] of survival, R&D propensity, growth and factors [independent variables] impacting innovation performance. The constructs for survival will assist to ascertain the time it takes for firms to put emphasis on R&D propensity and growth (Minguillo, 2014). The degree of R&D propensity is analysed based on: R&D activities with regard to budget, time, number of inventions, and patents among others. Empirical studies show that R&D propensity indicators including R&D, patents and number of innovations are widely used to gather information on firms' R&D activities (Vásquez-Urriago, 2014). However, R&D propensity is essentially an input and not a measure of innovation performance (Vásquez-Urriago, et al., 2014).

The main dependent variable is product innovation commercialized by NTBFs. The variable selected as the dependent variable is a percentage of NTBFs' turnover from new innovation (products or services) introduced to the new market (Vásquez-Urriago, et al., 2014). We further analyse which type of incubators are most likely to enhance the firm's innovation performance by gathering demographic data including information on the type of incubator and access to new innovation products or service projects that contributed to the completion of existing innovation).

3.6. Data collection and measures

In order to test the afore-mentioned hypotheses, online data collection (i.e. qualtrics.com), emailing and handing out questionnaires methods were used. The survey was targeting technopreneurs or owners of the new venture. Following Alegre (2006), we select and draw responses from venture-owners as they are directly responsible for startup growth and sustainability. The study adopts Alegre‘s (2006) measuring scale for each instrument variable to scale innovation performance. The constructs and factors variables are measured using a Likert scale from 1 to 5. Respondents rated each instrument variables using a five (5) points Likert; where 1 represents ‘‘strongly disagree’’ and 5 ‘‘strongly agree (Wei, 2004). A detailed literature review was done to outline the instrument variables (*See Chapter 2 and Figure 3).*

3.7. Data Analysis

The data was formatted and transformed from MS Excel 2010 to SPPS software statistical software program. The initial step was to test the reliability and validity of the instrument and models to be used to analyze the data. The data analysis includes descriptive statistics using means, standard deviation and correlation between variables, exploratory factor analysis and regression analysis to draw conclusions about the general population. In regards to model fits indices, we follow 1) Hooper‘s (2008) conclusion, which found that the most commonly reported model fit indices are Chi-Square; 2) According to Hooper (2008), Bentler’s measurement for fit model must be 0.90 or above to be considered an acceptable model.

3.7.1. Validity and reliability of research design

To test scale reliability, we assess instrument variables for reliability. The most common technique for assessing reliability is Cronbach’s Alpha. Furthermore, variable-correlation will be tested to purge the scales for each factor, for instance, Cronbach’s Alpha values must have α coefficient of above 0.70 and thus the researcher should eliminate those variables whose correlations are below 0.50 (Ar, 2011). According to Gliem (2003), Cronbach's alpha reliability ordinarily is between 0 and 1, though limit of the coefficient depends to the researcher. However, the closer the alpha values to 1.0 the higher the internal consistency of research instrument scales.

Validity allows the researcher to specifically test whether operationalization and the scoring of factors (IV and DV) sufficiently reflect the hypothesized model the researcher intends to measure (Adcock, 2001). Hooper's (2008) conclusion found that the most commonly reported validity model fit indices are Chi-Square and *p-value*. Chi-Square for regression model is significant at $p < .0001$.

3.7.2. Exploratory factor analysis

The use and the approach of factor analysis are wide utilized as mathematic method to examine a relationship between set of item variables (constructs) and identified factor. Examination of factors, or measurements, is often connected with the validation of measurements and acceptance of measures, for example measuring innovation performance (Beavers, Lounsbury, Richards, Huck, Skolits, Shelley, and Esquivel, 2013). Although, for many years researchers have raised concerns about limitation of factor analysis while others criticizing the basic use of factor analysis (Fabrigar, Wegener, MacCallum & Strahan, 1999). Note that factors analysis is a set of statically analysis involving various methods. Therefore, in separate cases, researchers agreed that proper application of factor analysis methods were reasonably effective in extracting the known underlying structure of the data (Fabrigar, 1999). On the other hand, Beavers, et al. (2013) considered factor analysis as process of continuously reviewing and testing particular model until the most meaningful solution is presented.

3.7.2.1. A stepwise treatment of factor analysis

In order to address the issues, limitations and critics as pointed out by Beaver, et al. (2013) and Fabrigar, et al. (1999); perhaps it was important for researcher to pay attention to study design (i.e. sample size, model fit indices), extraction methods and rotations. According to Costello (2005) the **data sample** issues in connection with factor analysis have mostly disappeared; one of the issues that have been uncovered is that the sufficient size is partly dictated by the nature of the data. It is commonly suggested for researchers to consider at least three or more construct variables for each factor; as three or more constructs with strong loading indicate a solid factor (Fabrigar, et al., 1999; Costello, 2005). Upon close review of existing literature the sample size for factor analysis is determined by the measurement of loading; a weaker load advocate for larger sample. We adopt Beaver, et al. (2013) conclusion for factors, at least four or more construct variables with measure of .60 or more the sample size is irrelevant. With exception of a factor with two or more underlying constructs variables, we adopt Jolliffe's standard which prescribes holding variables above .70 (Yong, 2013).

With regards to sample size, Fabrigar et al. (1999); William, Brown & Onsman (2012) concluded that when constructs variables accounts an average of .70 or more, an appropriate sample parameter can be as little as 100. As discussed in the above section for population and size, in this study the sample size is over 100. The sample size is 206 and it is above the recommended, therefore it is appropriate to produce accurate results in the analysis of factors impacting innovation performance.

Testing of validity of sample data is important before analyzing the factors. To test suitability, we assess each factor with its construct variables for suitability. The validity is assessed using two tests: Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity values (Lorenzo-Seva, 2006; William, et al., 2012). The recommended KMO index ranges from 0 to 1, with 0.50 considered practical for factor analysis. The Bartlett's Test of Sphericity should be significant ($p<.05$) (William, et al., 2012). The absence of suitability becomes difficult to have effective correlation of factors to analyze the impact of survival, R&D propensity and technological capability of new technology-based firms associated with innovation performance.

The starting point for **extraction method** is the correlation matrix of items (construct variables). William et al. (2012) suggested that assessing method for relationship matrix (often termed Factorability of R), the correlation coefficients should be over 0.30. The rule of thumb is when there are items whose value is below .30 and other items exceed 0.30; the item below .30 should be removed. According to Beaver, et al. (2013) the lower (<.30) correlation is not good indication to explain that factor would be significant for analysis of factors impacting innovation performance of new technology-based firms. Measure construct variables can results in poor estimates of factor analysis and skew study results and conclusion. Hence, Willian, et al. (2012) and Fabrigar et al. (1999) suggested assessing the relationship matrix guideline as ±0.30=minimal, ±0.40=important, and ±.50=practically.

A construct variable is considered to be a significant item of the factor if the loading is .70 or higher and does not significantly cross load on another factor greater than .40 (Beavers, et al. (2013). The decision to **extract** factor is important, however it need to be balance as less items may results in poor adoption for common factor.

In order to test the hypothesis model, the researcher employs Exploratory Factor Analysis (EFA) to test the performance of the construct variables whether these variables load to factors. Survival, R&D propensity and technological capabilities factors are measured by underlying construct variables developed from other existing research instruments. The literature review considered various constructs for factors that are likely to influence startup survival, R&D propensity and growth. Exploratory factors analysis (EFA) is used to load the construct variable to each factor. However, construct validity is a central issue when inferences are made concerning unobserved variables, and factor analysis is an important tool for questions of validity and the loading of survival, R&D propensity and growth constructs (Hayton, 2004). For instance, on the basis of startup survival literature, hypotheses were constructed to identify determinant factors associated with survival. In factor analysis, the ultimate goal is usually the identification of underlying constructs that summarize a set of variables discussed for each factor in the literature review chapter (Ford, 1986).

3.7.3. Regression

In addition to EFA, a regression model will be developed for this study in order to test the hypotheses (*See Figure 3*), so as to establish whether there is a relationship between two or more exploratory variables. In simple explanation, regression is articulated as when the value of the dependent variable Y is a linear function of a corresponding independent variable X. This study employs regression analysis as a technique to explore the association, covariance and explain whether the dependent variable is explained by one or more factors or variables. Chatterjee (2006) explained regression analysis as covariance and connection coefficient as measures of the course and strength of the straight relationship between the one or more variables. Lee (2015) defines regression as association between multiple variables the research assumes that one of the variables (dependent variable i.e. innovation performance) is defined or caused by other variables (independent variables i.e. survival, R&D propensity and technological capabilities). Furthermore, regression attempts to represents a best fit straight line as a way to model the correlation between survival, R&D propensity, and growth and innovation performance. To ensure the appropriate regression analysis is used for this study, we define two type of regression analysis. The initial conceptualization of linear and multiple regression was efforts by Karl Pearson and Francis Galton around 1900 by introducing the statistical analysis on coefficient, correlation and slope line between one or multiple variables (Stanton, 2001). Regression signifies a straight line as the most ideal approach to display the relationship between two continuous variables. In essence, linear and multiple regression analysis are used to test the correlation between factors and the dependent variable**. Linear regression** is a simple regression where a single predictor variable attempts to explain one dependent variable (Lee, 2015). According to (Kleinbaum, Kupper, Nizam & Rosenberg, 2013) **multiple linear regression** can be looked upon as an extension of linear regression analysis (which involves only one independent variable) to the situation in which more than one independent variable is considered. Among other measurement for regression analysis considered for this study includes correlations, fit and multicollinearity.

3.7.3.1. Step by step regression analysis

The first step of regression analysis that is necessary is to determine the **appropriateness of the data** and the technique used for regression. Hence, a common '*R'- value* present the researcher with an estimate of appropriateness of fit of the function to the data (Brown, 2001). A number of models are built utilizing the results from exploratory factor analysis. The initial step taken by the research is to analysis the correlation matrix prior the regression model. **Correlation** is an assessment of how far or closes the variable being referred to will be to another observed variable. This is followed by analysis of data in the form (x, y), where x is the ‘independent’ variable and y is the ‘dependent’ variable (Brown, 2001). Subsequent to fitting a straight model relating Y to X, we are interested not just in knowing whether a direct relationship exits, additionally in measuring the nature of the fit of the model to the data (Chatterjee, 2006). The correlation analysis was utilized to interpretation the strength of relationship amongst variables, and the researcher made decision to exclude certain independent variables as that display very little correlation when analysed against the dependent variable (i.e. innovation performance).

Regression Models: In order to test factors impacting innovation performance hypotheses, multiple linear regression models were fitted with the survival, R&D propensity and technological capabilities variables with innovation performance as the dependent variable.

The follow independent variables were considered for multiple linear regression models. See Table 4.

- Survival
    - Number of years under incubation management
    - Access to knowledge and collaboration
- R&D propensity
    - Internal R&D
    - External R&D
- Technological capabilities
    - Technology Adaptation
    - Innovativeness
    - Marketing
    - Ahead of competitors

3.7.4. Regression Assumption analysis: Score, values and range

Data and regression model fit: The r2 value, otherwise called the correlation matrix or coefficient of determination, is significant somewhere around 0 and 1, it communicates the extent of fluctuation in the "dependent" variable predicted by the "independent" variable; R^2 estimation of 0 implies that knowing x does not anticipate y. As the R^2 value increments towards 1 the all the more precisely the capacity fits the data (Brown, 2001). In analysis the EFA and regression model, the researcher presents statistic statement to portray the relationship between one or more indicator variables and the reaction variable. In exploring factors impacting innovation performance, statistically assumption is conducted at 0.05 (95%) **significance level**.

The most commonly used value to measure the fit protocol for regression line or curve is **R^2** This is based on various scholars adopting R^2 include (Rogers, 1998; Lee, 2015) who used Pearson's *'R^2' value as* formal correlation measure, and it is still the most widely used measure of relationship in most academic researches.

3.8. Limitations of the study

The study had the following limitations:

- Due to the limited resources to conduct intensive research, the research is carried out once to represent a snapshot of one point in time (Cooper, 2003).
- The study focuses on university-run incubators and government-run incubators; while excluding private or industry-run incubators.
- The sample population was dominated by ICT sectors and be underrepresented in other sectors such as pharmaceuticals, automotive and agriculture.
- Given the fact that R&D in some industries take longer and return on invest equally so, cross-sectional study was a limiting factor for industries that may takes an average of 12 years to see return on R&D such as bio-pharmaceutical sector. A longitudinal study might be used to draw conclusion in respect to R&D and turnover.

3.9. Conclusion of research methodology

Chapter 3 outlined the research methodology and addressed the techniques and approaches for this study. The researcher adopts a positivist research paradigm to support the quantitative method. In this study, the sample population includes NTBFs located at university and government technology incubators which may not represent the entire population of all NTBFs. A judgment sampling is assumed to select the most useful sample to respond the research questionnaires. The selected and adapted research instruments based on EO and the CIS enable the researcher to analyse firms based on instrumental variables. The constructs and variables from the research instrument will be used to test the three hypotheses.

4. RESULTS PRESENTATION

4.1. Introduction

The methodology explained in Chapter 3 is used to present the results which explore the research questions and hypotheses. A recap of the main research problem is that despite the supporting environment, there is a poor rate of survival of NTBFs which affect firms' innovation performance. Thus, prompting the following research questions:

1) What are the determinant factors related to the survival of nascent firms?
2) What is the relationship between R&D propensity and NTBF's innovation performance?
3) Does technological capability (non-R&D activities) of a NTBF lead to innovation performance? If so, under what conditions?

Furthermore, Chapter 4 presents results pertaining to the three (3) research hypotheses. The results of the following hypothesis are presented. In summary this chapter outlines the demographic of respondents in a form of description. We then present the hypothesized model results in three sections (1) descriptive and (2) categorical, (3) constructs and (4) factors influencing innovation performance.

A total of 228 responses were received. Of the 228 responses, 22 were incomplete and thus removed from the sample. The final sample analysed had 206 responses.

4.2. New technology-based firm characteristics

4.2.1. Industry

More than half of the respondents in the sample were in the ICT industry (51%) followed by energy (11%) and Biotech (8%). There was another 24% that were from other industries that were not classified. The results are shown in Figure 4.

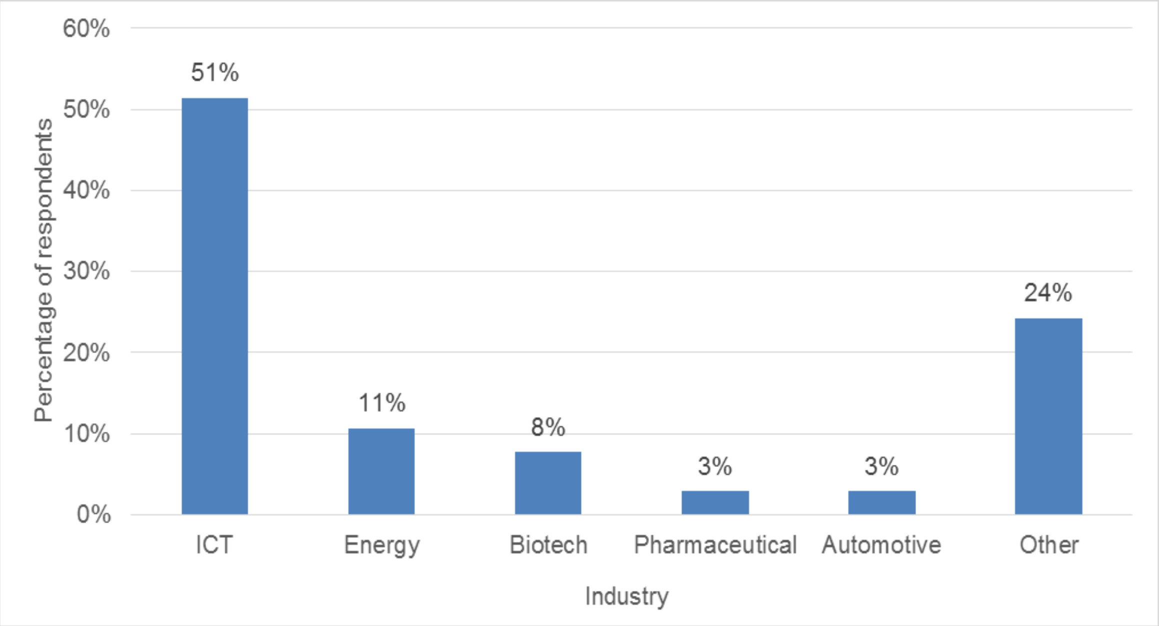

Figure 4: New-technology-based firm - Industry type

4.2.2. Size

The sizes of the start-ups represented in the sample ranged from 1-2 employees for 24% of the sample, 3 – 4 employees (45%), 5 – 6 employees (23%) and the other 8% had 7 employees and above. It can be noted that majority of the state-ups in the sample had 1 – 4 employees only (69%). See Figure 5.

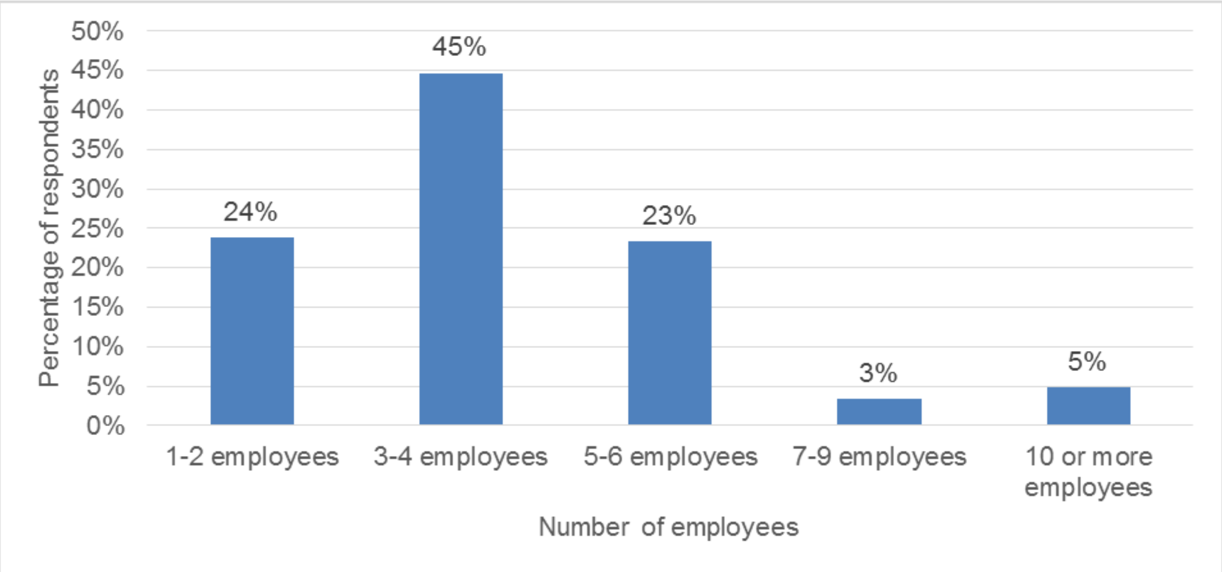

Figure 5: New-technology-based firm - Size of start-up

4.2.3. Duration of incubation

Figure 6 shows the distribution of time that the start-ups have been in incubation. It can be noted that 9% had been in incubation for 1 – 3 months, another 9% for 4 – 5 months, 19% for 6 – 10 months, and 35% for 11 – 20 months while the other 28% had been in incubation for more than 20 months.

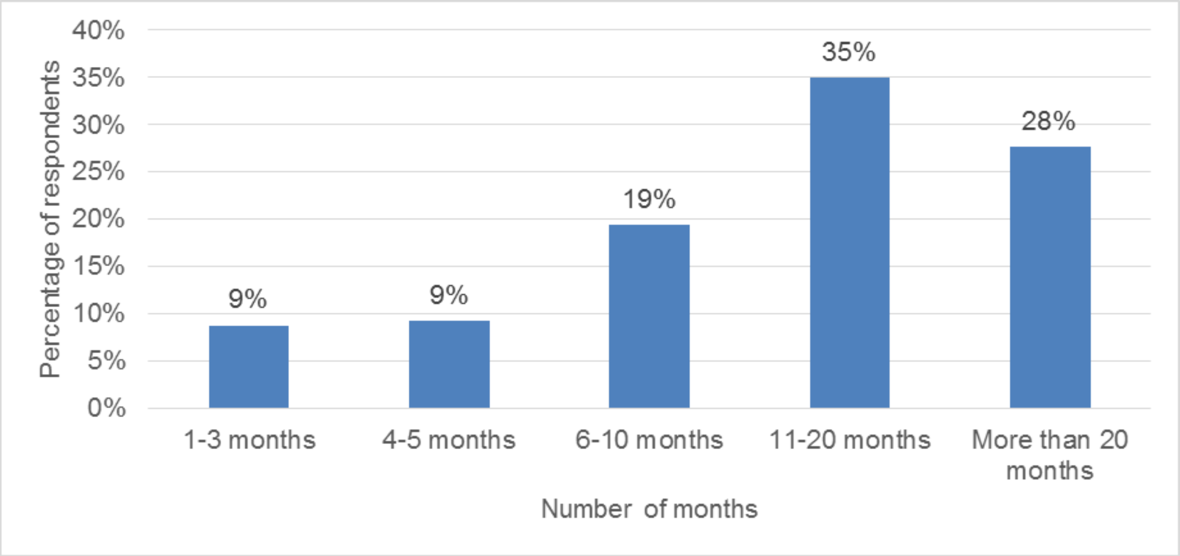

Figure 6: New-technology-based firm - duration of incubation

4.2.4. Type of technology incubator management

The pie chart below shows the type of technology incubation management. Most of the start-ups in the sample were under government-aligned incubators (80%) with the other 20% under university-aligned incubators. See Figure 7.

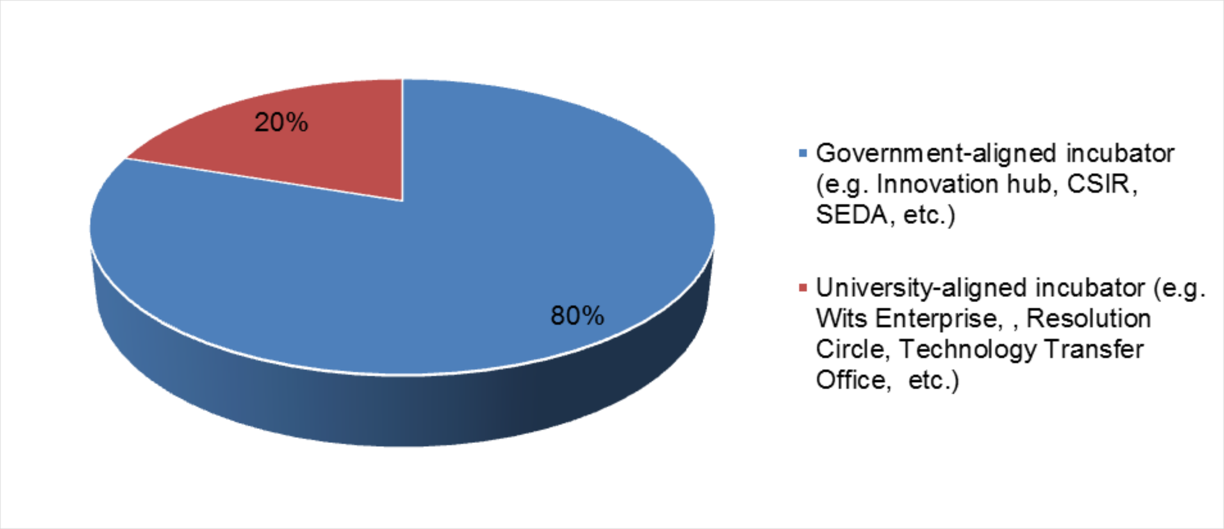

Figure 7: New-technology-based firm - Type of technology incubator management

4.3. Number of years in existence

The number of years in existence for the stat-ups is summarized in Figure 8. A proportion of 30% of the start-ups had been in existence for 1 – 2 years at the time of the survey, 55% had been in existence for 3 years, 12% for 4 years and the other 3% for 5 years and above

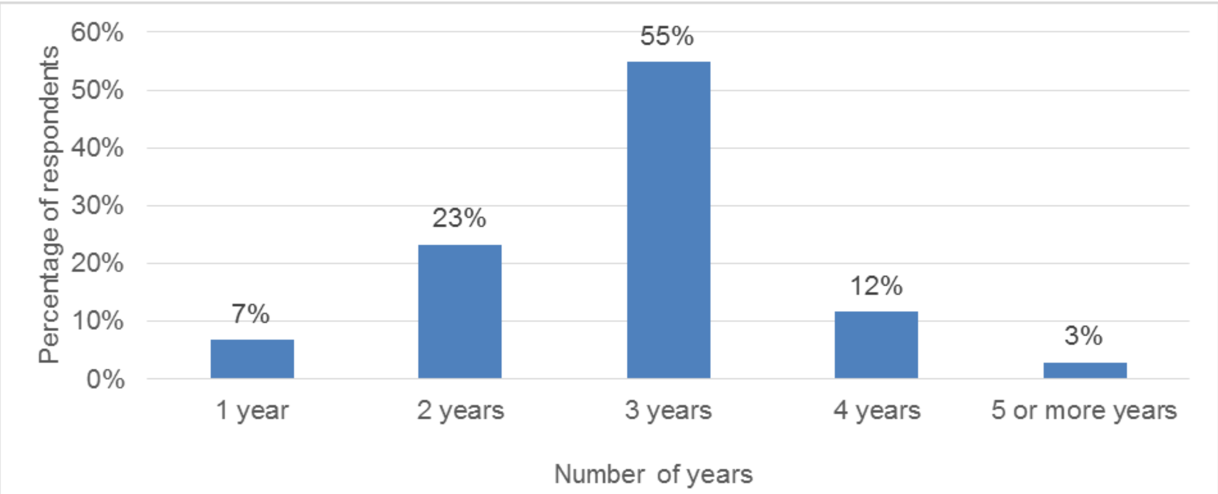

Figure 8: New-technology-based firm - Number of years in existence

4.4. Start-up received funding in the past year

The research also established whether the start-ups received funding in the previous year. The results are shown in Figure 9. It can be noted that 60% of the start-ups received funding in the previous years and the other 40% did not receive any funding.

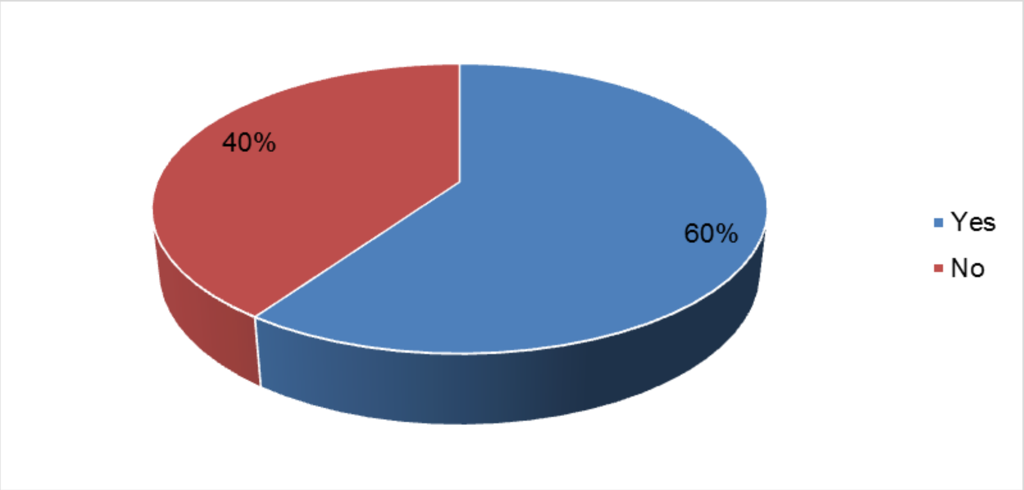

Figure 9: New-technology-based firm - Start-up received funding in the past year

4.5. Duration of funding

Based on the 123 stat-ups that received funding in the previous year, 42% received funding for 1 year, 43% received funding for 2 years, 13% for 3 years and 2% received funding for 4 years. The results are shown in Figure 10.

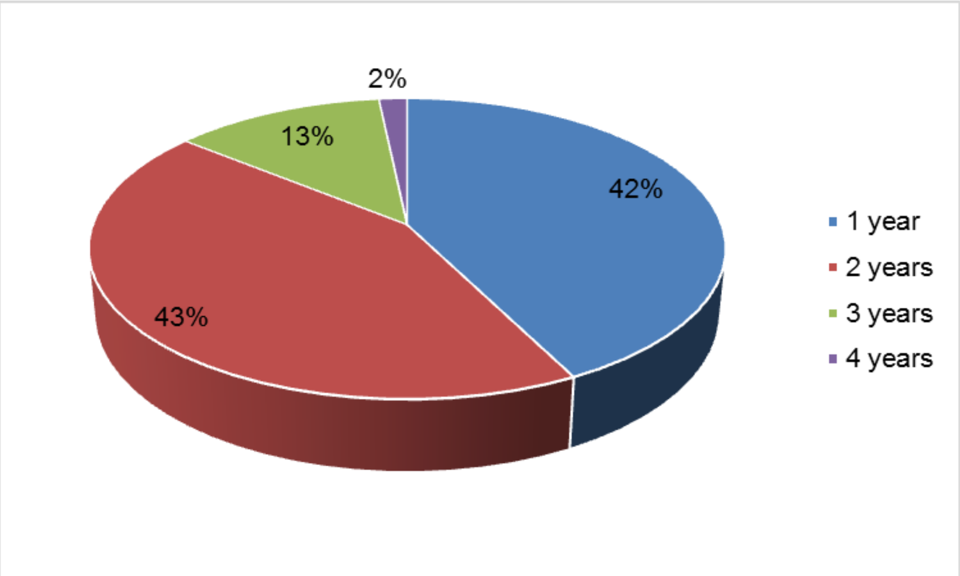

Figure 10: New-technology-based firm - Duration of funding

4.6. Constructs and factors measurement

In this section, we present the exploratory results of construct variables deliberately created by researchers in order to conceptualize the hypothesized model. In order to test the hypothesis model, the researcher initially employed exploratory factor analysis to estimate the predictors or underlying variables and estimate of latent loadings. The underlying construct variables and underlying variables require validity and reliability test before testing the correlation between factors that impact innovation performance is performed. Subsequently, the correlation between survival, technological capability, R&D propensity and innovation performance measurements is presented. Table 4 presents the structure of constructs and factors.

Table 4: Structure of measured constructs and factors

Main construct (Variable)	Sub-main Construct (Sub-factor)	Code	Item (Underlying construct)
Survival	Years of Residence	Y1	For how long has your organisation been mentored by a technology incubator
	Knowledge & Collaboration	C1	Research co-operation with important scientific and academic institutions
		K1	To what extent are Universities / Higher Education institutions sources of information for new innovation products / s
		C2	Maturity of the new technology, product or service
		K2	To what extent did the Government or public research institutions are sources of information for new innovation products / s
R&D Propensity	Research & Development Internal (RDI)	RD2	Our organisation invests heavily in new product development
		RD1	Our organisation has a strong focus on Research and Development activities
		RD3	The approved budget for Research and Development activities in our organisation stimulates innovation
	Research & Development External	RD5	Our organisation commits significant resources to ventures in uncertain conditions
		RD4	Our organisation's Research and Development division

	(RDE)		has a culture of introducing new products into the complex market
Technological Capability	Technology Adaptation (TA)	P3	Our organisation has a strong emphasis on Research & Development
		P5	Our organisation is good at adapting or modifying existing products or services originally developed by other enterprises or institutions
			Our organisation is open to outside ideas that can lead to new business opportunities
		P1	Our organisation has an emphasis on introducing new innovation or technology
		P2	Our organisation has a strong emphasis on the marketing of tried and true products or services.
		INS 3	During the past 3 years, the amount of previous research used to implement or improve products or services can best be described as
	Innovativeness (INS)	INS 4	During the past 3 years, the quantity of patents produced by your organization can best be described as
		INS 5	During the past 3 years, the quantity of publications produced by your organization can best be described as
		INS 2	During the past 3 years, the quantity of new services launched/marketed by your organization can best be described as
		INS 1	During the past 3 years, the quantity of new products launched/marketed by your organisation can best be described as
Technological Capability	Marketing (M)	M2	Renewing the distribution channels without changing the logistics processes related to the delivery of the product
		M1	Renewing the design of the current and/or new products through changes such as in appearance, packaging, shape or volume
		M3	Renewing the product promotion techniques employed for the launch of the current and/or new products.
		M4	Renewing the product pricing techniques employed for the pricing of the current and/or new products.
	Market Leadership (ML)	P7	Our organisation is leading in new market identification ahead of its competitors (experimenting innovation methods)
		P6	Our organisation is leading in introducing new innovation or technology ahead of its competitors
		P8	Our organisation always strives for market share through proactive sales

4.7. Results - Research design

4.7.1. Reliability

The reliability of the scale for the retained factors and/or constructs was assessed using Cronbach's Alpha (Knight, 1997). An Alpha value >0.9 is an indication of excellent reliability (internal consistency), > 0.8 signifies good reliability, > 0.7 is acceptable reliability, > 0.6 is questionable, > 0.5 is poor while < 0.5 is unacceptable. The reliability scores for constructs are presented in Table 4.

The results show that Technological Capability sub-constructs 1) Market Leadership (0.891) had the highest level of reliability (internal consistency) followed by 2) Technology Adaptation (0.886) and 3) Innovativeness (0.877). R&D propensity sub-construct 1) Research & Development External (0.862), 2) Research & Development Internal (0.820), Technological Capability sub-constructs Marketing (0.851) and Survival (0.800) which all had a good level of reliability.

The levels of reliability were all greater than 0.7 which is an indication that the items within each of the 7 scales can be assembled together to calculate a summated scale for every item (or construct). The summated scale for every scale was figured by ascertaining the average of construct (or items) within that particular construct, see Table5.

Table 5: Summated scale for each variable.

Main Construct	Construct	Number of Items	Cronbach's Alpha	Level of reliability
Technological Capability	Ahead of competitors	3	.891	Good
	Technology Adaptation	6	.886	Good
	Innovativeness	4	.877	Good
	Marketing	4	.851	Good
R&D Propensity	External R&D	2	.862	Good
	Internal R&D	3	.820	Good
Survival	Survival	4	.800	Good

4.7.2. Validity

Adopting the common explanation of variance for factor loading, an estimate of 60% and above is recommended. Statistical outcomes shown that Technological Capability construct had four underlying constructs which clarified 74% of aggregate difference (variance) in the constructs within the scale. The factors or constructs were Technology Adaptation, Innovativeness, Marketing and Market Leadership. The loading of factors were high, estimating from 0.602 to 0.850 all the underlying items within the formulated assumed construct were held. Survival - Knowledge and Collaboration construct estimated 63% of variation from underlying constructs within the scale. The items within the factor loaded highly onto the factor ranging from 0.726 to 0.843. There were two Research and Development (R&D) sub-constructs which were retained. The two factors explained 81% of total variance from underlying items within the scale. The factors loadings for items loading onto one factor were high ranging from 0.714 to 0.930. Results are shown in Table 6.

Table 6: Scale Validity

Main construct	Sub-Construct	Code	Component				Total variance explained
			1	2	3	4	
Survival	-	C1	.843				63%
		K1	.828				
		C2	.763				
		K2	.726				
Research and development (R&D)	Internal R&D	RD2	.904	.207			81%
		RD1	.894	-.018			
		RD3	.714	.397			
	External R&D	RD5	.082	.930			
		RD4	.226	.904			
Technological Capability	Technology Adaptation (TA)	P3	.850	.163	.172	.134	74%
		P5	.794	.095	.278	-.080	
			.790	.217	.128	.166	
		P1	.762	-.113	.302	.354	
		P2	.738	-.136	.415	.029	
		INS3	.602	.148	.319	-.378	
	Innovativeness (INS)	INS4	.088	.856	.052	.181	
		INS5	.004	.849	.089	.227	
		INS2	.007	.788	.189	.407	
		INS1	.241	.652	.265	.199	
	Marketing (M)	M2	.256	.094	.792	.107	
		M1	.273	.046	.774	.201	
		M3	.252	.267	.747	.073	
		M4	.354	.235	.685	.130	
	Market Leadership(ML)	P7	.092	.388	.209	.799	
		P6	.118	.319	.138	.794	
		P8	.063	.430	.145	.751	

The reliability and validity tests for Survival - Years of Residence (YoR) sub-main construct were not done for one reason. This variable is similar our dependent variable "Average % of total turnover from products and services that were new to the market in the past (3) three years", where its only one statement on that construct/variable. Thus, one does do not need to conduct validity and reliability tests since these tests are meant for multi-item constructs.

4.7.3. Exploratory Factor loading results

The validity of the research instrument was resolved based on utilizing existing research variables and analyzing each item or underlying variable in respect to validity. Validity allows the researcher to specifically test whether operationalization and the scoring of factors sufficiently reflect the hypothesized model the researcher pursues to measure. The first step is to assess the statistical measurements to show that the data and the model correspond sufficiently. Exploratory Factor Analysis (EFA) allows testing of the hypothesis by first observing the number of underlying variables and estimates factor loading. The latter part of EFA is results of each factor (i.e. survival, R&D propensity and technological capability) which are constituted by underlying measured variables in the analysis.

Attention is given to a number of underlying variables and the researcher resorted in retaining at least four construct variables for each factor gained from the consensus of existing literature for item analysis. The extraction of latent (construct variables) assists the research to identity the underlying factor structure of the hypothesis model. The researcher retains all factors with eigenvalues greater than 1.0 and variance which is recommended to be above the 60%, highlighted in red.

Validity of the constructs was tested using exploratory factor analysis. With an exception of Survival as a main construct, all underlying variables loaded for each factor. Although in some instances, some main construct had to be decoupled in to sub-constructs. See Table 4 - Structure of measured constructs. The following section shows the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Bartlett's Test of Sphericity results.

4.7.4. Survival - Knowledge & Collaboration

Six (6) variables were designed in the research from existing theories to measure Survival – Years of Residence, Knowledge and Collaboration constructs estimate loading. For the Knowledge and Collaboration constructs, which had five statements, three measuring knowledge and two measuring collaboration, the variable "K3- Mentors as a source of information for new innovation products" was excluded since it had communality less than 0.4 (communality was 0.217). The KMO values were higher that the recommended value of 0.5; Survival was (0.638) while the Bartlett's Test of Sphericity had significant p-values at 0.000 as required for factor analysis (p-values < 0.05). This suggests that the surveyed firm's data was suitable to perform factor analysis for Survival Knowledge and Collaboration (See Table 7)

Table 7: Underlying variables assumptions of factor analysis of Survival construct.

Survival Knowledge & Collaboration		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.638
Bartlett's Test of Sphericity	Approx. Chi-Square	363.347
	Df	6
	Sig.	.000

4.7.5. R&D propensity

The researcher considers the factors that predict observed main constructs which are guided by the theory and observational results from previous research. The main construct, R&D propensity was decoupled into sub-constructs Research and Development Internal and Research Development External. The KMO values were higher that the recommended value of 0.5; being (0.672) Internal R&D. This suggests that the surveyed firm's data was suitable to perform factor analysis. The Bartlett's Test of Sphericity had significant p-values as required for factor analysis (p-values < 0.05), with statistical significant for R&D propensity of 0.000. See results in Table 8.

Table 8: Underlying variables assumption of factor analysis of R&D Propensity construct.

Research and Development		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.672
Bartlett's Test of Sphericity	Approx. Chi-Square	491.640
	Df	10
	Sig.	.000

4.7.6. Technological Capability

A matrix of 17 variables made up of four (4) sub-constructs for Technological Capability which includes “Market Leadership” Technology Adaptation”, “Innovativeness” and “Marketing” were being considered as underlying variables. None were excluded since all underlying variables had communality more than 0.5 The KMO values were higher that the recommended value of 0.5; Technological Capability was (0.876) The Bartlett's Test of Sphericity had significant p-values as required for factor analysis (p-values < 0.05). See results in Table 9.

Table 9: Underlying variables assumption of factor analysis of Technological Capability construct.

Technological Capability		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.876
Bartlett's Test of Sphericity	Approx. Chi-Square	2401.446
	Df	136
	Sig.	.000

4.7.7. Conclusion of reliability and validity of measured variables

To test scale reliability, we assessed each underlying construct and each factor for reliability. The Cronbach’s Alpha values tested the internal reliability and consistency of the research instruments as the absence of reliability makes it difficult to have validity associated with the scales. The reliability of the scale for the retained factors and/or constructs was assessed using Cronbach's Alpha. The levels of reliability were greater than the minimum of 0.6; all construct Alpha scores were between 0.800 and .891 which is an indication good reliability.

Validity of the constructs was tested using exploratory factor analysis. Regarding the number of estimates of the factor loadings, at least four or more construct variables with a score of at least of .50 were accepted for each factor. All the KMO values were higher than the recommended value of 0.5, Technological Capability (0.876), Survival (0.638), Research and Development (0.672).The Bartlett's Test of Sphericity had significant p-values as required for factor analysis (p-values < 0.05). The Bartlett's Test of Sphericity of 0.000 for all the constructs. With an exception of the Survival construct (i.e. Years of Residence (YoR), Collaboration and Knowledge), which had 5 statements, 3 measuring knowledge and 2 measuring collaboration, the variable "K3- Mentors as a source of information for new innovation products" was excluded since it had communality less than 0.4 (communality was 0.217). As observed all main construct structures accounted between 63% and 81% of the variance above the recommended 60%. We conclude that the hypothesize model and research instrument reliability and validity fit is acceptable and appropriate.

4.8. Descriptive statistics

Descriptive statistics are the centre of basic analysis for observed variables to draw conclusions on gathered data to analyse centrality, spread and other descriptions. When describing a set of data one of useful methods of describing data is mean, standard deviation (SD), and the correlation between observed variables.

- Mean – centrality of variables
- Standard Deviation - measure of the scattering of set of data from its mean
- Correlation – relationship between Likert scale variables.

4.8.1. Descriptive statistics and Pearson's correlation

We, initially concentrate on the correlation between independent variables Survival YoR, Collaboration and Knowledge, R&D propensity and technological capability; and subsequently, the relation between independent variables and dependent variable innovation performance. We adopted a significance 5%-level (p-value 0.05).

4.8.1.1. Correlation amongst constructs

Table 10, show assessment of correlation in regards to how far or close sub-constructs Survival -Year of Residence (YoR), Survival - Knowledge and Collaboration, Technology Adaptation, Innovativeness, Marketing, Market Leadership, Internal and External R&D are to one another. Analysis of correlation were based on common Pearson's correlation interpretation; that is > 0.8 => very strong, 0.5-0.7=> strong, 0.3-0.49 => moderate and <0.2 => no real evidence. There is a strong positive correlation between Knowledge and Collaboration on the other hand and Internal R&D (r=0.740), Market Leadership and External R&D (r=0.712), Knowledge and Collaboration and Technology Adaptation (r=0.704). Table 4 also show a strong positive correlation between Technology Adaptation, Innovativeness, Internal R&D, external R&D, Market Leadership, Marketing and Knowledge and Collaboration recording between r=0.53 and r=0.679. The independent variables were significantly correlated amongst themselves but the correlation coefficients were all less than 0.9, which implies that there is no risk of multicollinearity. However, there was no strong correlation, the researcher concluded that there was some evidence of positive correlation between Innovativeness, Knowledge and Collaboration, External R&D, Technology Adaptation and Market Leadership, correlation between (r=0.256 and 0.238) significant at the 0.01.

4.8.1.2. Correlation between main constructs and dependent variable

The descriptive statistics and Pearson's correlation coefficient among constructs and the dependent variable "*Average % of total turnover from products and services that were new to the market in the past (3) three years (Turnover)*" are summarised in Table 10.

The descriptive statistics shows that Technology Adaptation (mean = 3.22, SD = 1.155) was the highest rated construct followed by Internal R&D (mean = 3.88, SD = 0.785) then Survival – Years of Residence (YoR) (mean = 3.64), Survival - Knowledge and Collaboration (mean = 3.07, SD = 1.093) and the least rated among the independent variables was Innovativeness (mean = 1.71, SD = 0.791).

Independent variables Technology Adaptation (r = 0.554), Survival Knowledge and Collaboration (r = 0.469), Innovativeness (r= 0.428), Marketing (r = 0.422), Internal R&D (r = 0.413), External R&D (r = 0.368) and Market Leadership (r = 0.256) were positively correlated to "Average % of total turnover from products and services that were new to the market in the past (3) three years (Turnover)", the dependent variable.

Concerning Survival Years (r=0.96), it was the least positive correlated to "Average % of total turnover from products and services that were new to the market in the past (3) three years (Turnover)", the dependent variable.

Table 10: Pearson's Correlation and Descriptive statistics for variables

	Mean	**SD**	1.	2.	3.	4.	5.	6.	7.	8.	9.
1.Survival – Years (YoR)	3.64	1.225	1								
2.Survival – Knowledge and Collaboration	3.07	1.093	.172*	1							
3.Marketing	2.56	0.840	.208**	.598**	1						
4.Innovativeness	1.71	0.791	-.075	.238**	.398**	1					
5.Technology Adaptation	3.56	0.995	.147*	.704**	.636**	.220**	1				
6.Market Leadership	2.35	1.090	-.132	.163*	.407**	.661**	.214**	1			
7.Internal R&D	3.22	1.155	.058	.740**	.553**	.252**	.678**	.256**	1		
8.External R&D	2.12	1.082	-.159*	.237**	.343**	.679**	.259**	.712**	.386**	1	
9.Turnover	2.25	1.387	.096	.469**	.422**	.428**	.554**	.256**	.413**	.368**	1
*. Correlation is significant at the 0.05 level (2-tailed).											
**. Correlation is significant at the 0.01 level (2-tailed).											

4.9. Hypothesis testing: Multiple Linear regression

Before presenting the results, we briefly recap the hypothesis for this study as previous section demonstrated the validity, reliability and correlation. This section tests the three hypothesis of the study. We first provide the hypothesis formulated in Chapter 2, here are the original hypotheses. See results in Table 11.

Table 11: Hypotheses re-formulation

Hypothesis		**Suggested alternative hypothesis (YES/NO)**
H1a	Survival Year	No
H1b	Survival Knowledge and Collaboration→ Innovation performance	Yes
H2a	Internal R&D → Innovation performance	Yes
H2b	External R&D → Innovation performance	Yes
H3a	Marketing→ Innovation performance	Yes
H3b	Innovativeness→ Innovation performance	Yes
H3c	Technology Adaptation→ Innovation performance	Yes
H3d	Ahead of competitors→ Innovation performance	Yes

These hypothesis set out three main constructs or factors that study seek to answer in respect to innovation performance. However, given the outcome of exploratory factor analysis and to test the above hypothesis the following null and alternative hypotheses were postulated. Newly formulated hypothesis are as following:

H1. The greater the number of years in the technology incubator, the higher the probability of new technology-based firms to produce new products or services and survive.

To test the above hypothesis the following null and alternative hypotheses were postulated.

H0: There is no relationship between survival and *"Average % of total turnover from products and services that were new to the market in the past (3) three years (Turnover)"*

H1a: The greater the number of years in the technology incubator, the higher the probability of new technology-based firms to produce new products or services and survive.

H1b: There is a positive relationship between survival and Turnover.

H2. The higher the R&D output (patents, invention) of technology-based firms, the better their innovation performance.

H0: There is no relationship between R&D output and *Turnover*

H2: There is a positive relationship between R&D output and Turnover.

This hypothesis was split into two (2) sub-hypothesis since R&D was measure using two (2) sub-constructs namely; Internal R&D and External R&D. The hypothesises are analysed below;

H2a: There is a positive relationship between Internal R&D and Turnover.

H2b: There is a positive relationship between External R&D and Turnover

H3: There is a positive relationship between Technological capability and Turnover.

This hypothesis was split into four (4) sub-hypothesis since technological capability was measure using four (4) sub-constructs namely; Marketing, Innovativeness, Technology Adaptation and Market Leadership.

The hypothesises are analysed below;

H3a: There is a positive relationship between Marketing and Turnover.
H3b: There is a positive relationship between Innovativeness and Turnover.
H3c: There is a positive relationship between Technology Adaptation and Turnover.
H3d: There is a positive relationship between Market Leadership and Turnover.

The analysis of factors impact innovation performance of new technology-based firms was completed utilizing multiple linear regressions.

Multiple linear regression was conducted to test the hypotheses with Turnover as the dependent variable and Survival, Technological Capability sub-main construct 1) Innovativeness, 2) Marketing, 3) Market Leadership and R&D propensity sub-main constructs 1) Internal R&D , and 3) External R&D as the independent variables. The results are shown below; see Table 12.

Table 12: Model summary and ANOVA

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.653[a]	.426	.406	1.069

a. Predictors: (Constant), External R&D , Survival – YoR and Knowledge and Collaboration, Marketing, Innovativeness, Technology Adaptation Existing Technologies , Ahead of competitors, Internal R&D

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	168.004	7	24.001	20.993	.000[b]
	Residual	226.370	198	1.143		
	Total	394.374	205			

a. Dependent Variable: Average % of total turnover from products and services that were new to the market in the past (3) three years

b. Predictors: (Constant), External R&D , Survival – YoR and Knowledge and Collaboration, Marketing, Innovativeness, Technology Adaptation , Market Leadership, Internal R&D

It can be noted from the results that the regression model was significant ($F = 20.993$; $p = .000$; $R^2 = .426$. An adjusted R^2 value of .406 shows that the model predicted approximately 40.6% of the variance in the turnover variable (i.e. dependent variable). The significance of each of the independent variables in predicting Turnover is presented in Table 13.

Table 13: Regression Coefficients

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-1.206	.366		-3.295	.001
	Survival – YoR	.054	.065	.048	.837	.404
	Survival - Knowledge and Collaboration	.167	.116	.131	1.432	.154
	Internal R&D	-.090	.108	-.075	-.828	.409
	External R&D	.191	.114	.149	1.682	.094
	Marketing	-.054	.134	-.032	-.400	.690
	Innovativeness	.579	.141	.330	4.103	.000
	Technology Adaptation	.623	.119	.447	5.224	.000
	Ahead of competitors	-.188	.108	-.147	-1.737	.084

Coefficients[a]

a. Dependent Variable: Average % of total turnover from products and services that were new to the market in the past (3) three years

The regression model is given by;

$$\text{Turnover} = -1.206 + 0.167\text{SUY} + 0.167\text{SU} - 0.054\text{M} + 0.579\text{INS} + 0.623\text{A} - 0.188\text{AC} - 0.090\text{RDI} + 0.191\text{RDE}$$

The results show that only Innovativeness and Technology were significant predictors of Turnover. Technology Adaptation (ß = 0.447; p = 0.000) contributed the most towards explaining the variance in turnover followed by Innovativeness (ß = 0.330; p = 0.000). Market Leadership (ß = -0.154; p = 0.109) had the lowest contribution.

The collinearity statistics indicated that all the tolerance values were close to 1 and the variance inflation factor (VIF) values were all less than 10. This implies that there are little or no multicollinearity concerns.

4.10. Results per hypothesis

H1. The greater the number of years in the technology incubator, the higher the probability of new technology-based firms to produce new products or services and survive.

> H0: There is no relationship between the number of years in the technology incubator, and the probability of new technology-based firms to produce new products or services and survive.
>
> H1a: The greater the number of years in the technology incubator, the higher the probability of new technology-based firms to produce new products or services and survive.

The results from the coefficients table shows that the relationship between Turnover and Survival - Year of Residence (YoR) ($\beta = 0.048$, $t = 0.837$, p-value = 0.404) is positive since the standardised coefficient for YoR is greater than zero, but the relationship is not significant since the p-value is greater than 0.05. It therefore suggested that that H1a is not backed. Hence, the null hypothesis is not rejected and it is therefore concluded that there is no relationship between the number of years in the technology incubator, and the probability of new technology-based firms to produce new products or services and survive.

> H1a: There is a positive relationship between Survival - Knowledge and Collaboration and Turnover.

The results from the coefficients table reveals that the connection between Knowledge and Collaboration and Turnover ($\beta = 0.131$, $t = 1.423$, p-value = 0.154) is positive since the standardised coefficient for Knowledge and Collaboration is greater than zero but the relationship is not significant since the p-value is greater than 0.05. This suggests that H1b is not supported. Therefore, there is no relationship between Survival Knowledge and Collaboration and Turnover.

H2. The higher the R&D output (patents, invention) of technology-based firms, the better their innovation performance.

H0: There is no relationship R&D output and *Turnover*

H2: There is a positive relationship between R&D output and Turnover.

This hypothesis was split into two (2) sub-hypothesis since R&D was measure using two (2) sub-constructs namely; Internal R&D and External R&D. The hypothesises are analysed below;

H2a: There is a positive relationship between Internal R&D and Turnover.

It is also noticed that although the connection between Turnover and Internal R&D (β = -0.075, t = -0.828, p-value = 0.409) is negative since the standardised coefficient for Internal R&D is less than zero, the relationship is not significant since the p-value is greater than 0.05. This suggests that H2a is not backed. Hence, the null hypothesis is not rejected and it is concluded that there is no relationship between Internal R&D and innovation performance (Turnover).

H2b: There is a positive relationship between External R&D and Turnover.

It can be noted that although the relationship between Turnover and External R&D (β = 0.149, t = 1.682, p-value = 0.094) is positive since the standardised coefficient for Internal R&D is greater than zero, the relationship is not significant since the p-value is greater than 0.05. This suggests that H2b is not supported. Hence, the null hypothesis is not rejected. Therefore, there is no relationship between External R&D and innovation performance (Turnover).

H3: The greater the level of Technology Capability (non R&D activities) of NTBFs, the higher their innovation performance.

H0: There is no relationship Technological Capability and *Turnover*

H3: There is a positive relationship between Technological Capability and Turnover.

This hypothesis was split into four (4) sub-hypothesis since Technological Capability was measure using four (4) sub-constructs namely; Marketing, Innovativeness, Technology Adaptation and Ahead of competitors.

The hypothesises are analysed below;

H3a: There is a positive relationship between Marketing and Turnover.

The results from the coefficients table shows that although the relationship between Marketing and Turnover (β = -0.032, t = -0.400, p-value = 0.690) is negative (since the standardised coefficient for Survival is less than zero), the relationship is not significant since the p-value is greater than 0.05. This suggests that H3a is not backed. Hence, the null hypothesis is not rejected and it is therefore concluded that there is no relationship between marketing and innovation performance (Turnover).

H3b: There is a positive relationship between Innovativeness and Turnover

The results from the coefficients table shows that the relationship between Turnover and Innovativeness (β = 0.330, t = 4.103, p-value = 0.000) is positive since the standardised coefficient for Innovativeness is greater than zero and is also significant since the p-value is less than 0.05. This implies that H3b is supported. Thus, the null hypothesis is rejected in favour of the alternative hypothesis. It is therefore concluded that a there is a positive relationship between Innovativeness and innovation performance (Turnover).

H3c: There is a positive relationship between Technology Adaptation and Turnover.

The results from the coefficients table shows that the relationship between Turnover and Technology Adaptation ($\beta = 0.447$, $t = 5.224$, p-value = 0.000) is positive since the standardised coefficient for Technology Adaptation is greater than zero and is also significant since the p-value is less than 0.05. This implies that H3c is supported. Thus, the null hypothesis is rejected in favour of the alternative hypothesis. It is therefore concluded that a there is a positive relationship between Technology Adaptation and innovation performance (Turnover).

H3d: There is a positive relationship between Market Leadership and Turnover.

The results from the coefficients table shows that although the relationship between Market Leadership and Turnover ($\beta = -0.147$, $t = -1.737$, p-value = 0.084) is negative since the standardised coefficient for Market Leadership is less than zero, the relationship is not significant since the p-value is greater than 0.05. This implies that H3d is not supported. Thus, the null hypothesis is not rejected and it is therefore concluded that there is no relationship between Market Leadership and innovation performance (Turnover).

The summary of all three hypothesis are shown in Table 14.

Table 14: Summary of Hypotheses results

Hypothesis		Standardised Beta (β)	T - value	P-value
H1a	Survival Year	.048	.837	.404
H1b	Survival Knowledge and Collaboration→ Innovation performance	.131	1.508	.133
H2a	Internal R&D → Innovation performance	-.075	-.896	.371
H2b	External R&D → Innovation performance	.149	1.610	.109
H3a	Marketing→ Innovation performance	-.032	-.231	.818
H3b	Innovativeness→ Innovation performance	.330	4.103	.000
H3c	Technology Adaptation → Innovation performance	.447	5.239	.000
H3d	Market Leadership→ Innovation performance	-.147	- 1.824	.070

4.10.1. Conclusion of presentation of results

As introduced in Chapter3, in exploratory factor analysis, we only concluded which underlying variable loads to main construct (or sub-main construct); at this stage the research has no prior models to test other than to test the reliability and validity of the new instruments/factors. The levels of reliability were greater than the minimum of 0.6; all construct Alpha scores were between 0.800 and .891 which is an indication good reliability. In respect to validity, All the KMO values were greater than the minimum required value of 0.5. Observed main construct and sub-main constructs were above the recommended 60% variance. The research instrument variable was valid and reliable.

Results pertaining to the three research hypothesis were presented. This included descriptive statistics, correlation amongst independent variables and dependent variables. We concentrate on the correlation between Survival, R&D propensity, Technological Capability and innovation performance. We adopt Significance 5%-level, P-value_0.05). All the independent variables were positively correlated to dependent variable Turnover, r value range between (r = 0.554) and (r = 0.256). Pearson correlations between independent variables were significantly positive strong, but the correlation coefficients were all less than 0.9, which implies that there is no risk of multicollinearity.

Taking into account the result of exploratory factor analysis, alternative hypothesises were formulated. The findings of the sampled revealed the following results for research hypotheses:

H1a There is a positive relationship between Survival - Year of Residence (YoR) and Turnover.

It was concluded that there is no relationship between the YoR in the technology incubator, and the probability of new technology-based firms to produce new products or services and survive.

H12 There is a positive relationship between Survival Knowledge & Collaboration and Turnover.

It was concluded that there is no relationship between the YoR in the technology incubator, and the probability of new technology-based firms to produce new products or services and survive.

H2a: There is a positive relationship between Internal R&D and Turnover.
There is no relationship between Internal R&D and innovation performance (Turnover).

H2b: There is a positive relationship between External R&D and Turnover.
There is no relationship between Internal R&D and innovation performance (Turnover).

H3: There is a positive relationship between Technological capability and Turnover. This hypothesis is made up of three (3) sub hypothesises testing relationship between Marketing, Market Leadership and Turnover, it was concluded that there is no relationship. On the other hand the results show that for **H3b:** There is a positive relationship between Innovativeness and Turnover and for **H3c:** There is a positive relationship between Technology Adaptation and Turnover.

5. CHAPTER 5: DISCUSSION OF RESULTS

5.1. Introduction

In Chapter 4, the research methodology results of the exploratory factor analysis were thoroughly presented. The initial section provides a basic discussion of descriptive statistics to provide insight about the demographic details of the study. Furthermore, the empirical results of the study are contextually discussed with respect to the implication of the results towards the hypothesized model and the literature review discussed in Chapter3.

Chapter 5 provides the discussion of results pertaining to the aim of this study to identify the determinant factors (underlying factors) related to survival, R&D propensity and technological capability main constructs; and analyse the nexus of these factors and innovation performance of new technology-based firm with respect to the existing literature. Figure 11 show the conceptual model.

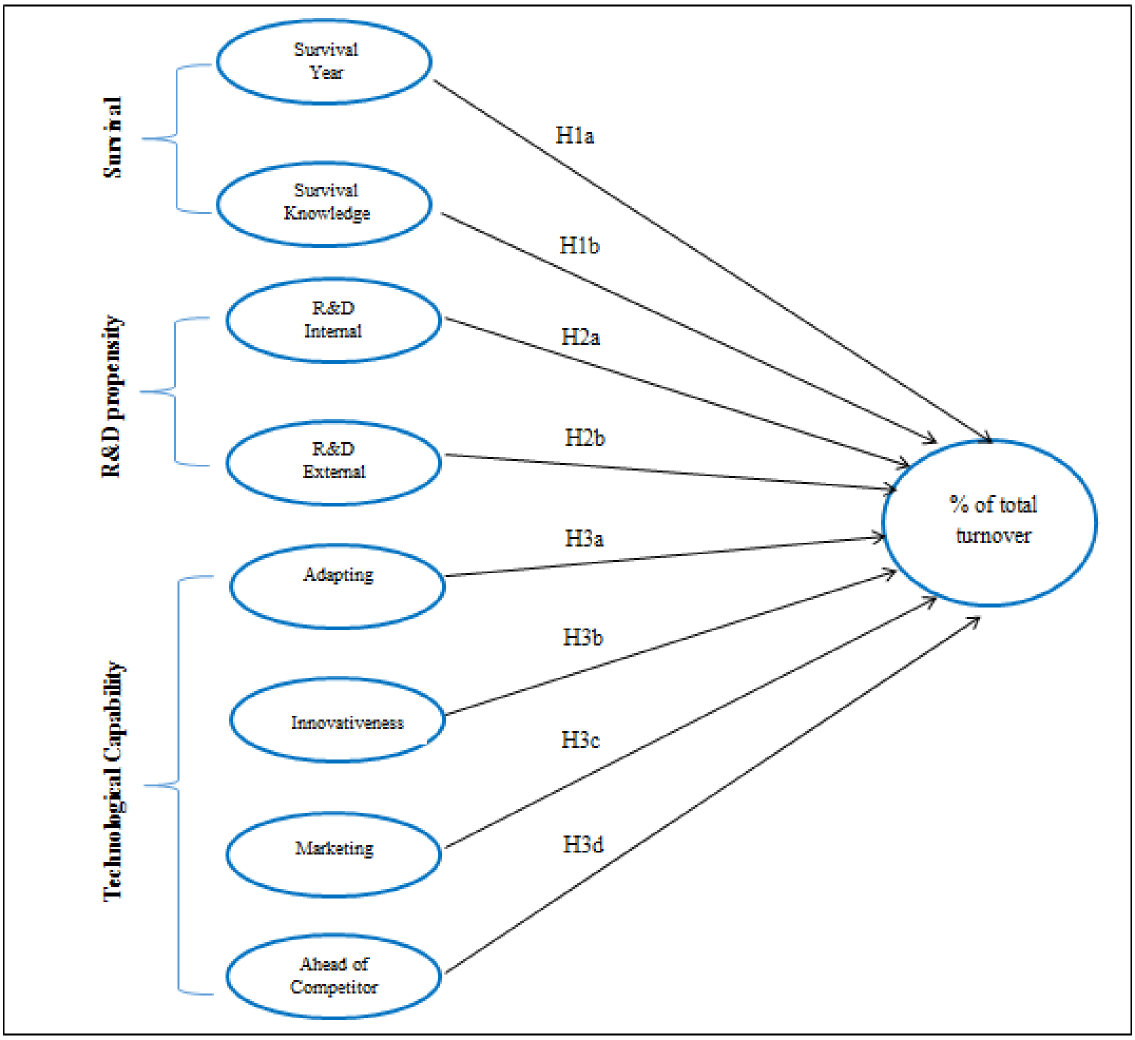

Figure 11: Conceptual model for three hypotheses

The results discussion is structured as follows:

- Descriptive statistics
- Determinant (underlying factors)
- Research hypothesis
- Summary of the results

5.2. New technology-based firm

5.2.1. Characteristics

In spite of the fact that new technology-based firms in South Africa are made up of pharmaceutical, agriculture, Information and Communication Technology (ICT), this study is more disposed to the ICT sector as the way of technopreneurs in South Africa (SA) is overwhelmed by ICT e-services. The results revealed that half of the respondent for the survey were in ICT (51%). This can be explained by the fact that other sectors are underrepresented due to the nature of technopreneurship in SA. More broadly, a technological innovation indeed occurred with the emergence of ICT (Lechevalier, 2014). The innovation space in Gauteng is most dominated by ICT sector, most notably similar to the United State of America, Silicon Valley. The results reveal that new technology-based firms are likely to be in the ICT sector, followed by other sectors at 24%.

5.2.2. Number of years in existence

It was expected that a majority of startup would be in operation between 2-3 years. The recognition is that numerous new technology-based firms (NTBFs) fail, due to the absence of business administration abilities in South Africa which are among the levers hindering NTBF business development (InfoDev, 2010). The results show most firms located at the technology incubator have been in existence for three years, that is, 55% of total surveyed firms. It must be taken in account that the number of years in existence may most likely assist new technology based firm to survive and performance in regards to profitability on the basis they have learned how to do things over a period of time. In opposition to this, newly established ventures may perform better due to less bureaucratic processes. As argued by (Dıez-Vial, 2014), years in residence does not give clear proof of the impact of firm age on firm’s innovation performance. The issue of firm’s age should be investigated exactly taking into consideration the conjunction of both positive and negative impacts of firm’s age.

5.2.3. Number of employees

The number of employees is a component of external market forces (Oi, 1999). In the wake of sifting through the descriptive statistics, the number of employees in a new technology-based firm (NTBF) is between 3 and 4 employees; very few NTBF have 10 or more employees. This is in line with the view of theories that startups are faced with funding issue, which subsequently delay the growth of employees; hence employee's growth is higher for NTBF in the following months after securing funding, hence the average number of employees for new technology-based firm is 3-4 employees (Davila, 2003).

5.2.4. Incubation

The sample data reveal that a majority of the new technology-based firms were under government-aligned incubators, that is, 80%. This is due to the fact that government-aligned incubators have a long history of backing R&D, technology transfer and dissemination of technology into industries. However, government in general has additionally assumed a key part in promoting universities to play a more dynamic part in supporting development and commercialization of technologies (Lofsten, 2003).

Within existing literature, incubation is recognized as a viable effective instrument for new technology-based firms. McAdam (2008) argued that it depends on the effectively provisioning of shared offices, for example, office, managerial staff and different resources by NTBFs. The duration of new technology-based firm (NTBF) at the technology incubator receiving support was fairly distributed between 6 months to more than 20 months. However, the longer the NTBFs spend time at the technology incubator does not concretely translate into survival and high profits potential from innovation in new markets. Another logical way to assess the duration of incubation, according to Lindelöf (2002) found firms utilize this time to complete or expand product line.

5.2.5. Funding and duration of funding

New technology-based firms seek funding mechanisms to produce products or services from various sources including personal savings and government programmes. 60% of the respondents received funding from technology incubators in the past year. It is commonly recognized that firm from an early stage required funding to promote innovation activities and sustain their existence. It is for this reason that Moore (1993) suggested that government funding supports the development of new technology ventures.

Without the source of funding, the future of start-ups is uncertain. Hence, funding is provisioned for network of startup to deliver new products and services (Hanna, 2002). As expected a majority of start-ups either at the government-run or university-run technology incubator receives funding for a period of 1 and 2 years, that is 42% and 43% respectively. Breaking down the influence of industry in relation to the duration of funding; in reality, previous empirical results have noticed that when the development period of a product is considered in certain industries, funding could be required for longer as well; for example the biotech industry and pharmaceuticals where it takes up to 10 years before launching a product

5.2.6. Correlation analysis - determinant factors for survival, R&D propensity and technological capability

This section discusses the results concerning correlation between the main constructs. It does not attempt to test the research hypotheses.

The determinant factors also referred to underlying variables of the sub-constructs, which were defined by the researcher from different research instruments of technopreneurship. A total of 24 determinant variables were loaded to each factor, survival, R&D propensity and technological capability, refer to Table 4. As per the factor loading, survival, R&D propensity and technological capability are made up of a number of underlying variables. Furthermore, Pearson’s correlation coefficient gives a different perspective over and above the underlying factor indicated by EFA.

5.2.7. Survival – Years of Residence (YoR)

We had expected that number of years under incubation management would not translate into innovation performance. However the results, suggest the relationship between marketing and adapting of existing technology may assist firm to survive and produce products and services. Results (Table 10) indicate that there is a positive and negative relationship between Survival Years and Technological Capability (Marketing r=.203, Technology Adaptation r=.147 and -.159). The number of years spent at the technology incubator is the only factor to assist firm to develop and market products. Marketing and adapting of existing technology activities constitute a critical contribution to new technology-based firms' innovation performance. This view is supported by Coad (2008) that no depends solely on licenses. However, the correlation value between these variables is too low to draw any conclusion.

5.2.8. Survival - Knowledge and Collaboration

The sample results revealed that Knowledge and Collaboration were positively correlated to Technological Capability (Marketing r=.598, Technology Adaptation r=.704) and R&D propensity (Internal R&D r=.740). This suggests that marketing and launching of new products and services attempt to elevate the firm from R&D activities to commercial activities. In the event that the firm takes longer to market the product; firms becomes helpless in the event that innovation takes longer than foreseen, thus affecting the survival of new technology-based firms (Mason, 2012).

Furthermore, these results should take into account that another key part in the achievement of technological capability is the degree of their inventiveness (adapting, incrementing innovation). The opposite side of the coin, obviously, is that a firm that puts resources into R&D, yet does not make profits, therefore adapting and modifying existing product should be encouraged as innovation sometimes is not about bringing a spectacular products or services to the market (Coad, 2008). A standout amongst the most vital discoveries was that potential business people do not have the right stuff and mentality to end up as genuine business people. This position is based on the critical examination of the South African Total Early Stage Entrepreneurship Activity (TEA) indexes, a standout amongst the most vital findings was that generally some, if not most entrepreneurs do not have the right mix of skills to become successful innovators.

Our results also indicate the relationship between access to Knowledge, Collaboration, and Internal R&D. As expected, collaboration and knowledge sharing is among the most critical variables that effects on business execution i.e. survive (Hult, 2004). Technology incubators in South Africa provide networking platforms through events, co-sharing of spaces where incubatees (or NTBF) can share peering learning and form partnerships.

5.2.9. R&D propensity and Technology Capability

Essentially, majority of the firms that consider, in-house R&D propensity (i.e. efforts within the firm inside either central/corporate Internal R&D centers or divisional R&D offices) tends to develop capability to source of innovation which is critical firms (Tidd, 1997). The results show a strong positive correlation between Internal R&D (that is NTBF has approved budget, invests heavily in internal new product development and has a strong focus on R&D activities) and Technological Capability (marketing r= .553, Technology Adaptation r=.678). Generally, the provisioning of support for startups is often directed towards the development of technology and funding; less attention is given to marketing. In agreement with this, Mason (2012) found that the lack of understanding and investment in sales and marketing functions has various consequences: uninformed initial specifications of the product/service and expensive re-development after initial market. A firm that duplicates or adapts existing technologies develops the capability to bring about rapid technologies innovation to the market.

We further consider the relation between performing external R&D where firms utilize this platform to develop the technological capability of firms to enter an uncertain market. Another assumed position in this study, External R&D which is introducing new products into the complex market and adapting or modify innovation increases R&D output i.e.

patents and products, services and publications. The sampled results show that there is a positive strong relationship between External R&D and Technological Capability (Innovativeness r=.679, Technology Adaptation r=.712). In such cases, experimenting in the development of existing products in new or uncertain market tends to increase number of innovation quantity as a result of the continuous development of innovation.

5.2.10. Technological Capability – Innovativeness and Market Leadership

A New technology-based firm with innovativeness capability and market leadership tends to have a higher potential profit. The correlation results show a strong positive relationship between Technological Capability sub-main constructs (Market Leadership and Innovativeness r=.661). Mason (2012) offers a strong argument on this point, explaining that Venture Capitalist are likely to put resources into firms that are exploiting existing high technology that has been created – where existing evidence of an extensive potential market and where rapid development is both achievable and offers considerable profits in regarding upper hand ahead of competitors.

5.3. Discussion of Hypotheses 1 to 3 – factors impacting innovation performance

All three hypotheses (including sub-hypothesis) were tested by means of multiple linear regression. Three factors (main constructs survival, R&D propensity and Technological Capability) were measured against the dependent variable, turnover. This study addresses the impact of above-mentioned factors on innovation performance and key determinant factor, sub-main constructs to innovation performance, that is a*verage % of total turnover from products and services that were new to the market in the past (3) three years (Turnover).*

This section also analyses the factors impacting innovation performance in conjunction with existing literature.

H1. The greater the number of years in the technology incubator, the higher the probability of new technology-based firms to produce new products or services and survive.

H1a: The greater the number of years in the technology incubator, the higher the probability of new technology-based firms to produce new products or services and survive

H1b: There is a positive relationship between survival and Turnover.

H1a: The greater the number of years in the technology incubator, the higher the probability of new technology-based firms to produce new products or services and survive

The empirical results suggest that there is no relationship between the number of years under the incubation management and producing new products and services that firms can launch in new markets to gain profits in order to survive. This implies that H1a is not supported. Consistent with the literature, the technology incubators are viewed as an imperative and compelling instrument for supporting startups in other aspects other than product or service development. These results also conform to the notion of other research conclusions that technology incubators do not necessarily channel investment resources into R&D output. Lofsten's (2002) conclusion was that 1) new technology-based firms (NTBFs) at under incubation do not have dedicated R&D functions to produce while under the incubation management and 2) NTBFs, being generally new and largely sensitive business forces, are not in a position to embrace lengthy R&D activities.

Furthermore, and in opposition to finding of Years in Residence, the result should also be interpreted with a different view, that 1) some of the firms try not to depend on R&D output (products and services) yet rather on their market dynamic and their nature of size of firm (Lofsten, 2002); 2) depending on the type of industry, for example; in the ICT sector development of product may take less than a year while in the bio-pharmaceutical sector may take on an average 12 years. The better fit for a number of years under incubation management and production of products depends on industry dynamics, for example some are fast-growth industries (i.e. ICT) while others take a long time to finalize products (bio-pharmaceutical).

Hence, the number of years under incubation management should not be measured by R&D output or products or service to survive. In particular to South Africa context, technology incubator movement is still in infancy stage (Alessandrini, 2013; Masutha, 2015); and 80% of sampled new technology –based firms are based in government-run technology incubator. Government-run technology incubators are associated with provision of funding and value-added services such a financial training, number of years spent at the incubator is associated with formation or establishment of NTBF (Chan, 2005); provision of support programmes (Lofsten, 2002); lack incubator management experience of NTBF amongst decision-makers or managers (Kim, 2010) and make a propelled environment for firms (Vásquez-Urriago, 2014).

H1b: There is a positive relationship between Survival – Knowledge and Collaboration and Turnover

Collaboration is critical for producing products and service where joint efforts are applied to launch and commercialise innovation. Concerning H1b, there is no relationship between Knowledge and Collaboration and Turnover. This implies that H1 is not supported. According to literature, there is a strong case among scholars that collaboration and access to knowledge are essential for NTBF to grow (in this instance, turnover). Indeed, cooperation with other firms is expected to enable firms to produce R&D output and commercialize it. On the contrary, the results are in opposition to the existing literature. Furthermore, our descriptive results revealed that the ICT industry dominated the sampled population. With that view, it is common knowledge that the speed of knowledge obsolescence in the ICT sector is high and this is a short-coming for completing product development and commercialization since these firms are inexperience (most of the sampled firms are have been in existence for 2-3 years) and could lack intra-organizational capability to form partnerships. Perhaps, the reason not to form partnerships is due to the high discontinuance rate of new technology-based firms in South Africa (Global Entrepreneurship Monitor, 2012). Hence, given the nature of surveyed new technology-based firms, we suggest that knowledge and collaboration specifically in the ICT sector is not likely to impact positive performance with respect to turnover.

H2. The higher the R&D output (patents, invention) of technology-based firms, the better their innovation performance.

H2a: There is a positive relationship between Internal R&D and Turnover.

H2b: There is a positive relationship between External R&D and Turnover.

H2a: There is a positive relationship between Internal R&D and Turnover.

It was noted in existing literature that implementing entities of the national innovation systems both government-run incubator and university-run incubator invest heavily in R&D expenditure in terms of supporting startup for instance. Westhead (1997) study of R&D inputs and outputs of technology-based firms located on and off Science Parks concluded that most of these firms spend more on R&D spend as a proportion of total sales revenue. It was expected that heavy investment in the product or service development, strong focus and allocating budget for R&D would produce patents, publications and which ultimately leads to innovation performance. In opposition to this, the empirical results suggest there is no statistical significance recorded with regards to Internal R&D efforts such as approved budgets and investment in new product development and turnover. Therefore, H2a is not supported. What does this mean for the financial performance of new technology-based firms? The results further underscore the role of the environment that the surveyed firms operate in. Understanding, how the environment influences the relationship between R&D efforts and financial performance would assist in explaining why there in no relationship. The reasons are two-fold. First, the primary determination is the rate of return on R&D, which is around 33%, with a return on investment of round five (5) years (Tidd, 2001). Therefore, due to the fact that this was a cross-sectional study, capturing a snapshot of financial performance at single time; it is accepted that there reason there is no relationship between Internal R&D and Turnover is that these firms could be within the expected R&D period only, not the return on R&D period.

Second, considering the South African context, specifically universities (i.e. university-run technology incubator), specifically, generally have a poor track-record of capabilities to commercialize. According to National Intellectual Property Management Office, it has just been five years since the Intellectual Property Rights from Publicly Financed Research and Development. Act No. 51 of 2008 was introduced to address the inadequate management i.e. R&D output idling in university portfolio (Department of Science & Technology, 2012). Our explanation is that combination of these factors relies on the nature of market dynamics. This explanation is based on a suggestion by Tidd (2001) that complexity and instability of nature technology and its environment influences the degree, sort, new technology-based firm product development and commercialization. Considering South African context, specifically universities (i.e. university-run technology incubator) are generally having a poor track-record of capabilities to commercialize.

In the absence of successfully commercializing R&D output, South Africa has been lingering behind technology-advanced economies such as Scandinavia and Finland as well as other Brazil-Russia-India-China-South-Africa (BRICS) members.

H2b: There is a positive relationship between External R&D and Turnover

Given the nature of innovation space for instance in few highly industrialized countries, it is expected that the firms that produce a high number of R&D output such a patent, publication and products and services are assumed to generate more value and gain profits. However, according to the results there is no relationship between External R&D and innovation performance (Turnover). Innovation comprises of effectively launching innovation outcomes within the organization, where there central part of innovation is in positively growing the firm with respect to sales (Coad, 2008). Based on the observed firms, we therefore conclude that a firm's External R&D i.e. introduction of new products or services into complex market and committing significant resources to venture into an uncertain market do not result in positive revenue i.e. turnover. This implies that H2b is not supported.

Similar to the conclusion of Internal R&D, External R&D should be viewed with the understanding of complexity in measuring R&D impact to turnover, which proves to be difficult. Numerous financial measures focus on immediate measure such as sales against innovation, and consequently might underestimate the value of R&D effort in regards to gain (or indirect) market share or firm's share prices (Tidd, 2001).

H3: The greater the level of Technology Capability (non R&D activities) of NTBFs, the higher their innovation performance.

H3a: There is a positive relationship between Marketing and Turnover.

H3b: There is a positive relationship between Marketing and Turnover.

H3c: There is a positive relationship between Technology Adaptation and Turnover.

H3d: There is a positive relationship between Market Leadership and Turnover.

H3a: There is a positive relationship between Marketing and Turnover.

On a broader scale, the research has focused on innovativeness, R&D propensity and R&D output; on the other hand, marketing approach is one of the key capabilities that can benefit new technology-based firm's (NTBF) performance. Technological Capability involves learning including developing of marketing capability. Following Mason's (2012)'s conclusion about technology-based firms in Scotland, these firms have little in the method for market data – frequently in light of the fact that they are occupied with the development of high technology activities that requires the development of a market. When marketing capability was considered for this study with respect to whether it impacts innovation performance i.e. turnover, our sampled results oppose the study's hypothesis position that marketing has a relationship with firm's turnover. It is further noted that gaining technological knowledge (e.g. marketing) is typical not a primary focus for NTBF. Although applying marketing capability is reportedly to be a key to NTBF profitability, however, H3a was rejected. Thus, it is concluded that there is no relationship between marketing and innovation performance (Turnover).

This finding with respect to Marketing, possible suggests that new technology-based firms are more geared to R&D activities such as product developments, attracting financial and human capital to increase the number of R&D output; while less attention is allocated to competitive strategies to market the products or services (Westhead, 1997; Tidd, 2001; Lofsten, 2003). Also, recent Global Entrepreneurship Monitor (GEM) report confirmed this argument, an economy like South Africa is in its early -phases of technical development and advancement where it is more centred on getting essential prerequisites set up of systems and infrastructure to support technological entrepreneurship. However, it is worth noting that technology incubators provide a platform for new technology-based firms to access value-added services to improve product marketing, design and value proposition, but inefficiencies and lack of value added services implementations may cause lack of attention to marketing effort. Equally, this should not be interpreted as a convenient reason for inability to implement marketing strategies to effect turnover by new technology-based firms.

H3b: There is a positive relationship between Innovativeness and Turnover.

Innovativeness identifies with the firm’s ability to take part in innovation. The ability to innovate is among the most vital variables that effect on firm’s performance, such ability is generally internalized for potentially critical innovations development ahead of the competitor (Hult, 2004; Tidd, 1997). Innovativeness is brought about by some researchers as the extent to which an individual, contrasted with others in the social framework, is generally ahead of schedule in embracing something new. Empirical evidence from this study suggests there is a positive relationship between Innovativeness and innovation performance (Turnover). Organization learning, in this instance, new technology-based firm’s innovativeness signifies the generation, developing and implementation of new ideas and successful commercialize. In this context, innovativeness is considered as complementary to R&D output capability to firms’ innovation performance. This implies that H3b is supported.

In this study, innovativeness, specifically, from the correlation results appeared to be one of the factors in the web of connections among the sub-main constructs. Consistent with existing literature, innovativeness is of critical significance to technology firms in impacting innovation performance, (Coad, 2008; Hult, 2004). However, it must be emphasized that the relationship between innovativeness and turnover conclusion must be considered carefully on a specific industry. This opposing argument is in line with previous research work that innovativeness does not necessarily translate into profit gains; it is important to note this argument may not be applicable to all surveyed industries.

H3c: There is a positive relationship between Technology Adaptation and Turnover.

Indeed, empirical findings confirm that Technology Adaptation as an important determinant of innovation performance (Turnover). This implies that H3c is supported. It is therefore concluded that a there is a positive relationship between Technology Adaptation and innovation performance (Turnover). Depending on the technological capability the firm possess, adapting or modifying existing technology originally developed by other enterprises or institutions, use previous research to implement or improve innovations and has a strong emphasis on the marketing of tried and true products or services can play a role in the performance of the business. In essence, new technology-based firms once in a while introduce new products and services by means of adapting existing innovations. This also suggests that, presently one can contend that new technology-based firms don't make new innovation, but instead, that the demand is idle and has been there constantly, the contention being that there is nothing new under the sun (Shanklin, 1987). Technology Adaptation or modify existing technology approach might be more productive and sensible than focusing on R&D output such as patents and publications that in any case perform negatively towards turnover (as concluded in H2a and H2b). The way that comparative results are obtained when we take into account Technology Adaptation as a factor impacting innovation performance of new technology-based permits us to overlook issues identified with the challenges confronted in previous hypotheses.

H3d: There is a positive relationship between Market Leadership and Turnover.

The relation between Market Leadership and Turnover is located in the existing literature including work done by Tutar, Nart & Bingöl (2015); that strategic innovation of a new technology-based firm cannot be concluded without considering internal and external environment it operates in. However, the result of the study implies there is no relationship between Market Leadership and innovation performance (Turnover). This suggests that H3d is not supported. We had expected that new technology-based firms would be more risky averse in regards to adopting advanced technology ahead of its competitor for these reasons. First, generally, financial and non-financial support is not promptly accessible, but when it is possible, it is hard to access, because of bureaucratic inefficiencies and absence of suitable expertise on the financing side (Global Entrepreneurship Monitor, 2012). For this reason, firms are not equipped with resources to experiment on innovation methods or lead in new market identification. Therefore, startups first need to manage issues as the lack of venture capital before outperforming competition and leading in marketing identification. Second, given the nature of the business environment, new technology-based firms are faced with bringing new innovation to new market at the same time these that firms compete with well-established firms or against each other.

5.3.1. Conclusion of results discussion

Our study explores the relationship between independent variables survival, R&D propensity and technological capability and the dependent variable, innovation performance. The findings show a large positive correlation and few negative correlations between the main construct variables. In regards to correlation among the main-sub constructs, there was a strong positive correlation between survival of new technology-based firm in terms of number of years under technology incubator, access to knowledge and collaboration, R&D propensity (i.e. efforts) and technological capability, that is adapting or modify existing technology, utilizing existing research to produce number of new products, services, patents, publications, marketing and being ahead of competitors;

all were above .07, this shows a good evidence of relationship. This was followed by positive correlations between Technology Adaptation, Innovativeness and Internal R&D recording between .53 and 0.679.

Next, empirical findings supported H3b and H3c. The following hypotheses were rejected H1a, H1b, H2a, H2b, H3a and H3d. The summary of all three hypothesis are shown in the Table 15.

Table 15: Summary of Hypotheses

Main Construct	Hypothesis		Supported or Not	Literature
Survival	H1a	Survival Years → Innovation performance	Not Supported	Moore (1993), Lindelöf (2002), Mazzarol (2014), Hanna (2002), Haeussler, et al., (2012), Díez-Vial (2015).
	H1b	Survival Collaboration and Knowledge→ Innovation performance	Not Supported	(Coad, 2008; Hult, 2004).
R&D propensity	H2a	Internal R&D → Innovation performance	Not Supported	Westhead (1997), Tidd (1997), Kim (2010), Ar (2011).
	H2b	External R&D → Innovation performance	Not Supported	Coad (2008), Tidd, (2001), Grilo (2015).
Technological Capability	H3a	Marketing→ Innovation performance	Not Supported	Mason (2012), Tutar, et al. (2015), Westhead (1997), Tidd (2001), Lofsten (2003).
	H3b	Innovativeness→ Innovation performance	Supported	Hult (2004), Tidd (1997).

	H3c	Technology Adaptation → Innovation performance	Supported	Shanklin (1987).
	H3d	Market Leadership→ Innovation performance	Not Supported	Tutar, et al. (2015).

6. CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1.1. Introduction

In this chapter, the first section presents the conclusions of the study, that is, summary of literature which is followed by summary of findings presented and discussions in chapter 4 and 5 respectively. This is section is followed by section that deals with the recommendations, limitations and implications of this study to academia, technology transfer officers, incubator managers, funders, and policy-makers. Furthermore, the last section briefly discusses suggestions for future research.

6.1.2. Conclusion of the study

In view of the research problem, in conjunction with the literature review, the following research questions arise:

1) What are determinants factors related to the survival of nascent firms?
2) What is the relationship between R&D propensity and NTBF's innovation performance?
3) Does technological capability (non-R&D activities) of a NTBF leads to innovation performance? If so, under what conditions?

It is understood that there is no doubt that measuring the relationship between factors and innovation performance in the literature has not been pinned-down precisely to the underlying constructs or factors. Globally, there has been literature assessing factors impacting performance of NTBFs within technology incubators.

This study explored the determinant factors related to new technology-based firms (NTBFs) innovation performance. Economies are recognizing the role played by NTBFs to produce technological ventures by creating conditions that foster new technologies. The study follows an earlier research of factors impacting innovation performance of technology-based firms (Hult, 2004; Coad, 2008; Haeussler, et al., 2012; Alessandrini, 2013; Ferreras-Méndez, et al., 2015). An effort was made to explore and identify factors impacting innovation performance for new technology-based firm in Gauteng located a government-run and university-run technology incubator. It must be noted that, new technology-based firms operates with in the process of entrepreneurship which is, a process of making new markets, new commercial ventures, new innovation, new institutional structures, new employments, and net expansions and generate profitability (Schumpeter, 1983; Venkataraman, 1997). From this point of view it is clear that the process involve put right mix of capabilities and resources to exploit opportunities. It is therefore, critical to explore factors that would impact firm innovation performance. Factors such as survival, research and development (i.e. R&D propensity) and technological capabilities are seen as levers that impact new technology-based firm's innovation performance.

While there is a various clarification of factors impacting innovation performance, in perspective of general literature, there is no a remarkably acknowledged methodology of factors supporting the evidence of NTBFs' survival, R&D propensity and the successful launching of new products and services into profitable businesses. Be that as it may, the confirmation is not indisputable as Tidd (2001) highlighted the difficulty in drawing a single conclusion of set of factor and relationship the relationship to new technology-based firm's innovation performance, are due to unique economies. It is significant to qualify the existing global body of knowledge to Gauteng's context in order to identify factors impacting innovation performance of new technology-based firms.

Majority of existing literature concurs that there are numerous variables of factors that can influence the product or service performance in respect to turnover.

Supporting new technology-based firms will enormously add to their possibility of accomplishing products and services development and survival (Hanna, 2002; Ghasemizad, 2009; Rubin, 2015). A view is that the time spent at the incubator offers networking opportunities where firms may establish new co-operation or partnership with other firms and leverage to complete R&D products and/or services. As mentioned earlier, also depending on the type of technology incubator, the duration of the funding enables firms to survive.

Another factor that is considered to impact innovation performance is R&D propensity of new technology-based firm. The body of knowledge on innovation performance (specifically, inventiveness of products and services) recognized that there is a relationship between R&D effort and firm's turnover (Tidd, 2001; Ar, 2011). Many research contributions are noteworthy in showing that, investment in R&D efforts through product or service development, strong focus and allocating budget is likely to innovation performance.

Technological Capability is also seen as a factor impacting innovation performance. If Technological Capability is among the factors enabling new technology-based firm to attains a potential turnover. Then what are those underlying factors? NTBFs are regularly not able to pull together the right blend of capacities required for acquainting innovation to the market, thus resulting to positive sales or turnover (Haeussler, et al., 2012). In the literature, generally, technological capability is defined as a term that is related to products and services, additionally identified with a marketing approach (Hult, 2004; Mason, 2012); innovativeness identifies with the firm's ability to take part in innovation and produce number of products, service, patents and publications (Hult, 2004; Tidd, 1997, Kuratko, et al,. 2011); adapting or modifying existing technology originally developed by other enterprises or institutions and use previous research (Shanklin, 1987); and introducing products and services ahead of competitors in uncertain markets (Tutar, et al., 2015).

The study contributes to the existing literature on technopreneurship in the following ways. In a narrow sense, it explore the relationship between survival, R&D propensity, technological capability as independent variables and their impact on innovation performance, that is, average percentage (%) of total turnover from products and services that were new to the market in the past (3) three years (Turnover)", the dependent variable. The sampling population comprises of new technology-based firms or start-ups based at the technology incubators around the City of Tshwane and City of Johannesburg area, Gauteng, South Africa.

The finding is in opposition to the findings of Aruna (2012) and Lindelöf (2002) who reported that new technology-based firms utilize their time under technology incubation to complete or expand product lines.

The finding in the present study, generally, suggest that there is no relationship between the number of years under the incubation management and producing new products and services that firms can launch to new market to gain profits in order to survive. Consistent with critique of the literature, technology incubators lack of efficiency which can compromise the development of products and services (Kim, 2010; Rubin, 2015; Mazzarol, 2014). Particularly in South Africa, technology incubator movement is still in its infancy, hence firms starting new venture and producing products is difficulty. The result in respect to the number of years under the incubation management and producing new products and services also conforms to the notion of other research conclusions that 1) technology incubators do not necessary channel investment resources into R&D output and 2) NTBFs at under incubation do not have dedicated R&D functions. However, it should be highlighted that the number of years spent at the technology incubator may be one of the factors to assist firm to develop and market products.

Although, it was expected that access to Knowledge and Collaboration are the most critical variables that affects business performance (Hult, 2004). The evidence from this study, also found no relationship between Survival (i.e. access to Knowledge and Collaboration) and Turnover. Perhaps, the underlying reasons could be the high discontinuance rate of new technology-based firms might cause firm not to form partnership and have little knowledge of the sector since there are newly formed.

It was expected from the literature that investing vigorously in R&D would create patents, publications, products and services which would impact Turnover (Campbell, 1987; Kim, 2010). However, the empirical results found no statistical relationship between R&D propensity (i.e. Internal R&D and External R&D) and Turnover. Nonetheless, the findings confirms that commercialization of R&D outputs is generally has a poor track-record. In consistent with findings by Lofsten (2002) that there does not seem to be some any reasonable connection between R&D and new technologies commercialization. Also it might be caused by the complexity and instability of the nature of the environment that the firm operates in. Our results should also be interpreted in a broad sense; measuring R&D propensity (i.e. efforts) should be viewed with the understanding of complexity in measuring R&D impact to turnover, which proves to be difficult; which consequently one might underestimate the value of R&D effort in regards to other gain (or indirect) market share.

The research results opposed the researcher's assumed position on relationship between Technological Capability (i.e. Marketing) and Turnover. There is no relationship between marketing and firm's turnover. Although applying marketing capability is a key to new technology-based firms (NTBFs) launch and commercial new products and services (Hult, 2004), these firms tend to place more focus on product developments and pay less attention to marketing capabilities (Tidd, 2001; Lofsten, 2003). Equally, this ought not to be translated as an excuse behind the failure to actualize marketing systems to impact turnover. The lack of understanding and investment in sales and marketing functions has various consequences. New technology-based firms must consider marketing; Mason's (2012) study of technology-based firms found marketing capability was one of the factors that impacts innovation performances i.e. turnover.

Consistent with Tidd (1997), Hult (2004) and Coad (2008) the study found that the there is a positive relationship between Innovativeness and innovation performance (Turnover). This is in line with the researcher's position that generation, developing and implementation of new ideas leads to the successful performance of innovation. It must also be also noted that, the correlation finding revealed innovativeness as one of the factors in the web of connections among the sub-main constructs. In spite of the fact that innovativeness is of critical significance to the new technology-based firms' innovation performance (Coad, 2008; Hult, 2004).It is important to emphasize that the relationship between innovativeness and turnover conclusion must be considered carefully on an industry-specific basis.

While we have contended that adapting or modifying existing technologies, emphasises the introduction of new products, marketing of tried and true technologies and using previous research to implement technologies as determinant factors to Technological Capability (i.e. Technology Adaptation) impact innovation performance. The results of the study concluded that there is a relationship between Technology Adaptation and innovation performance (Turnover). The view is that new technology-based firms should consider adapting or modify existing technologies approach, which might be more effective and sensible than focusing on patents and publications that in any case perform negatively towards turnover (as concluded by the empirical results of this study). This may be because a firm that duplicates technologies tends to bring about rapid technology innovation to the market. Consistent with McAdam (2008) finding adapting existing innovations enables firms to commence trading quickly without large overheads.

Although introducing technology ahead of competitors and striving for market share yields competitive advantage for new technology-based firms. The literature also suggests that outperforming rivalry might lead to innovation performance (Tutar, et al., 2015). However, the present study found that no relationship exists between Market Leadership and innovation performance (Turnover). It was expected that these firms would avoid taking risks, firm are not equipped with resources to experiment on innovation methods or lead in new market identification.

6.1.3. Contributions of the study

The empirical evidence generated from this study is significant and contributes to the existing body of knowledge for these reasons:

- Technopreneurship is assumed to be one of the most important sources of economic value creation and development, translating R&D output to commercial gains is not easy. Hence, understand that these factors is key for new technology-based firms to survive, sustain and generate revenue
- There has been little analysis of determinant factors that impact the innovation performance of new technology-based firm in Gauteng; specifically with respect to survival, R&D propensity and technological capability

- The outcome of this study may have implications for new technology-based firms in other provinces including similar economies to South Africa.
- The study advances the literature of measurements of innovation performance which varies from one study to the other.
- Entrepreneurs, practitioners and incubator managers should consider the mix of determinant factors for Technology Adaptation and Innovativeness into account when setting or supporting new ventures or new technology-based firms.

6.1.4. Implications and recommendations

- New technology-based firms should be encouraged to produce a number of products, services, patents and publications as these improves technological capability of the firm. Such capability is generally internalized for innovations development with potential profit gains (Hult, 2004; Tidd, 1997).

- In situation where new technology-based firms (NTBFs) take longer to complete products and/or service, NTBFs might consider adapting and modifying existing technologies and avoid attempting to bringing a spectacular set of products or services (Shanklin, 1987; Coad, 2008).

- Collaboration and knowledge sharing should be encouraged among the new technology-based firms at the technology incubator; existing literature suggests that entrepreneurs appear not to have the right mix of skills to successfully manage new ventures.

- In order to attract funding and support, technopreneurs should consider exploiting existing high technology that has been created – where existing evidence of extensive potential market and where rapid development and commercialization is likely to occur. This is a strong argument to also attract investor (Mason, 2012).

- A better measure innovation performance of new technology-based firm under a technology incubator requires a better fit between sector and the number of years required producing and commercializing new innovations. E.g. ICT is a fast-growth industry (i.e. ICT) with delivery-time for products and services under one year while other industries might take up to 12 years to finalize products (e.g. bio-pharmaceutical).

- Based on inadequate management to commercial R&D portfolio in South Africa, according to Department of Science & Technology; nascent firms should not only consider technological capability as a term is identified with products and service, but also related to marketing techniques.

6.1.5. Suggestions for future research

This research has demonstrated the mix of factors impacting on the innovation performance of new technology-based firms. Though, we explored the relationship between survival, R&D propensity, technological capability and innovation performance; future research can further contribute to the literature in South Africa and to other contexts. Based on the implications of the study, we propose that other researchers consider these topics that can stimulate future research:

- While our study concluded that 1) innovativeness as organizational learning (generation, developing and implementation of new ideas) and 2) adapting (existing technology and marketing of tried and true innovations) impact innovation performance. What this study did, was to establish the relationship of factors by surveying ICT, pharmaceuticals, energy and other sectors; actually, each sector has its own dynamics. A deeper understanding of innovativeness, adapting impacting and innovation performance should be explored further in the context of certain industry.
- According to the literature R&D output is then used to create firm's new channels of revenue stream (Rubina, 2015). However, depending on the type of industry e.g. ICT and pharmaceutical, return on R&D could take less than a year and up to 12 years; respectively. This study was a snapshot of R&D effort versus financial performance at a single time. Hence due to the nature of return on the R&D longitudinal study assessing R&D efforts in relation to innovation performance should be considered.

- Although this research explores three factors (survival, R&D propensity and technological capability), the study was limited to these three factors. We propose an exploratory study to investigate other factors, particularly with regards to the introduction of Intellectual Property Rights from Publicly Financed Research and Development Act, 2008 whether it impacts the innovation performance of new technology-based firms.

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8. APPENDIX 1 – RESEARCH INSTRUMENT

DEMOGRAPHIC

1. Please select which industry or sector you belong to, from the list below

O ICT
O Biotech
O Pharmaceutical
O Automotive
O Energy
O Other

2. Size of the firm in terms of number of employees

O 1-2 employees
O 3-4 employees
O 5-6 employees
O 7-9 employees
O 10 or more employees

SECTION A – SURVIVAL

3. For how long has your organisation been mentored by a technology incubator? (E.g. SEDA, University, Innovation Hub, etc.)

O 1-3 months
O 4-5 months
O 6-10 months
O 11-20 months
O More than 20 months

4. Under what type of incubator management system is your organization located or currently engaging with?

O Government-aligned incubator (e.g. Innovation hub, CSIR, SEDA, etc.)
O University-aligned incubator (e.g. Wits Enterprise, UJ, Resolution Circle, etc.)

5. How long has been your company in existence?

O 1 year
O 2 years
O 3 years
O 4 years
O 5 or more years

6. During the past year, has your organization received any financial support?

O Yes
O No

7. If yes, how can you best describe the duration of funding?

O 1 year
O 2 years
O 3 years
O 4 years
O 5 or more years

Please identify the sources below that provided information for new innovation products / services or contributed to the improvement of an existing innovation.

	1- Strongly disagree	2- Disagree	3- Neither Agree/ Disagree	4- Agree	5- Strongly Agree
8. Universities / Higher Education institutions	O	O	O	O	O
9. Government or public research institutes	O	O	O	O	O

Assessment of the current business environment: (from 1 (poor) to 5 (good))

	1- Very Poor	2- Poor	3- Fair	4- Good	5- Very Good
10. Research co-operation with important scientific and academic institutions	O	O	O	O	O
11. Maturity of the new technology, product or service	O	O	O	O	O

SECTION B- TECHNOLOGICAL CAPABILITY

Marketing innovation capability

	1- Not implemented	2- Imitated from national markets'	3- Imitated from international markets	4- Current marketing practices were improved	5- Original marketing innovations were implemented
12. Renewing the design of the current and/or new products through changes such as in appearance, packaging, shape and volume	O	O	O	O	O

13. Renewing the distribution channels without changing the logistics processes related to the delivery of the product	O	O	O	O	O
14. Renewing the product promotion techniques employed for the launch of the current and/or new products.	O	O	O	O	O
15. Renewing the product pricing techniques employed for the pricing of the current and/or new products.	O	O	O	O	O

Using 5-point agreement scale below, please rank the following items from 1 to 5, with one being much less, and 5 being much more.

	1- Much less than most	2- Less than most	3- Above average	4- More than most	5- Much more than most
16. During the past 3 years, the quantity of **new products** launched/marketed by your organisation can best be described as	O	O	O	O	O
17. During the past 3 years, the quantity of **new services** launched/marketed by your organization can best be described as	O	O	O	O	O
18. During the past 3 years, the quantity of **publication**s produced by your organization can best be described as	O	O	O	O	O
19. During the past 3 years, the quantity of **patents** produced by your organization can best be described as	O	O	O	O	O

To what extent do you agree or disagree with the following statements?

	1- Strongly disagree	2- Disagree	3- Neither agree/ disagree	4- Agree	5- Strongly Agree
20. Our organisation has an emphasis on introducing new innovation or technology	O	O	O	O	O
21. Our organisation has a strong emphasis on the marketing of tried and true products or services.	O	O	O	O	O
22. Our organisation has a strong emphasis on Research & Development	O	O	O	O	O
23. Our organisation is open to outside ideas that can lead to new business opportunities	O	O	O	O	O
24. Our organisation is good at adapting or modifying existing products or services originally developed by other enterprises or institutions	O	O	O	O	O

Proactiveness

To what extent do you agree or disagree with the following statements? (1 strongly Disagree - 5 Strongly Agree)

	1- Strongly Disagree	2- Disagree	3- Neither Agree/ Disagree	4- Agree	5- Strongly Agree
25. Our organisation is leading in introducing new innovation or technology ahead of its competitors	O	O	O	O	O
26. Our organisation is leading in new market identification ahead of its competitors	O	O	O	O	O
27. Our organisation always strives for market share through proactive sales	O	O	O	O	O
28. Our organisation always strives to introduce new products or services ahead of competitors	O	O	O	O	O

Organizational Climate for Innovation

To what extent do you agree or disagree with the following statements? (1 strongly Disagree - 5 Strongly Agree)

	1- Strongly Disagree	2- Disagree	3- Neither Agree/ Disagree	4- Agree	5- Strongly Agree
29. Employees are encouraged to come up with new ideas	O	O	O	O	O
30. New ideas tend to receive quick go/no go decisions from management in this company	O	O	O	O	O
31. Ours is a company that celebrates innovative achievements	O	O	O	O	O
32. Red tape and slow approval cycles are problems in this company	O	O	O	O	O

SECTION D- R&D PROPENSITY

To what extent do you agree or disagree with the following statements? (1 strongly Disagree - 5 Strongly Agree)

	1- Strongly Disagree	2- Disagree	3- Neither Agree/ Disagree	4- Agree	5- Strongly Agree
33. Our organisation has a strong focus on Research	O	O	O	O	O

and Development activities					
34. Our organisation invests heavily in new product development	O	O	O	O	O
35. The approved budget for Research and Development activities in our organisation stimulates innovation	O	O	O	O	O
36. Our organisation's Research and Development? division has a culture of introducing new products into the complex market	O	O	O	O	O
37. Our organisation commits significant resources to ventures in uncertain conditions	O	O	O	O	O

SECTION D **INNOVATION (FINANCIAL) PERFORMANCE**

How would you rate the level of achievement of the following financial performance items in your organization in the last three years compared to the previous years?

	1- Very Unsuccessful	2- Unsuccessful	3- Neutral	4- Successful	5- Very Successful
38. Return on sales (profit/total sales)	O	O	O	O	O
39. Total sales	O	O	O	O	O
40. Market share	O	O	O	O	O

41. Please estimate the average percentage (%) of your total turnover from products and services that were new to the market in the past (3) three years

O 0% to less than 1%

O 1% to less than 5%

O 5% to less than 10%

O 10% to less than 25%

O 25% or more

9. CONSISTENCE MATRIX

The purpose of this research was to conduct an exploratory study on three main constructs – namely: survival, R&D propensity and technological capability of new technology-based firm in Gauteng, South African and the impact of these factors on innovation performance.					
Research question: 1) What are determinants factors related to survival of nascent firm? 2) What is the relationship between R&D propensity and NTBF's innovation performance? 3) Does technological capability (non-R&D activities) of a NTBF leads to innovation performance? If so, under what conditions?					
Aims of research	**Literature Review**	**Hypotheses**	**Source of data**	**Type of data**	**Analysis**
1. To determine the determinant factors for the survival of NTBFs	Moore (1993), Chan (2005), Grilo (2015), Vásquez-Urriago (2014), Davila (2003), Lindelöf (2002), Lofsten (2003), Hult (2004), McAdam (2008), Rubin (2015) , Kim (2010), (Aruna, 2012), Mason (2012), Díez-Vial (2015), Bergek (2008) argued that incubator provision of capital assist firm to survive and impact innovation performance. However, lack of efficiency can compromise the survival of incubated firms, regardless of the funding and duration (Mazzarol, 2014; Hanna, 2002; Haeussler, et al.,, 2012; InfoDev, 2010; Dıez-Vial, 2014).	**H1 -** The greater the number of years in the technology incubator, the higher the probability of new technology-based firms to produce new products or services and survive.	SECTION A: Q3, 8-11	Ordinal data - 5 Likert Scale	Exploratory Factor Analysis. Multiple Linear Regression. Descriptive Statistics – Correlations.

2. To determine the determinant factors of R&D propensity.	Campbell (1987), Westhead (1997), Tidd (1997), Alex (2008), Rothaermel (2005), Coad (2008), Kim (2010), (Rubina 2015), Mason, (2012), Ar (2011) suggested that R&D results are used to introduce new product in the market (commercialized) However, Coad (2008), Tidd (2001), Grilo (2015) argued that patents sometimes have no effect on sales growth.	**H2 -** The higher the R&D output (patents, invention) of technology-based firms, the better their innovation performance.	SECTION B, C: Q33-37	Ordinal data – 5 Likert Scale	Exploratory Factor Analysis. Multiple Linear Regression. Descriptive Statistics – Correlations .
3. To determine the determinant factors for technological capability and identify factors related to NTBFs' innovation performance.	Shanklin (1997), Hult (2004), McAdam (2008), Coad (2008), Haeussler, et al., (2012), Oyelaran-Oyeyinka (2006), Jensen, et al. (2002), Kuratko, et al. (2011), Lofsten (2003), Rubina (2015), Mason (2012), Mason (2012), Tutar, et al. (2015) suggested that doing and learning as capabilities contributes to innovation performance However, the number of innovations does not necessarily reflect economic success (Hult, 2004, Tidd, 2001).	**H3 -** The greater the level of technology capability (non R&D activities) of NTBFs, the higher their innovation performance.	Instrument SECTION B and C, E:Q12-33	Ordinal data – 5 Likert Scale	Exploratory Factor Analysis Multiple Linear Regression Descriptive Statistics – Correlations