An analysis of the process from innovation to commercialization - A South African perspective

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DECLARATION

I, the undersigned, Karen Booysen, declare that the dissertation hereby handed in for the qualification Magister Comemrcii at the University of the Free State, is my own independent work and that I have not previously submitted the same work for a qualification at/in another University/faculty.

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KAREN BOOYSEN DATE

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ABSTRACT

Economies, organizations (small, medium and large) and individuals must discover and commercialize new products in order to compete and prosper in the 21st century global economy. The importance of introducing new products to the market can be seen in the fact that it builds a sustainable competitive advantage for economies, organizations and individuals. Furthermore, these new products do not only lead to profits for individuals and organizations, but it also improves the quality of life of all individuals and generate further economic opportunities.

Through the commercialization of innovation, the gap between the needs of the market and the inventions which innovators have can be bridged. However, it remains a key challenge to all innovators to take an invention from the idea phase to the market in order to produce economic returns. Ideas or inventions cannot generate economic returns for the innovator. It is only once the invention is successfully absorbed into the marketplace that the inventor can benefit from its profit, and therefore the importance of commercializing inventions is highlighted.

Globally the failure rates of new products are especially high, preventing innovators from gaining financial benefits. New product failure rates are estimated at between 50-80% and even major companies with sufficient resources struggle with the commercialization of inventions.

The high failure rates of inventions can be attributed to a wide variety of factors, including limited access to resources, failure of innovators to sufficiently protect their inventions or weak marketing efforts, among others. One such reason for failure, however, is the fact that innovators are unsure about the steps to follow in commercializing an invention. Innovators either take false steps and waste valuable time, or they leave out critical steps in the process.

It is important for innovators to know what the steps in the commercialization process are and to follow them, in order to ensure that they follow a logical process; plan for all the important aspects regarding commercialization and are aware of what will be required of them at the different stages in the process.

South Africa is not doing well in bringing new research discoveries to the market and there may be many reasons for this problem. In order to introduce new inventions to the market successfully through commercialization, it is important to know what the problems/barriers are that innovators experience during the commercialization process. It is also important to identify the need for a common framework understood by government, higher education, research councils, technology organizations and venture capital to help identify roles and functional relationships in the system of innovation.

This study aimed to acquire information regarding the problems and/or barriers confronting entrepreneurs in the commercialization process, by determining how successful individuals and SMMEs were in commercializing their innovation. The client base of the Centrum for Rapid Prototyping and Manufacturing (CRPM) and the Technology Station (PDTS) for 2005 to 2010 were used in this study. The secondary objectives were to investigate the steps the entrepreneur followed in the commercialization process; to identify the factors, both positively and negatively, that influence the commercialization of innovation; to determine the problems/mistakes that entrepreneurs made in the commercialization process; and to determine the success factors for entrepreneurs in the commercialization process.

The results showed that the minority of the respondents (20%) managed to commercialize their inventions successfully. The remaining 80% of the respondents were either still busy moving through the commercialization process or had become stagnant.

Furthermore, the results indicated that the typical innovator does not follow the chronological order of the steps in the commercial process, as indicated in the literature. Many of the steps in the commercialization process were not completed as thoroughly as needed and some of the steps were omitted completely.

The reasons most often cited by the respondents for their lack of progress and/or stagnation in the commercialization process are a lack of funds and a lack of support. In other words, the respondents did not have sufficient capital to commercialize the invention on their own and either did not know where to go to obtain the financial aid needed or were not successful in their application for funding. The lack of support the respondents referred to include support in terms of knowledge regarding the commercialization process, i.e. what each step in the commercialization process entails as well as what should be done next in the commercialization process. These two reasons were the most often cited barriers to the successful commercialization of the respondents.

Several recommendations are made at the end of this study that could bridge the abovementioned barriers. The focus falls mainly on the Government, and various recommendations regarding government support institutions are made that could better aid innovators through the commercialization process.

UITTREKSEL

Ekonomieë, ondernemings (klein, medium en groot) en individue moet nuwe produkte ontdek en kommersialiseer om mee te ding en vooruit te gaan in die globale 21ste eeu ekonomie. Die belangrikheid daarvan om nuwe produkte aan die mark bekend te stel kan gesien word in die feit dat dit ‘n volhoubare mededingende voordeel vir ekonomieë, ondernemings en individue meebring. Die nuwe produkte lei nie net na wins vir individue en ondernemings nie, maar dit verbeter ook die kwaliteit van lewe van alle individue en genereer verdere ekonomiese geleenthede.

Deur die kommersialisering van innovasie word die gaping tussen die behoeftes van die mark en die uitvindsels van die innoveerders oorbrug. Dit bly tog ‘n kern uitdaging vir alle innoveerders om ‘n uitvindsel van idée-fase na die mark te neem, ten einde ekonomiese opbrengste te produseer. Idees of uitvindsels kan nie ekonomiese opbrengste vir die innoveerder lewer nie. Slegs wanneer die uitvindsel suksesvol in die mark absorbeer word kan die innoveerder wins genereer en hierdeur word die belangrikheid van kommersialisering weer beklemtoon.

Die mislukkingskoers van nuwe produkte is internasionaal baie hoog en dus verhoed dit innoveerders om finansiële voordele te bekom. Nuwe produkte se mislukkingskoers word bereken op tussen 50-80% en selfs groot ondernemings met genoegsame hulpbronne sukkel met die kommersialisering van uitvindsels.

Die hoë mislukkingskoers van uitvindsels kan toegeskryf word aan ‘n wye verskeidenheid faktore, insluitend beperkte toegang tot hulpbronne, die onvermoë van innoveerders om hul uitvindsels genoegsaam te beskerm of swak bemarkingspogings, Een so ‘n rede vir mislukking is die feit dat innoveerders onseker is oor die stappe om te volg in die kommersialisering van hul uitvindsel. Innoveerders neem vals stappe en mors kosbare tyd, of hulle laat kritiese stappe in die proses uit.

Dit is belangrik vir innoveerders om te weet wat die stappe in die kommersialiseringsproses is en dit te volg ten einde te verseker dat hulle ‘n logiese proses volg, beplan vir al die belangrike aspekte aangaande kommersialisering en bewus is van wat van hulle vereis sal word in die verskillende fases van die proses.

Suid Afrika vaar nie goed daarmee om nuwe navorsingsuitvindsels na die mark te bring nie en daar kan verskeie redes vir die probleem wees. Ten einde suksesvol nuwe uitvindsels aan die mark voor te stel deur kommersialisasie is dit belangrik om te weet wat die probleem/hindernisse is wat innoveerders gedurende die kommersialiseringsproses ondervind. Dit is ook belangrik om die behoefte aan ‘n gemeenskaplike raamwerk wat verstaan word deur die regering, hoër onderwys, navorsingsrade, tegnologie ondernemings en risikodraende kapitaliste, ten opsigte van die rolle en funksionele verhoudings in die sisteem van innovasie uit te wys.

Die studie het gepoog om inligting rakende die probleme en/of hindernisse wat entrepreneurs in die kommersialiseringsproses konfronteer te bekom deur te bepaal hoe suksesvol individue en SMMEs was in die kommersialisering van hul innovasie. Die kliëntebasis van die Centrum for Rapid Prototyping and Manufacturing (CRPPM) en die Tegnologie Stasie (PDTS) vir 2005 tot 2010 is gebruik in die studie. Die sekondêre doelwitte het ingesluit om die stappe wat die entrepreneur in die kommersialiseringsproses gevolg het, te ondersoek; om die faktore, beide positief en negatief, wat die die kommersialisering van innovasie beïnvloed te identifiseer; om die probleme/foute wat entrepreneurs maak in die kommersialiseringsproses te bepaal; en om die suksesfaktore vir entrepreneurs in die kommersialiseringsproses te bepaal.

Die resultate het gewys dat die minderheid van die respondente (20%) suksesvol hul uitvindsels kommersialiseer het. Die oorblywende 80% van die respondente was of steeds besig om deur die kommersialiseringsproses te beweeg of het stagneer.

Die resultate het verder ook uitgewys dat die tipiese innoveerder nie die kronologiese orde van die stappe in die kommersialiseringsproses, soos aangedui in die literatuur, volg nie. Baie van die stappe in die kommersialiseringsproses is nie so deeglik voltooi soos wat nodig is nie en verskeie van die stappe is bloot uitgelaat.

Die redes wat die respondente die gereeldste aangehaal het vir hul tekort aan vordering en/of stagnasie in die kommersialiseringsproses was ‘n tekort aan fondse en ‘n tekort aan ondersteuning. Met ander woorde, die respondente het nie genoegsame kapitaal gehad om die uitvindsel op hul eie te kommersialiseer nie en het of nie geweet waar om finansiële hulp te kry nie, of was onsuksesvol in hul aansoek om finansiering. Die tekort aan ondersteuning waarna verwys word, sluit in ondersteuning ten opsigte van kennis aangaande die kommersialiseringsproses (maw. wat die stappe in die kommersialiseringsproses behels) sowel as wat volgende gedoen moet word in die kommersialiseringsproses. Die twee redes is gereeld genoem as hindernisse tot die suksesvolle kommersialisering.

Ten einde die bogenoemde hindernisse te oorkom word verskeie aanbevelings aan die einde van die studie gemaak. Die fokus val hoofsaaklik op die regering, en verskeie aanbevelings aangaande die regeringsondersteuningsinstellings word gemaak ten einde innoveerders beter deur die kommersialiseringsproses te help.

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Creativity

Invention

Innovation

Commercialization

Diffusion

Chapter 1

The importance of innovation for economic growth

1.1 Introduction and Background to research

Innovation is viewed as one of the most important, if not the most important, factor influencing economic progress and competitiveness, human well being, social development and organizational rivalry (Beaver and Prince, 2002:29; Storey and Salaman, 2005:4; Salavou, 2004:33). The correlation between innovativeness and the advancement of a country or region is continuously reinforced, and from 1991 until 2006, the correlation has strengthened significantly (*Innovation and Economic Development,* 2006). Furthermore, it is a worldwide phenomenon that new technologies and the application thereof drive economic growth. Thus, during periods of strong growth, new jobs and new industries are created. When slow growth in technology occurs, a lack of innovation is present and growth in the economy is also slow. Therefore, a positive relationship exists between innovation and economic growth (Mandel, 2004).

It is argued that half of economic growth can be attributed to the increase in capital and labour, the other 50 per cent is attributed to technological innovation (Von Broembsen, Wood and Herrington, 2005:31). In another research study it is stated that technological advancements, rather than improvements in labour productivity, account for more than 60 per cent of all economic growth. This explains why the importance and necessity of innovation is frequently emphasized by governments all over the world (Beaver and Prince, 2002:29; Storey and Salaman, 2005:5).

Although large organizations have a fundamental role to play in innovation, it is evident that through innovation, small, medium and micro enterprises (SMMEs) not only have a distinct and crucial role to play with their contribution to the economic growth and job creation (Beaver and Prince, 2002:29), but they have to innovate if they are to survive in a turbulent and highly competitive environment (Allocca and Kessler, 2006:279). According to Humphreys, McAdam and Leckly (2005:283), the need for SMMEs to develop their innovation capabilities ever more is promulgated by the increased agility in larger organizations which nullifies the SMMEs renowned competitive advantage of being able to make decisions quickly and being able to adjust just as quickly to new surroundings.

Unfortunately, regardless of the best efforts of organizations, SMMEs and individuals, the development of new products and services often still fails (Hanna et al., 1995:33; Hivner, Hopkins and Hopkins, 2003:80). It appears that most organizations and individuals are not satisfied with the returns that their investment in innovation is yielding, although these organizations continue to invest heavily in innovation (Innovation frustration, 2005:36). Furthermore, the actual problem is that most organizations and individuals do not know how to do a better job of turning ideas and

innovations into a successful product on the market, and eventually derive profit from it (Innovation frustration, 2005:36).

This inability of organizations and individuals to turn ideas/innovations into successful products plays a crucial role in the economy as new product failures are widespread. This is illustrated by the fact that some general research has shown that nearly 300 ideas are needed to attain one successful product (Knowledge that matters, 2003: 33) and compounded by the fact that in 1998 less than 20% of more than 25 000 products that were introduced in 1997 were still on the market (Logar et al., 2001:206).

The aforementioned phenomenon is a worldwide problem:

- In Canada, according to The Conference Board of Canada, it is estimated that "for every 3,000 new ideas that emerge in industrial research and development (RandD), 125 become "small projects", 4 grow into major developments, 1.7 make it to market launch and 1 idea becomes a market success" (Courtois, 2004).
- A conservative estimate of product failure rates are between 50% and 80% and even in organizations with large amounts of money to spend on research, advertising and development, only 12 proposals from 58 were successful past initial screening and only one successful new product emerged from these 12 (*Can You Make Money With Your Idea or Invention,* 2007).
- Similar results are found in the United States of America (U.S.A.), where between 30 – 40% of the products that get to the market, are not successful (Hanna et al., 1995:33).
- From other research done, it follows that out of every 100 ideas, 85 had too many defects and were eliminated immediately. Only five ideas from the remaining 15 will be produced and of those five only one might make money. The odds against an idea being a monetary success are roughly 99 to 1 (*Can You Make Money With Your Idea or Invention,* 2007).
- The "rule of thumb" has so far been that about 80% of new products fail. An examination of 11 000 new products and services revealed that only 56% were still on the market 5 years after introduction (Etzel, Walker and Stanton, 2001:223).
- Clayton Christensen states that organizations offering a new technology, which produces and sells an improved, but similar product as his competitors to the same customers has only a 6% chance of success (Black, 2006). Yet, the majority of innovations fall in this category.

The chances of success for a "disruptive strategy", where there is no need to steal someone else's customer to succeed, is 33% (Black 2006). Unfortunately, new-to-the-world product development remains flat compared to update product development. In fact, in 2002, 11.2% of owner-managers operated in markets where they had no competitors. In 2005 this declined to 1.8% of owner-managers, confirming that a smaller number of firms offer products and services differentiated from their competitor's offerings (Hanna et al., 1995:42; Von Broembsen, Wood and Herrington, 2005:32). The rate of large organizations around the world going out of the market or generating

returns below the market average, is not only astonishingly high, but also accelerating (*Long term Success or Survival?,* 2006).

In general, for many organizations a considerable percentage of a specific year's sales volume and profit will be generated from products that did not exist 5 to 10 years ago (Etzel, Walker and Stanton, 2001:223). The long-term prosperity of most organizations are without a doubt linked to their ability to innovate and therefore providing their existing customers with new or improved products and services (Hanna et al., 1995:33).

At the heart of innovative activities there will always be uncertainties as it is extremely difficult to forecast whether a market, with its specific preferences, will accept a new product, service or technology (Hanna et al., 1995:33; Rosenerg, 2004). In 1994, only 74 of the top 500 organizations that appeared in Standard and Poor's index were still active, which represents a lifespan of less than 40 years for some of the one-time leaders! The reasons most often noted for the failure of these firms is that they either resisted change or were not innovative enough (Chandrasekar, 2006:46).

In South Africa (SA) the situation appears particularly bleak given that the TEA (Total Entrepreneurial Activity) rate of SA was 7.8% in 2008. In other words, for every 100 adults in SA an estimated 7.8% owned either start-up or new businesses. In 2009, this rate dropped and a TEA of 5.9% was recorded. Furthermore, SA's TEA rate is below the average of 14.8% of all the middle- to low- income countries that participated in the Global Entrepreneurship Monitor (GEM) study in 2009 (GEM study shows recession has hit SA entrepreneurship hard).

Based on the abovementioned TEA rate, SA ranked 35th out of 54 countries. Countries such as Argentina, Chile, Brazil and Peru, which are also emergent economies with similar GDP per capita as SA, recorded TEA rates that are three to four times higher than that achieved by South Africa in 2009. Dr Mike Herrington (Director of the UCT CIE) states that: "These findings are cause for serious concern, particularly as they continue to confirm the trend of below-average entrepreneurial activity demonstrated in previous GEM surveys. According to the GEM data, a country at SA's stage of economic development would be expected to have a TEA rate in the order of 13%, more than double South Africa's actual rate of 5.9%. Together with the low rate of new firm activity, this reconfirms that the prognosis for survival and sustainability of early-stage businesses in South Africa remains poor" (GEM study shows recession has hit SA entrepreneurship hard).

When focusing only on these statistics, the decline is not significant or cause for panic, but according to the data from the Global Entrepreneurship Monitor Report, released January 2006, SA is performing poorly on two out of three measures of innovation, and is becoming less innovative each year (To become globally competitive, SA businesses must become more innovative, 2006).

The low success rate of start-up businesses in South Africa does not just mean financial losses for the entrepreneur, but also that the contribution to economic growth and job

creation is very limited (Von Broembsen, Wood and Herrington, 2005:29-30) and this emphasizes the significance of inculcating a culture of entrepreneurship in South Africa (Thale, 2005).
Starting a business and growing the business into an income-earning organization is a daunting task and when the high failure rates are kept in mind, it is not surprising that many organizations do not want to risk investing in innovation (Logar et al., 2001:206). The risk associated with innovation is compounded by an era of rapid changes, in both consumer preferences and technology as well as` shorter life cycles of products (Cumming 1998:27; Yelkur and Herbig, 1996:38). A further barrier of the current business environment to innovation, for organizations and individuals alike, is a culture of zero-error. Pressure is on high performance and cost cutting, and both foster the imitation of tested behavioral patterns, at the expense of innovation (Stokes and Wilson 2006, p.83-84). Despite all the inherent risks, innovation remains the fundamental process through which products and services are created and in the process, jobs and wealth is generated (Stokes and Wilson, 2006: 101).

In addition, the pressure is not just on innovating, but also the speed at which an innovation is diffused. This concept refers to the time that passed from initial development to successful commercialization (Hivner, Hopkins and Hopkins, 2003:81). In today's rapidly changing environment, not introducing an innovation to the market in a timely manner may mean that the need the innovation was supposed to address has already changed again.

The diffusion speed plays an important role in creating and sustaining a competitive advantage, because earlier introduction implies a longer product life cycle, cost advantages in development and manufacturing and pricing of the product (Etzel, Walker and Stanton, 2001:230; Hivner, Hopkins and Hopkins, 2003:81; Howe, Mathieu and Parker, 2000:277). The risk of not commercializing on time is not limited to small businesses, but even large organizations will suffer losses and perhaps even fail eventually if they fail to commercialize innovations in a timely manner (Innovation and Commercialization, 2001).

Andrew Groove, Intel's ex-Chief Executive Officer (CEO), confirmed the importance of being first to market a product with the statement: "The first mover and only the first mover, the company that acts while others dither, has a true opportunity to gain time over its competitors; and time advantage, in this business, is the surest way to gain market share" (First mover advantage revisited, 2006). However, while it is desirable to be first in the market with a new or improved product, creating a product that will satisfy the needs of the target market is priority (Herdman, 1995; Tong, 1994:44).

There are numerous ideas worldwide, and especially in South Africa, that have existed for many years, but found only limited use or were never developed, because some factor(s) that would allow those ideas to be fully realized were missing (Cumming, 1998:25). This emphasizes the need to know more about effective product or service development.

There is a wide variety of research available on innovation that provides valuable insights on innovation in general. However, there is a scarcity of in-depth studies on the problems confronting innovators and commercialization in SMMEs. This problem was already noted in 1986 by Andrew van de Ven, and it seems to be a growing problem as South Africa is becoming less innovative every year (Storey and Salaman, 2005:8).
The focus of researchers during the past 20 years has been on examining critical success and failure factors/activities in the development process of new products or services and recommendations related to aspects of the product development process (Gounaris, Papastathopoulou and Avlonitis, 2003:266). As a result of this research, several factors have been identified as correlates of new product success or failure.

Some of these factors include product advantage, marketing support, establishing an environment conducive to innovation and the nature of the marketplace, to name a few. In spite of all this research, roughly 40% of all new products and services are still unsuccessful (Gounaris, Papastathopoulou and Avlonitis, 2003:266) and looking at the low success rate in SA, it is clear that some factors influencing innovation in SA is absent or the wrong factors have been identified as success or failure factors or activities.

While most of the knowledge gained from past research provided valuable insights, the focus has been on theory and overlooked practice (Hanna et al., 1995:33). This statement is confirmed by the Global Entrepreneurship Monitor which states: “While the role of new venture creation – and specifically its potential to solve the unemployment crisis – enjoys academic attention in South Africa, there is a serious dearth of empirical data, specifically longitudinal data, to inform debate and ultimately to inform policy.” (Von Broembsen, Wood and Herrington, 2005:7).

Apart from the abovementioned, SMMEs are not smaller versions of large organizations and the assumption that the factors that influence innovation in large organizations are necessarily the same factors that influence SMMEs, is incorrect. Consequently, research on how innovation is implemented in SMMEs, with its characteristics and constraints, is needed (Humphreys, McAdam and Leckly, 2005:284).

The evidence shows that South Africa is not doing as well as other nations in bringing new research discoveries to the market, preventing us from capitalizing fully on our research investment. The reasons for this are, however, not clear and mandate research on what factors influence innovation in SMMEs; whether the factors that influence large organizations are transferable to SMMEs; and whether the factors identified internationally influence successful innovation in SA as well.

In light of the exposition above, innovation, especially also in South Africa, is essential, yet beset with challenges. The primary research question this study aims to answer in this regard is ***if innovation is vital to all businesses and entrepreneurs in order to survive in this changing environment, why do most innovators find it so extremely difficult to commercialize their innovations?***

The need for innovation is clear, and it is important to bridge the gap between needs of the market and forthcoming innovations. However, large organizations, with capital, knowledge and skilled employees' as well as wide support networks readily available, struggle to commercialize innovation. It can be expected that the already complex process of commercialization is an even more daunting task for individuals and SMMEs, with limited capital, expertise and support. The commercialization process is clearly difficult and understanding it is crucial. A better mechanism for, as well as more knowledge on, commercialization - especially for individuals and SMMEs - is needed.

1.2 Term description

Innovation should not be confused with creativity (Storey and Salaman, 2005:17-18) which is the process of idea generation the precursor of innovation (Cumming, 1998:22). The distinction that is made between **creativity and innovation** is thus that creativity is the original idea and innovation is when the idea is developed for commercialization (Von Oetinger 2005: 29).

Furthermore, a distinction should be made between **invention and innovation**. Invention refers to new ideas, products or services that arise from individuals' creativity or scientific research. Innovation, on the other hand, refers to the commercialization of the invention. The distinction between these two terms is important as an invention may have no, or little, economic value and to monetize an invention, innovation is essential (Invention vs. Innovation, 2006). Any new concept must be used successfully before innovation has taken place (Cumming, 1998:22–29; Stokes and Wilson, 2006: 101). The definition of innovation will be refined in section 2.2.

Commercialization is the process whereby new products, processes or services are sold or used in an attempt to profit from the investment made in research and innovation (Herdman, 1995). This definition will be elaborated on in section 3.2.

Diffusion is a process by which innovation spreads throughout a social system over time (Etzel, Walker and Stanton, 2001:122).

1.3 Problem statement

There is an enormous need for innovation and it is important to bridge the gap between the needs of the market and the forthcoming inventions. The study recognizes that the South African system of innovation remains fragmented and that the country is becoming less competitive year after year according to the GEM report.

South Africa is not doing well in bringing new research discoveries to the market and there may be many reasons for this problem. In order to introduce new inventions to the market successfully through commercialization, it is important to know what the problems/barriers are that innovators experience during the commercialization process.

It is also important to identify the need for a common framework understood by government, higher education, research councils, technology organizations and venture capital, that would help identify roles and functional relationships in the system of innovation.

1.4 Objectives of the study:

The primary objective of this study is to determine what the problems and/or barriers confronting entrepreneurs in the commercialization process are, by determining how successful individuals and SMMEs were in commercializing their innovations.

The secondary objectives are:

- To investigate the steps the entrepreneur followed in the commercialization process.
- To identify the factors, both positively and negatively, that influences the commercialization of innovation.
- To determine the problems/mistakes that entrepreneurs made in the commercialization process.
- To determine the success factors for entrepreneurs in the commercialization process.

1.5 Methodology of the study

1.5.1 Literature study

The aim of this research study is, first, to gain a body of knowledge regarding the constructs of innovation and the innovative process; and to understand the relationship between these constructs and successful commercialization.

Secondly, an all inclusive literature study of the innovation and commercialization processes provide a better understanding of the overall process.

Finally, the factors that may influence successful commercialization are identified from the different theoretical sources.

In the literature study, use was made of secondary data, such as those in published and unpublished reports, articles, academic journals and other publications and the Internet to provide a background to the problem, as well as previous, related research.

1.5.2 Research design

1.5.2.1 Methodology

Hussey and Hussey (1997:54) defines methodology as 'the overall approach to the research process, from the theoretical underpinning to the collection and analysis of the data'. The methodology intends to provide the rationale for using a particular approach and the methods employed to obtain analysed data (Jankowicz, 2000:212).

The empirical study consisted of quantitative questions as part of one questionnaire that supplied an indication of the perceptions of the innovators regarding the factors that hindered the entrepreneur from successfully commercializing an invention, the process followed by the innovator and the steps of the commercialization process that were left out either by decision of the entrepreneur or because the entrepreneur did not know of these steps.

Quantitative research differs from qualitative research in that it generalises results from a sample to the population of interest, while qualitative research provides insight into the setting of a problem. Qualitative data can be collected through surveys, observation or experiments (Cant, Gerber-Nel and Kotzé, 2003:77).

1.5.2.2 Background regarding study population

Tshumisano Trust (which means Co-operation or Partnership) provides technical and financial support to Technology Stations, which are based at Universities of Technologies/Technikons. The Technology Stations in turn offer technical support to existing and/or new SMMEs in terms of technology solutions, services and training. Technology Stations that fall under the control of the Trust are listed in table 1.1 below, along with the relevant host institution:

Table 1.1: Technology centres under control of Tshumisano Trust

Technology station:	**Speciality:**
Tshwane University of Technology	***Electronics and Electrical Engineering, Complemented by IT***
Central University of Technology, Free State	***Metals Value Adding and Product Development***
Tshwane University of Technology	***Chemistry and Chemical Engineering***
Mangosuthu Technikon	***Chemistry and Chemical Engineering***
Vaal University of Technology	***Materials and Processing***

	Technologies
Nelson Mandela Metropolitan University	***Automotive Components***
Nelson Mandela Metropolitan University	***Downstream Chemicals***
Cape Peninsula University of Technology	***Clothing and Textile***
University of Johannesburg	***Metal Casting Technology***
Durban Institute of Technology	***Reinforced and Moulded Plastics***
Cape Peninsula University of Technology	***Agri-food Processing Technologies***

The technology station at the Central University of Technology, Free State (CUT) in Bloemfontein is the Product Development Technology Station (PDTS), along with the Centre for Rapid Prototyping and Manufacturing (CRPM).

The PDTS and CRPM at CUT are the only stations of Tshumisano that focus on product development and therefore it is the only option for entrepreneurs with product innovation that they want to commercialize. For this reason the sample of respondents will be drawn from the population of the two stations only.

Bloemfontein is in the centre of the country and with technology it lends itself to service delivery to the whole country. The PDTS concentrates its efforts on the local community and industries, but due to the specialized equipment they boast there is a national need for their services. The fact that PDTS is quite remote from the main cities of South Africa (SA) the inventors feel ensured that their new products will not be seen by opposition organizations in and around South Africa.

The PDTS, at the Central University of Technology, Free State, augmented its internationally renowned Centre for Rapid Prototyping and Manufacturing (CRPM). The PDTS, through collaboration with CRPM, focuses on the stimulation of SMME innovation capacity. The delivery structure of CRPM is in place with all-financial support, which includes invoicing, statements, and debtors follow-up mechanisms and budget control. The personnel and students involved in CRPM are specialists in prototyping and product development. The machines and secondary technologies are of the best in the world.

In the South African context there is no other company that can provide the same comprehensive product development service with the support of different prototyping machines. Due to the expensive nature of product development, industrial designers and product development organizations concentrate on big companies that can afford their services. Due to the research backup, PDTS and CRPM can also assist SMMEs with larger research and development (RandD) projects. The PDTS personnel can be used on different projects in which they acquire new skills and competencies.

Therefore, this research will focus on the customers of the PDTS and CRPM at the CUT, as the customer population of the CRPM is representative in that the customers come from all over the country and are not confined to Bloemfontein only.

According to its vision, the PDTS (Product Development Technology Station) at the CUT provide small, medium and micro enterprises in the South African manufacturing industry with technological support and skills transfer that will enable them to become globally competitive.

The aim of these centres are also to assist entrepreneurs with an invention to get to the proof of concept stage. Most of the entrepreneurs who contact the PDTS and CRPM have a rough idea of the product they would like to create, but no market research, very little legal advice and more often than not, not a lot of money. In other words, these individuals represent the entrepreneurs for whom this research study is conducted in order to help them get from idea to successful commercialization, as they also do not have the backing in terms of money, skills, etc. of large organizations.

The research population of this study consisted of all the clients from 2005 until 2010 of PDTS and CRPM at the Central University of Technology, Free State. The reason for this is that the entrepreneurs who contacted the CRPM in 2005 has had enough time to work with their inventions in order to get market share and make a success of their product (they are through the process of getting an idea to the market) and can provide valuable insights on the typical problems and success factors they experienced en route. It will also be possible to determine the success rate of these ventures. The individuals from 2010 would be able to share their fears and the obstacles they had to overcome thus far.

1.5.2.3 Population

In order to make provision for a non-response, it was decided to use the whole population from 2005 to 2010. This decision eliminated the use of a population sample. Due to the fact that all individuals in the population had a non-zero probability of selection, each member of the population had an equal probability of being selected.

All the individuals on the client name list of PDTS and CRPM were contacted telephonically in order to ask them whether they would be willing to participate in the research study. The response on the telephone call further determined the sample size, as can be seen from table 1.2.

Table 1.2: The sample size of the study

Total population	Total population in Bloemfontein	Total population in Bloemfontein (%)	Total number of respondents	Percentage of Bloemfontein population	Percentage of total population
209	120	57.4%	60	50%	28.7%

The respondents consisted of 60 clients from the PDTS and CRPM client base.

The barriers in the commercialization process can be classified under exploratory research. This approach is utilised when a new interest is examined or when it is a relatively new subject matter (Babbie and Mouton, 2005:79). The issue concerning the commercialization process, as well as the factors that influence successful commercialization has been under discussion in more developed countries, but the South African perception and context has not been examined in great detail. Studies of an exploratory disposition are done to 'better comprehend the nature of the problem since very few studies might have been conducted regarding the phenomena needed to be understood'. To gain familiarity with the problem, preliminary research needs to be done before a model or design can be developed to investigate and understand the occurrence or trend completely (Sekaran, 1992:95).

As stated, articles, unpublished reports, academic journals, the Internet, newspapers and other publications were used as secondary data. This study contains literature from South Africa, as well as other countries, where more comprehensive research has been done on innovation and commercialization.

The research technique employed in this study was of a quantitative nature by making use of surveys to ascertain the data required. As was pointed out above, the study aims to determine the factors that hindered the entrepreneur from successfully commercializing an invention, the process followed by the innovator and the steps of the commercialization process that were left out either by decision of the entrepreneur or because the entrepreneur did not know of these steps through the use of fully structured questionnaires. After the information is gathered the data needs to be analysed using statistical procedures to settle the research objectives.

The questionnaire aimed to verify the factors that hindered the entrepreneur from successfully commercializing an invention, the process followed by the innovator and the steps of the commercialization process that were left out either by decision of the entrepreneur or because the entrepreneur did not know of these steps. The majority of the questions in the questionnaire consisted of "YES" and "NO" questions with the options "I do not think it is important" and "I did not know about it" in the cases where the innovators answered "NO". The innovators also had the option to give any other reason for answering "NO" on the questionnaire.

A pilot survey allows for the pre-testing of the target population (Hair, Bush and Ortinau, 2003:464). Hussey and Hussey (1997:163) emphasise the importance of pilot testing a questionnaire to smooth out any discrepancies or difficulties that could cause misunderstanding of the questions. It is imperative to test the questionnaire on individuals that is similar to those in the sample to improve the effectiveness or the data. This study was pilot tested by a sample of five innovators from the client base of the PDTS and CRPM. The questionnaire was presented to a pilot study group during personal interviews which took about an hour to complete. The necessary changes were made after the pilot study was conducted.

1.6 Demarcation of the study

- Chapter 1: Introduction and research design
- Chapter 2: Innovation
- Chapter 3: Commercialization
- Chapter 4: The combined innovation and commercialization process.
- Chapter 5: Results (Empirical study)
- Chapter 6: Conclusions and Recommendations

Chapter 2

Innovation and the innovation process

2.1 Background to innovation

Nieman and Nieuwenhuizen (2009:3) states that “Economic development can be directly attributed to the level of entrepreneurial activity in a country. Entrepreneurship ensures growth in the economy as entrepreneurs intend to grow their businesses and are responsible for job creation in the economy”.

Nieman et al. (2009:3) furthermore argues that SMMEs plays a critical role in the entrepreneurial activities of South Africa as they:

- account for 97.5 per cent of all businesses,
- generate 35 per cent of the gross domestic product,
- contribute 43 per cent of the total of salaries and wages paid and
- employ 55 per cent of all formal private sector employees in South Africa

It can therefore be deduced that entrepreneurs who start their own businesses successfully are vital to the economic well-being of South Africa. In fact, research into entrepreneurship and its effects were initiated several years ago when Schumpeter first investigated entrepreneurs and innovation, and the consequences thereof.

In 1934, Schumpeter associated entrepreneurs with innovation and with his impressive research made the link between entrepreneurs and economic development clear. Following on his research Clarke (1899), Higgins (1959), Baumol (1968), Schloss (1968) and Leibstein (1978), to name a few, also confirmed the association of entrepreneurship with innovation. The focus of their research was on entrepreneurs as the drivers of the economic system (Nieman and Nieuwenhuizen, 2009:5). From their research it became clear that entrepreneurs, through innovation, had an important role to fulfill in the economic development of a country.

However, as the interest in the field of entrepreneurship increased, many different viewpoints and focus areas arose. In contrast with the purely economic focus of entrepreneurship in the 1980s, management scientists of all fields have since attended to the support systems that entrepreneurs needed and worked to identify appropriate support systems for entrepreneurs (Nieman and Nieuwenhuizen, 2009:7).

From the 1990s entrepreneurial activities and the related competencies became the focal point of research. Attention moved to research that can help the practice of entrepreneurial action (Nieman and Nieuwenhuizen, 2009:7).

In other words, while the important contribution that entrepreneurship makes to the economic development of South Africa remained the centre of research on entrepreneurship, it was acknowledged that entrepreneurs need help in many other

areas, as well as the process of taking innovations successfully to the market. Research in later years therefore started to focus on the support systems that entrepreneurs need as well as the basic entrepreneurial activities that entrepreneurs need to complete.

2.1.1 Importance of innovation for an economy

As already stated, economic development can be directly attributed to entrepreneurship, among other things. However, it is not just the economy as a whole that benefits from entrepreneurship.

Organizations will not be able to compete successfully or, for that matter, survive, if they do not innovate continuously and successfully. In the competitive environment of today, with individualized customer preferences, rapid change, non-linear dynamics and globalized market competition, innovation and entrepreneurship is of vital importance to ensure organizational sustainability and organizations that do not succeed in innovation are facing an uncertain future and risk (Johne 1999:6,10; Loewe and Dominiquini 2006:24–31; Zhoa, 2005:25–41).

There are several forces that raised the importance of bringing new products and services to market, namely:

- rapid technological changes, which make existing products obsolete;
- new income streams have to be identified by management;
- organizations have to distance themselves from a growing number of competitors both nationally and globally by means of a competitive advantage; and
- competitors can copy a successful product, which can neutralize an innovative product's advantage (Cumming, 1998:26; Etzel, Walker and Stanton, 2001:222).

As Slater and Narver noted, "It is no longer adequate to do things better; it's about "doing *new and better* things" (Humphreys, McAdam and Leckly, 2005:283).

In addition to the abovementioned, product life cycle is getting shorter because of changes in technology and therefore the profits of products that are on the market will diminish over time or the product will be made obsolete by new or improved products (Hanna et al., 1995:33). This presents a real problem for SA as the number of organizations who can differentiate themselves successfully from competitors are declining at an alarming pace (from 11 in 100 owner-managers in 2003, to only 2 in 100 in 2005) (Von Broembsen, Wood and Herrington, 2005:32). Because of this threat, all organizations should, and do, continuously aim to differentiate themselves from their competitors by creating and/or implementing new products, processes, techniques or procedures (Cooper, 1998:493; Howe, Mathieu and Parker, 2000:277).

Innovation does not only benefit economies, and large organizations, but is also vitally important for individual businesses. The competitiveness of businesses improves as a result of innovation, and change necessitates innovation. The increasing rate of change in the business environment, which occurs in every industry, profession and product/service model, is increasing dramatically. It is crucial for both nations and

businesses wishing to compete in the 21st century global economy to find and implement new knowledge and to do things more correctly and efficiently (Highsmith and Cockburn, 2001; Carroll, 2006).

The prediction that managing innovation would become the paramount organizational task was already made in 1986 by Tushman and Nader, but not even they could have imagined that innovation, and managing innovation, would escalate to these heights (Cozijnsen, Vrakking and Ifzerloo, 2000:150). Furthermore, the increasing pressure on both large organizations and SMMEs to innovate is encouraged and aggravated by the turbulent competitive environment in which firms operate (Stokes and Wilson, 2006:66–68).

However, the rapid pace of change in the 21st century does not necessarily have dire consequences only, as change can provide people with opportunities (Paine, 2005). The discovery of new knowledge will enhance our understanding of the world around us, which in turn will lead to new and better products and services. New and/or improved products and services present the opportunity for improving the quality of life and creating economic opportunities for individuals and businesses. The need for persistent innovation must be met in this fast-changing and unstable environment, and the right culture must be forged (Highsmith and Cockburn, 2001).

2.2 Innovation defined

The importance of innovation might be clear, but there is not a proper consensus regarding the definition of innovation or what innovation entails. To some, this might seem trivial, but without an accepted definition of innovation, measures of innovation remain absent. This absence of sufficient measures hamper theory development on innovation, as without a common agreement on what innovation entails it becomes impossible to suggest what managers, innovators and the nation as a whole can do to improve and/or pursue innovations (Cooper, 1998: 493 – 502).

Researchers and practitioners have defined innovation in several different ways (Cooper 1998: 493 – 502) and as a result the term innovation is often used with such indistinctness that it is used interchangeably with words such as “creativity”, “invention”, “change” and “entrepreneurship” (Storey and Salaman, 2005: 4) - none of which is a true reflection of the term innovation.

Where creativity is concerned, there is agreement that creativity entails idea generation and this is an important precursor to innovation. However, the two terms are not synonymous (Cumming, 1998: 21 – 29). The distinction between the two is that creativity is an original idea and innovation is the development of that idea for commercialization (von Oetinger 2005: 29 – 36), as was pointed out in 1.2 above.

To distinguish “invention” (or creation) from innovation, creation is simply the invention of products that may not have a market, whereas innovation is defined as creating something to meet the demands of a market (Li, Tricker and Wong, 2002: 425 – 434).

There is general consensus that the definition of innovation should include the concept of “newness” (Johannessen, Olsen and Lumpkin, 2001: 20 – 31), which distinguishes innovation from change and is important in understanding the link between innovation and entrepreneurship.

Innovation is the specific tool of entrepreneurship by which entrepreneurs exploit change as an opportunity for a different business or service. Moreover, innovation has to address market needs, and requires entrepreneurship if it is to achieve commercial success. It must be stressed that innovation and entrepreneurship is complementary because innovation is the source of entrepreneurship and entrepreneurship allows innovation to flourish and helps to realize its economic value. A combination of the two is vital to organizational success and sustainability in today’s dynamic and changing environment (Zhoa, 2005: 25 – 41).

What has become clear, however, is that without the presence of some form of entrepreneurial activity to exploit opportunities as they arise within organizations, innovation remains little more than an aspirational, rather than a tangible destination (von Oetinger, 2005: 29 – 36).

In the simplest form, innovation can be defined as the successful exploitation of new ideas (Salavou, 2004: 33; Wilson and Stokes 2005: 366 – 378; Wonglimpiyarat and Yuberk 2005). However from this, simple version, the definition of innovation has been extended to include the notion of success (Salavou, 2004: 33; Wilson and Stokes 2005: 366 – 378). It is argued that a new concept must be brought into successful use before innovation has taken place. To summarize, innovation is coming up with an idea and changing that idea into an opportunity through commercialization (Cumming, 1998:21 – 29; Kriegesmann, Kley and Schwering, 2005: 57 – 64; McFadzean, O’Loughlin and Shaw, 2005: 350 – 372).

To conclude, if an idea has not been developed and transformed into a product, process or service, or it has not been commercialized, it would not be classified as an innovation (Popadiuk and Choo 2006).

For the purpose of this study, innovation will therefore be defined as:

Innovations, which make a significant impact rather than mere routine and incidental chance, or the development of an idea for commercialization to meet the demands of a market. Seeing that innovations are often based on some previous contrivance, new adaptations, or some new combinations of existing ideas or artifacts, it must be perceived to be new by the relevant unit of adoption. The concept of successful commercialization must be included in the term innovation.

Therefore the need exists to understand the commercialization of innovation, which will be discussed in the following chapter.

The next part of this chapter will discuss the different types of innovations as an indication of the different innovative ways that exist.

2.3 Types of innovation

It is important to note that there are different types of innovation and that each of these types has a different effect on the market and necessitates a different approach from the innovator. The different types of innovation should be managed differently by the entrepreneur as it can either be low risk-low reward, or high risk – high reward innovations. Low risk-low reward innovations implies that the innovator does not assume high levels of risk, as the innovation the innovator wants to introduce is merely an extension or improvement of an existing product. While these innovations are "safe" they often yield low returns for the innovator as the market is already familiar with this type of product (Gopalkrishnan, LaPlaca and Sharma, 2006).

High risk-high reward innovations, on the other hand, are innovations that are completely new to the market. It is a completely revolutionary product being introduced into the market and the innovator runs the risk that the consumers will either not understand or not be interested in the new innovation. However, if this innovation is accepted into the marketplace, the innovator can expect great returns on the risk that was assumed (Chandrasekar, 2006: 46 ; Gopalkrishnan, LaPlaca and Sharma 2006).

The most prominent innovation dimensions can be expressed as dualisms:

- Incremental vs. Radical
- Product vs. Process
- Administrative, Social and Technological (Darso, 2001: 29; McFadzean, O'Loughlin and Shaw 2005: 350 – 372; Zhoa, 2005: 25 – 41) and
- Architectural innovation (Popadiuk and Choo, 2006).

Each one of the types of innovation will be discussed in more detail below.

2.3.1 Incremental vs. Radical innovation

The first types of innovation to be discussed are incremental versus radical innovations and these innovations vary along a continuum from incremental to radical.

Incremental and radical innovations will be discussed separately and in more detail in the section that follows in order to make the difference between these two types of innovation clear.

2.3.1.1 Incremental innovation

Incremental innovations are small advances made to existing products, processes and services which implies that these changes, rather than redefining the technology, enhances and extend the underlying technology (Cooper ,1998: 493 – 502; McFadzean, O'Loughlin and Shaw, 2005: 350 – 372; Zhoa, 2005: 25 – 41). In other words, the manufacturer's existing technological capabilities and the market knowledge remains, and is built on (Popadiuk and Choo, 2006). An example of incremental innovation is when a newer version of current software, with minor changes to certain settings, is introduced to the market.

According to Darso (2001: 29) incremental innovations, "include second generation products, new applications of existing products, and new markets for existing products". Incremental innovation tends to be predictable and has only a slight impact on the market and therefore it is often considered to be the least original form of innovation (McFadzean, O'Loughlin and Shaw, 2005: 350 – 372). Usually incremental innovations serve only to enlarge market share and market leadership (Gopalkrishnan, LaPlaca and Sharma, 2006).

While incremental innovations typically follow a low risk-low reward strategy, continuous improvements to products or the performance of products can be achieved (Gopalkrishnan, LaPlaca and Sharma 2006). A low risk-low reward strategy implies that the innovator assumes very little risk as the basic technology is preserved, but the rewards/returns that the innovation will yield will be low as well. The market will already be familiar with the basic function or look of the innovation and thus little interest in the innovation will be generated.

It should be noted that organizations or individuals that maintain incremental innovations will be threatened should new ideas or technologies arise (Gopalkrishnan, LaPlaca and Sharma, 2006). While incremental innovations can ensure continuous improvement, no real competitive advantage can be achieved through it and competitors who introduce a radically new innovation will obtain the interest of the market.

An example of an incremental innovation was when Gillette launched a razor specifically designed for women. The basic function and technology of a razor remained, but a new market was identified.

In South Africa, the tendency is to introduce more incremental innovations than radical innovations. Several product extensions or improvements have been introduced, but truly new and unique innovations remain scarce.

2.3.1.2 Radical innovation

In contrast with incremental innovations, radical innovations include considerably new technologies in comparison to existing technologies (Gopalkrishnan, LaPlaca and Sharma, 2006). Radical innovations therefore influence existing markets fundamentally and have the potential to create new markets (McFadzean, O'Loughlin and Shaw, 2005: 350 – 372). This type of innovation is path-breaking, discontinuous, revolutionary, original or major innovations (Zhoa, 2005: 25 – 41) and tends to be high risk-high reward innovations (Gopalkrishnan, LaPlaca and Sharma, 2006). Where radical innovations are concerned, the current technological and market knowledge are rendered obsolete (Popadiuk and Choo, 2006).

A high risk-high reward innovation implies that the innovator assumes a great deal of risk in commercializing this ground-breaking innovation as the reaction of the market is unknown and cannot be predicted accurately. The innovation can be rejected by the market or find only limited use, which will mean huge financial losses for the innovator. On the other hand, the innovation may be a great commercial success and the innovator can expect vast financial returns for the risk he/she assumed. The term radical is often associated with revolutionary and disruptive innovations, which are major innovations that radically influence the marketplace (Chandrasekar, 2006: 46 ; Gopalkrishnan, LaPlaca and Sharma, 2006).

Both the terms radical and disruptive innovation will be discussed in order to support the thought that these types of innovation are actually synonyms.

According to Chandrasekar (2006: 46) "revolutionary innovations describe situations where discontinuities totally redefine the meaning of an industry by creating new technological regimes or paradigms".

Disruptive innovations are market-based, which implies that a small segment of early adopters allow the organization or individual to develop and produce the innovation and compete in the market. Therefore marketers of known products that are already on the market find the innovation disruptive over the long term (Gopalkrishnan, LaPlaca and Sharma, 2006). In the context of previous research, this study combines these innovations due to their effects and labels them as radical innovations.

While considerable profit can be generated from radical innovations, there are also substantial risks in the development and implementation of these innovations (Saban et al. 2000: 99 – 119). For this reason it is understandable that most start-up organizations or entrepreneurs do not attempt radical innovation even though they do not stand to gain competitive advantages from incremental innovations (Gopalkrishnan, LaPlaca and Sharma, 2006).

In conclusion, radical innovation alters the previous way of doing things completely and renders the previous technology obsolete. In the South African market an example of

radical innovation can be when computers took over the market from typewriters completely.

In Figure 2.1, the main differences between incremental and radical innovation are summarized.

Figure 2.1: Incremental versus radical innovation

R I S K		REWARD			M A R K E T S
		High	Low		
	Low		**INCREMENTAL**	Existing	
	High	**RADICAL**		New	
		New	Existing		
		KNOWLEDGE			

(Source: Author's own construction)

2.3.2 Product or process innovation

Product innovation as well as process innovation can be pursued by both individuals and organizations and according to Fagerberg (2003) these two types of innovation "characterize the occurrence of new or improved goods and services, and improvements in the ways to produce these, respectively".

The main differences between product innovation and process innovation are highlighted in the next section.

2.3.2.1 Product innovation

Product innovation leads to changes in the end product or service that the organization or individual offers (Cooper, 1998) and should be new products or services with the intention of satisfying a need in the market (Popadiuk and Choo, 2006). It is expected that product innovations will lead to increased quality of the product (Bonanno and Haworth, 1998). Furthermore, Lundvall (1985) explain that product innovations are aimed at the needs of the market, which implies that the users are separated from the innovating unit (Bonanno and Haworth, 1998).

Product innovations can be either incremental or radical innovations. As small changes can be made to existing products in order to better satisfy customer needs (incremental innovation) or completely new and revolutionary products can be introduced (radical innovation).

Product innovations therefore present consumers with new and better product choices than what was previously available. An example of product innovation is cellphones.

The innovator understood the need in the market to have a phone with you at all times and not merely a landline at home.

2.3.2.2 Process innovation

Process innovation, on the other hand, signifies changes in the manner that organizations produce products or services (Cooper, 1998) and this is expected to result in lower unit costs for the organization or individual (Bonanno and Haworth, 1998). Therefore process innovations are aimed at addressing the internal needs of either the organization or individual (Lundvall, 1985).

A clear distinction is made between product and process innovation as the likely economic and social impact of these two types of innovation may be different (Fagerberg, 2003).

Individuals can also gain from process innovation as they can improve on the current method they use to do things. At the end of this study it is the hope that all innovators will adopt a new process to commercialize their innovations, which is process innovation in itself.

Even though it is likely that process innovation is associated with incremental innovation, it should be noted that process innovation can be radical as well. An example of incremental process innovation is streamlining an existing process. A radical process innovation is, for example, when labour by hand made way for machine processes to manufacture a specific product.

2.3.3 Administrative, technological and social innovation

In the following section administrative, technological and social innovations are discussed and defined.

2.3.3.1 Administrative innovation

Administrative innovations relate to the organizational structure and administrative process (Popadiuk and Choo, 2006) and comprise the introduction of a new management system, administrative process or staff development program (Subramamian and Nilakanta, 1996). In other words, administrative innovations relate to the strategies, structure, systems or people in an organization (Popadiuk and Choo, 2006). It differs from process innovation as administrative innovation focuses only on the administrative side of the organization, where process innovation focus on the production process of the organization.

An administrative innovation does not lead to the introduction of a new product or service, but the changes it brings about in an organization can indirectly influence the process of producing new products or services and the introduction thereof (Subramamian and Nilakanta, 1996).

Administrative innovation can refer to the implementation of a different or new computer program, for example, to make the working of an organization more efficient.

While administrative innovation consists of “changes that affect the policies, allocation of resources, and other factors associated with the social structure of the organization” according to Cooper (1998), technical innovation on the other hand constitutes the adoption of an idea that directly influences the basic output processes (Cooper, 1998).

2.3.3.2 Technical innovations

Technical innovations can either be approving a new idea relating to a new product or service, or it can entail changing the production process or service operations by introducing new elements (Subramamian and Nilakanta, 1996). Therefore, as Subramamian et al. (1996), explain “technical innovations occur in the operating component and affect the technical system of an organization and the technical system consists of the equipment and methods of operation used to transform raw materials or information into products or services”.

Seeing that technical innovations influence either the products or services an organization sells or the process and techniques used to produce these, it may require administrative innovation in some cases (Popadiuk and Choo, 2006).

Technical innovation is different from incremental and radical innovations as it can entail new processes or services as well, while incremental and radical innovations refer only to products.

2.3.3.3 Social innovation

Social innovations spring from social needs, rather than from technology, and are related to new ways of social interaction, behaviour or function (Darso, 2001:29).

In other words, the needs of a specific market changes and the demand for a product or service arise from this change. Social innovation does not depend on new technologies, but rather on innovators who recognize a need in the market and finds a way to satisfy this need.

2.3.4 Architectural innovation

Architectural innovation implies that both the technological and market capabilities are outdated (Popadiuk and Choo, 2006).

This type of innovation, therefore, is revolutionary in terms of both the technology that is used and the market it will satisfy. Innovators of this type of technology must develop completely new technical and market capabilities in order to achieve success.

In table 2.1 below, the types of innovation discussed are summarized.

Table 2.1: Summary of the types of innovation

Type of innovation	Discussion
Product innovation	Changes in products or services offered Focus: Satisfying a need in the market
Process innovation	Changes in the way an organization produce products or services Focus: Satisfying the needs of the organization
Administrative innovation	Changes in the organizational structure and administrative processes. Implementing new strategies, structures, systems or people
Technological innovation	Changes in the equipment/methods used to transform raw materials into products or services
Social innovation	Changes that arise from social needs The need for a product or service arise when the market changes
Architectural innovation	New market and technological capabilities are needed

(Source: Author's own construction)

2.4 Sources of innovation

There are countless sources of business opportunities and the entrepreneur, especially in a rapidly developing and changing society such as South Africa, has numerous places to find these. However, it should be noted that finding good ideas and converting them into opportunities is a conscious, deliberate and creative process.

The sources of innovation, as identified by different authors, will be discussed in the section below. The different sources of innovation, a summary of the each of the sources as well as an example of each can be found in table 2.3 at the end of this section.

a) According to Drucker (Drucker, 1995:31-32) several sources of innovative opportunity can be found. Among these are unexpected events, such as unexpected success or failure; incongruities, where there is a discrepancy between reality as it is and reality as it ought to be and innovation based on process need and changes within industry or market structure. The mentioned sources are mainly visible to people within a specific industry or sector (Drucker, 1995:31-32). Further sources of innovation that is visible to people within a specific industry, according to Nieman and Nieuwenhuizen (2009:87) is the generation of ideas from skills, expertise and aptitude as well as ideas that arise as a result of existing and everyday problems (Nieman and Nieuwenhuizen, 2009: 87).

b) The following four sources of innovation, according to Drucker (1995:31-32), are changes that occur outside the enterprise or industry and they include changes in the population, i.e. demographics; changes in the perception and/or needs of customers; new knowledge that can be either scientific or nonscientific and “bright ideas”. It should be noted that “bright ideas” are the riskiest and least successful source of innovation.

c) Further sources of innovation, as noted by Popadiuk and Choo (2006), include internal value chain; external-added chain of suppliers; customers; universities; government; private laboratories; competitors and related industries.

d) It is essential to note that changes and improvements in technology is also an important source of innovation. In many instances an idea was long thought of before the enabling technology existed. As technology progresses, new doors are opened that were previously closed, ideas that were once unfeasible may become practicable. One such technical enabler that led to several innovations over the years is the development of materials, for example steel (Cumming, 1998).

e) Van Aardt, Van Aardt, Bezuidenhout and Mumba (2008: 29) also note that libraries with information on existing products, which can trigger thoughts on better ways to satisfy needs,; talking to people to identify their needs; changes in

the external environment, such as political and social changes; information obtained from exhibitions, forums, workshops and seminars; and the internet are all sources of innovations.

f) Another source of innovation is the process of the diffusion of innovations. The diffusion of innovation theory is concerned with the manner in which a new technological idea, artifact or technique, or a new use of the old one, migrates from creation to use (Clarke, 1999). The stages through which a technological innovation passes are:

- Knowledge (exposure to its existence, and understanding of its functions);
- Persuasion (the forming of a favorable attitude to it)
- Decision (Commitment to its adoption)
- Implementation (putting it to use) and
- Confirmation (reinforcement based on positive outcomes from it) (Clarke, 1999).

g) Knowledge about the different stages an innovation passes through enables the innovator to identify new opportunities for innovation. The manner in which demand for the innovation or perceptions of the innovation change can present an innovator with new opportunities.

The stages of the product life cycle can also present the innovator with a source of innovation. If an innovator understands the life cycle of products the innovator can identify opportunities as his/her own innovation, or an innovation of another innovator or institution, passes through the different stages.

The stages though which every product passes are:

- Introduction; which is the entry of the product into the marketplace
- Growth; a definitive increase in the sales curve with a rise in demand as buyers become more familiar with the product
- Maturity; the environment becomes saturated and sales level off. At this point, the decision to maintain the product or allow it to wane is made. If the product can be modified to counter the declining sales, a new growth stage begins
- Decline; when the product is no longer viable and marketers take the product off the shelves (Hashimoto, 2003).

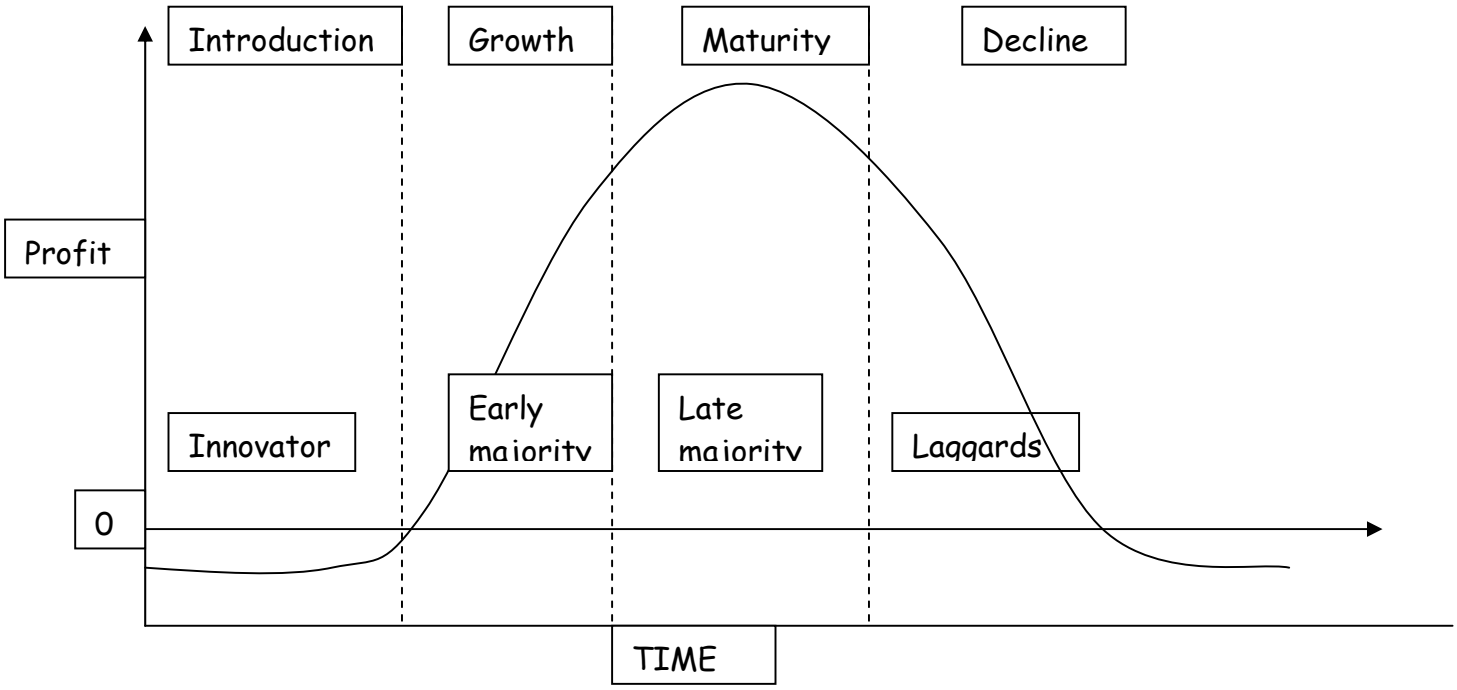
By understanding this process, the innovator can identify opportunities in every stage and be aware of the fact that a new innovation must be ready when the current innovation moves into the decline phase.

h) People adopt innovations at different times for different reasons and these different types of adopters and their unique needs and perceptions are also a source of ideas for an innovator. Differentiating between the different types of adopters enables innovators to understand who they are and how they consume the innovations on the market.
The five categories of adopters are:

Innovators. These are the risk takers. Innovators are eager to try new ideas and products. Generally they are well-educated and have a high income to absorb a mistake. In general the innovators are the focus of innovators during the introductory stage of the product life cycle as they are risk takers who are willing to try new products.
Early adopters. They are highly educated and wealthy like the innovators, but are more visible and respected among their peers. Early adopters rely more on group norms and values than innovators and as a result they play a key role in the adoption process, determining the time an innovation will be adopted by others and to what extent. During the growth phase of the product life cycle they form the target market for an innovator. The early adopters need a form of proof that the new product on the market performs as expected and really satisfy the needs it claims to.
Early minority. They do not take the risk of being the first to adopt, like the innovators and early adopters, but they do accept an innovation before the average person. They generally take a long time to fully adopt an innovation as the collect more information and evaluate more brands than the early adopters. They are both average in education and income. They are the target market during the later stages of the growth phase in the product life cycle, as this group of individuals had time to collect the needed information on the new product and can now make the decision to buy.
Late majority. This group will adopt a new product because their friends have already adopted it and they depend mainly on word-of-mouth communication. Their education and income are limited and they are not willing to take a chance unless the majority has already adopted the innovation fully. During the late stage of the maturity phase they become the target market. The late majority forms the target group during the late stage of the maturity phase as they usually represent a big group of individuals who can give a product new life after the innovators, early adopters and early minority have purchased the product.
Laggards. This is the final adoption group. They are more in-tuned with the past than the future. They are skeptical of all new ideas and often by the time they adopt an innovation there already is a new one to take its place. Marketers often ignore this group because of their lack of interest (Lamb et al., 2008: 253).

Figure 2.2 below illustrates the stages of the product life cycle and the different types of adopters. This figure was adapted from (Meade and Islam, 2006).

Figure 2.2: The stages of the product life cycle and the types of adopters



Van Aardt et al. (2008:20) distinguish between the sources of innovation and the causes of innovation. They argue that new technologies, new or shifting customer needs, the emergence of a new industry segment, shifting input costs or availability and changes in government regulations as well as the adoption process and the product life cycle are causes of innovation. In other words, as a result of these, innovation is necessitated. The innovator has no control over the causes of innovation; however, he/she must be aware of these changes in order to introduce a new innovation in a timely fashion.

In the table 2.3, the different sources of innovation, a brief discussion of each source and whether the source is within or outside the relevant industry are discussed. From this table the different sources of innovation, and what is meant by each source, is clear.

Table 2.2: The different sources of innovation

Industry	Source of innovation	Discussion	Example
Inside the industry	The unexpected	Such as unexpected success or failure.	Implementing a process for the first time and achieving success with it (unexpected success). Innovation has taken place as the new process proved to be a success and can be implemented again. Implementing a new process and failing will lead to an investigation into the reasons for failure. Identifying the reasons and improving on it will also lead to innovation as a new process will be implemented.
	Incongruities	Where there is a discrepancy between reality as it is and reality as it ought to be.	It sometimes happens that what is assumed as the status quo is different from what actually happens. People who identify this discrepancy and a way to correct it can introduce a new innovation.
	Process need	A current process is not efficient enough and the process can be improved.	In production industry it is especially visible. There is a constant need for a faster, more efficient way of producing products. Labor by hand was replaced with machinery and there is a constant need to improve on the technology used to produce products.
	Changes in industry	New competitors, products or technologies that are introduced enable a different innovation.	When the first cellphone was produced, the need for a cellphone charger arose. There are numerous examples of one new product that lead to/necessitated another new product.
	Skills, expertise and aptitude	From repeatedly doing the same job a person finds a better way of doing it or because	This is a typical example of process innovation. Repeatedly doing the same job enables you to identify a better and faster way to do the job.

		someone is truly skillful in his/her job he/she identifies a more efficient way than what is currently used.	
	Everyday problems	Different people are confronted with the same frustration of an insufficient or slow process or a problem in their everyday lives.	The need to find a quicker way to heat food than on the stovetop lead to the discovery of microwave ovens.
	Improvement in technology	The improvement in technology enabled a new innovation.	Before the technology was available it was impossible to create hybrid cars.
	Development of materials	Every new material that is discovered enables us to do new and better things.	For example, consumers moved from the stone age to the iron age when steel was invented.
Outside	Population	The composition of the population and when it changes is a source of innovation.	For example, women in managerial positions.
	New knowledge	Not related to a specific	Every piece of new knowledge we can accumulate can enable us to identify a more

the industry		industry, but any new knowledge that we gain.	efficient way than what is used currently or to create a completely new innovation.
	Bright ideas	Rare moments of great ideas.	No research was done; a great idea simply dawned on the innovator.
	Customers	Changes in preferences or needs.	The new awareness of a healthy lifestyle lead to innovations in exercise equipment as well as innovations in the fast food industry.
	Suppliers	The group of people who provide you with input materials for your business.	
	Universities	Intellectual property	Great ideas can come from University labs or from the projects that students had to complete.
	Government	Changes in laws, taxation law, etc.	Creates opportunities for innovation to satisfy new needs that arise as a result of the change in legislation.
	Private lab	Conducting research on a specific topic.	When an innovator becomes knowledgeable in a certain field it becomes easier to identify gaps in the current way of doing things or to identify a completely new product or process.
	Competitors	When innovators see their competitors doing something new and know it can be improved.	Especially in the motor industry. When innovators see their competitor develop a car that can start with the press of a button and develop a car that can be voice activated.
	Related industries	A change in a related industry creates a need in the industry you operate or opens the opportunity for an	

		innovation.	
	Changes in technology	As new knowledge is gained, technology is improved on or changed completely.	Cellphones, laptops, microwaves, etc. are all examples of changes/improvements in technology.
	Libraries	Doing research on a specific topic.	When one become knowledgeable in a certain field it becomes easier to identify gaps in the current way of doing things or to identify a completely new product or process.
	Talking to people	Identifying the needs or dreams of different people can lead you to identify an opportunity.	People can be a valuable source of information as they can give one insight into their problems, wants and needs much better than any research done in a lab or library.
	External environment	Changes in the economic, international, technological, etc environments.	As people become more aware of international trends they tend to want the same products or processes that are available internationally. For example, microwave meals that originated overseas, are now available locally.
	Exhibitions/ Forums	Sharing knowledge with people who are interested in the same industry as the innovator are.	Sometimes the different pieces of information that one can accumulate at an exhibition or forum can help an innovator piece together a solution to a current problem in the market or identify a new need altogether.
	Internet	Doing research on a specific topic.	When innovators become knowledgeable in a certain field it becomes easier to identify gaps in the current way of doing things or to identify a completely new product or process.
	Diffusion of innovation	The way an innovation moves through the market can	

		present innovators with an innovation.	
	Different Adopters	The different needs of the different types of adopters can lead to a new innovation.	For the different adopters, different strategies and products should be used. Understanding the needs of a certain group of adopters can enable one to create an innovation to satisfy these needs.
	Product life cycle	The way an innovation moves through the product life cycle can present one with an innovation.	Understanding that every product has a life span can help you to think of new and creative ways to give an existing product new appeal or to introduce a new product and to start the product life cycle again.

(Source: Author's own construction)

The following section will discuss the innovation process at length. In this section a combination of the research of various authors is used to create an all encompassing innovation process.

2.5 Innovation process

The development and successful commercialization of new products remain critical to the survival and prosperity of any organizations, but often product innovation entails high risks (Cooper and Kleinschmidt, 1986). To worsen the situation further the current global situation is plagued by constant changes, increased complexity and a great amount of uncertainty (Darso, 2001: 34).

Previous research indicated that new product success is closely linked to how well activities and steps from idea to product launch are performed in the new product development process as well as the completeness of the process. According to Cooper et al. (1986) it is not solely the markets, technology and synergy that influence success, but the people performing the product development activities as well (Cooper and Kleinschmidt, 1986).

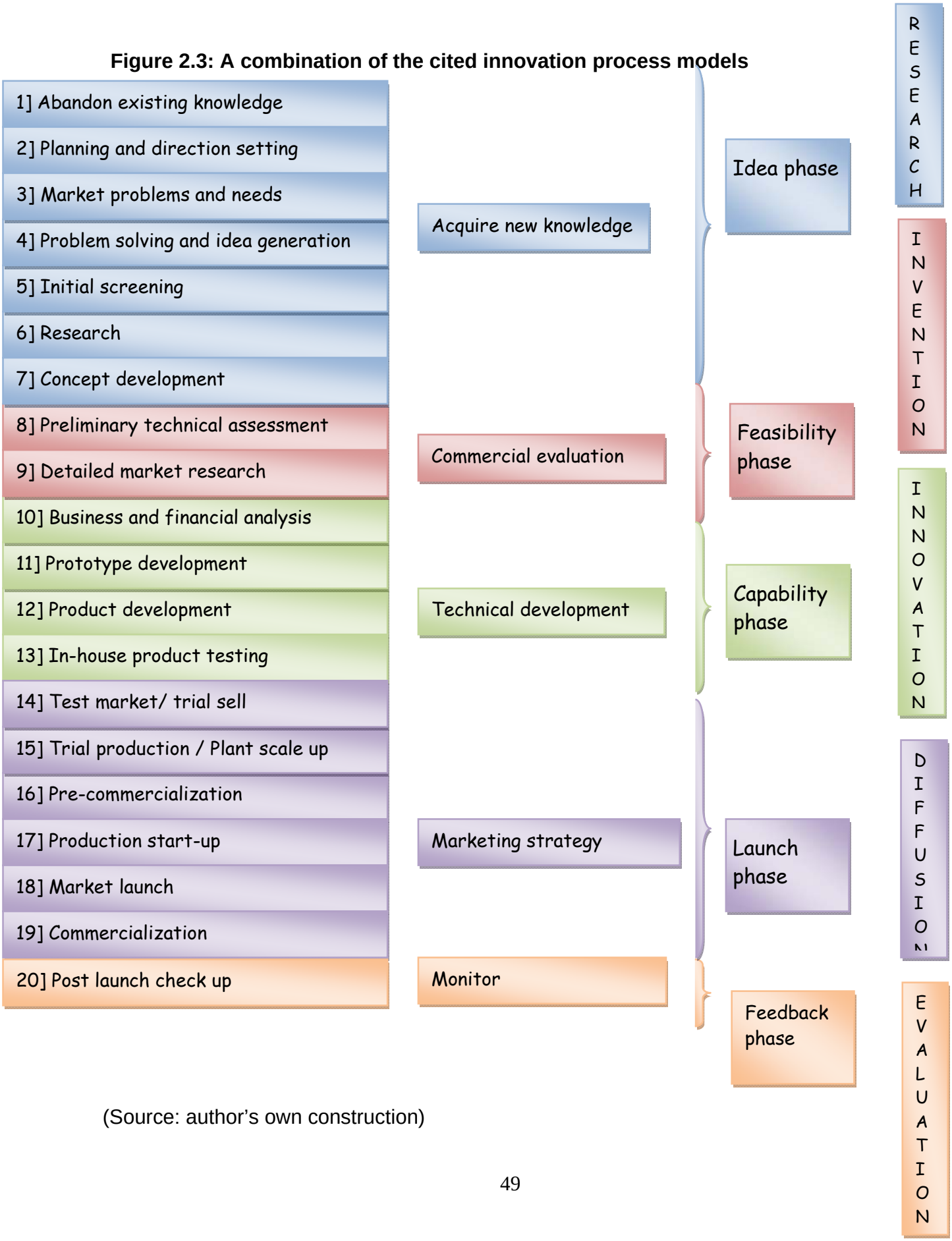
Cooper and Kleinschmidt (1986) found that many individuals and organizations did not go through all the stages in the new product development process nor successfully completed all the stages prescribed in the literature.

According to Darso (2001:94) “a good process model of innovation development does more than simply define its component events, it strings them together in a particular temporal order and sequence to explain how and why innovations unfold over time”. It therefore becomes paramount to understand the activities and actions that constitute the new product development process.

As Cooper and Kleinschmidt (1986) point out: “The critical nature of the majority of the activities of the process, combined with the major gaps and deficiencies uncovered, point strongly to the need for a standard activity plan – a new product process model. Such a flow model charts the activities that should or must be undertaken as a new product project moves from the idea stage to launch. By having such a model in place, the hope is that there will be fewer instances where critical activities are omitted or where insufficient time and resources are allocated to particular activities”. When an innovation model, as described above, is present it ensures that the innovations with commercial potential can successfully move through the innovation process and become successful products on the market. This, in turn, will generate income for the innovator, but the economy as a whole will benefit from successful commercialization through the creation of jobs and wealth.

In the literature there are several examples of different innovation processes. Figure 2.3 is a combination of the most often cited innovation process models. It should be noted that no single model included all the mentioned steps, and that this model is a combination of efforts of various authors. A discussion of each of the steps in the innovation model follows in section 2.5.1 after the model.

Figure 2.3: A combination of the cited innovation process models



(Source: author's own construction)

Each of the steps mentioned in figure 2.3 will now be discussed in detail in order to provide a comprehensive overview of the combined innovation process.

2.5.1 Innovation process model

Step 1: Abandon existing knowledge

At the beginning of the innovation process is the acknowledgement that there is a better way of doing things than present. Regardless of the industry or field in which entrepreneurs find themselves, there is always the option of doing things better – be it in a more cost-effective way, a faster way or an easier way (Herrmann, Tomczak and Befurt, 2006: 24).

Although this step might seem obvious, innovators who do not do this step generate incremental innovations (see section 2.3.1.1, page 19) when improvements are made on existing products. Incremental innovations, since they are small advancements made to known products, yield low returns and have only a slight impact on the market.

Should an innovator truly succeed in abandoning existing knowledge, radical innovations (see section 2.3.1.2, page 20) will be the result. Radical innovations are considerably new technologies in comparison to existing technologies it is path-breaking, discontinuous, revolutionary, original or major innovations. Although innovators assume a great deal of risk with radical innovations, they can also anticipate great returns should the innovation succeed.

The next step in the innovation process is to plan and set direction for the innovation.

Step 2: Planning and direction setting

During this phase product planning plays a crucial role. New product planning must provide the information links between the economic and technical capabilities of an individual or organization and the perceptions of consumers. This is important to ensure firstly, that the innovators have the financial and technical ability to create innovations that are viable and secondly, that the innovations produced are truly what the market wants (Karsak, Sozer and Alptekin, 2002). The goal of product planning is to create new or improved products in order to increase customer satisfaction.

It is important to develop a new product strategy that includes earnings and revenue growth gaps to be filled by new products, the roles the innovator want new products to fulfill, and an assessment of past new products to assess lessons learned (Davis and Moe, 1997: 345).

During the next step it is crucial to identify the market problems and needs that an innovation is expected to satisfy.

Step 3: Market problems and needs exploration

Once it is clear what the capabilities of the innovator are in terms of money and technology, the innovator must conduct qualitative research among consumers to explore and identify their needs, gripes, complaints, and hassles in a given product category. These problem areas provide a focus point for idea generation (Davis and Moe, 1997: 345).

The resources of the innovator must now be matched with the needs of the consumers. Innovators must ensure that the given set of skills, time and resources available to them can satisfy the needs of consumers adequately.

It is vital that innovators consider their capabilities to meet the needs of the market, otherwise the innovator can reach an insurmountable barrier while still in the process of bringing the product to the market and this will result in huge financial losses for the innovator. Furthermore, the innovator might make it through the innovation process, only to deliver a poor product to the consumers which they do not want.

During the next step solutions to consumer problems are generated, to identify the innovation(s) that will satisfy the needs of the customers.

Step 4: Problem solving and idea generation

Once innovators understand their limits and capabilities as well as the market needs, the next step is to create solutions to the needs of the consumers. New solutions and creative approaches that address consumer problems can now be generated.

The needs of the consumers must be clearly identified and defined in order to generate ideas that will satisfy the opportunity. An “idea” describes the purpose of the new product and outlines the benefits that the new product will provide to customers. Ideas for new products can be obtained from competitors, focus groups, employees and trade shows, to name a few. Formal idea generation techniques such as attribute listing, brainstorming and problem analysis can also be used (Davis and Moe, 1997: 345).

Once several ideas have been generated to meet the needs of the consumers, it is important to screen these ideas in order to identify the most viable idea and to not waste resources on an idea that has a fatal flaw.

Step 5: Initial screening

With several ideas in hand, the innovator must determine which of these alternatives to pursue through the use of initial screening.

Initial screening is where the preliminary go ahead/stop the project decision is made and resources are allocated to the new idea. In other words, ideas that are not viable are discarded before it consumes any of the limited resources of an innovator, be it time or money (Cooper and Kleinschmidt, 1986). Innovators should be ruthless in their attempt to remove unviable ideas, as too often they become too attached to a certain idea to see the pitfalls connected to it. The criteria that innovators use to screen ideas

can differ from one situation to the next, but some examples are compatibility with the innovator, costs to develop, quality needed and the reputation of the innovator.

Innovators must ensure that they accurately understand the needs of the consumers, know what their own capabilities and resources are and pursue only the ideas that will balance these needs.

The following step is to conduct research on the idea that the innovator decides to develop further.

Step 6: Research

During this step, preliminary market research is conducted. This entails a preliminary, nonscientific market assessment; which offers a first and quick look at the market (Cooper and Kleinschmidt, 1986). Preliminary research ensures that the idea truly is a viable option and that there is a need in the market that this idea will satisfy, or a problem it will solve (McFadzean, O'Loughlin and Shaw, 2005: 364).

It should be noted that this research is only to once again confirm that there is a need in the market, the innovator possesses the resources and skills to satisfy the need and that the ideas that the innovator generated is viable and sound. At a later stage, detailed market research will be done during which target markets and competitors, amongst other, will be identified.

Should the idea of the innovator be deemed worthy through the preliminary market research, the innovator must move on to the concept development step.

Step 7: Concept development

At this stage of the process, the viable ideas (screened during the initial screening step) are developed into "three-dimensional" descriptions of a product. This should describe the product features and attributes, intended use, and primary benefits perceived by consumers.

Concept development outlines the core technologies that will be used to produce the idea and states the general technical feasibility of the idea that already passed initial screening. Furthermore, how the product might be positioned against competition is also addressed and the primary purchaser is defined (Yelkur and Herbig, 1996: 41).

During the next step, the technical merit of the idea will be evaluated.

Step 8: Preliminary technical assessment

Now that the core technologies that will be used to produce the idea as well as the general technical feasibility of the idea has been identified, the innovator must do a technical assessment of the idea that was generated.

During preliminary technical assessment, an initial, preliminary appraisal of the technical merits and difficulties of the project is gained (Cooper and Kleinschmidt, 1986).

Thus the innovator gains a better understanding of the merits and difficulties associated with the technology that is needed to produce the selected idea(s). Innovators should come into the habit of continuously making kill/go decisions. This is not only a specific step at the beginning of the innovation process, but something that must be done after each major assessment. In other words, should the innovator realize that there are many difficulties associated with the technology needed to produce the innovation, it might be wiser to opt out instead of wasting even more resources trying to get an idea to the market that is doomed for failure.

The innovator now moves on to detailed market research.

Step 9: Detailed market research

Should the preliminary technical assessment deem the product viable, marketing research, involving a reasonable sample of respondents, a formal design, and a consistent data collection procedure is executed (Cooper and Kleinschmidt, 1986).

When a product passes the preliminary assessment step, it is argued that this product can be produced at a reasonable cost to meet the needs of the market and in other words, generate profit for the innovator. At this stage detailed research is needed to determine the target market of the product, the size and spending potential of the target market as well as the potential competitors, to name a few aspects.

From this step, innovators move to analyzing their business to determine the relative strengths and weaknesses of the business with regards to the specific situation.

Step 10: Business/financial analysis

Before the innovator can move to product development, the ability of the innovator in terms of the business and the available finances is analyzed. This business/financial analyses will lead the innovator to a further kill/go decision. If the innovator lacks the needed financial resources or business skills, the product must be abandoned. Even if there is an existing market for the specific product, if the innovator does not possess the needed expertise or finances, the product cannot be a commercial success.

Furthermore, the likely selling price that is determined through competition and customer feedback, the sales volume that can be expected based on the size of the market and profitability as well as breakeven point can be determined. A rough cut, three year pro-forma that estimates future financial performance should also be included (Cooper and Kleinschmidt, 1986; Davis and Moe, 1997: 346).

In addition, business analysis will help the innovator formulate a market and competitive assessment, which can determine the potential size and attractiveness of the new product (Yelkur and Herbig, 1996: 41).

The next step is prototype development where the innovator can move into the proof of concept phase.

Step 11: Prototype development

Once the concept development, technical assessment and business analysis is completed, the innovator can invest in prototype development. It is costly to design a product and produce a prototype, therefore it is essential that the innovator had ensured that all the abovementioned steps have been completed and that accurate information on the customer needs and product specifications were gained.

The product idea will now be designed and developed and once this is completed, the innovator will have a prototype or sampling product. With a working prototype in hand, the innovator can test product performance and consumer acceptance (Cooper and Kleinschmidt, 1986).

To correct a mistake while the product is still in the prototype phase is much less expensive than to correct a mistake when the complete product development phase has commenced. Therefore it is essential to confirm the product performance and consumer acceptance before the innovator moves on to complete product production.

When the innovator is satisfied that the prototype works as planned and will satisfy the identified needs, the innovator moves to the next step, which is product development.

Step 12: Product development

During the prototype development step, any changes that should be made to the product are identified, whereafter product development can occur (Cooper and Kleinschmidt, 1986).

Product development is very expensive as the required technologies and machinery to produce the product is now needed. The costs associated with the product development phase again underline the importance of adequate work in all the steps before this one. At this point, the innovator must be convinced about the fact that there is a big enough market for this product to generate profit; that the product itself will satisfy the needs of the consumers and that the prototype works exactly as it was supposed to.

After product development has commenced, it is important that the product be tested in-house, whereafter the product can be sold to a limited set of customers.

Step 13: In-house product testing

Once product development is complete, it is essential to test the product in the lab or under controlled conditions rather than with customers (Cooper and Kleinschmidt, 1986).

The reason for this is should an unexpected error occur, the problem can be fixed without the consumers knowing about it. If an innovator decides to omit this step and move the product directly to the market, any errors or malfunctions occur at the consumer's end. This can influence the perception of consumers negatively and innovators will struggle to enter the market again after the errors were fixed.

Even after the in-house product testing is successful, the innovator cannot move directly to full-scale production of the product, as a test or trial market sell must first be completed.

Step 14: Test market/trial sell

During the test market/trial sell a physical prototype or mock-up is produced and the product is sold to a limited or test set of customers. This is done to determine customer acceptance of the product and, if needed, make product adjustments (Cooper and Kleinschmidt, 1986).

In other words, during this step, the product is tested under real life conditions, e.g. with customers and/or in the field. Feedback from this step is essential as it again confirms all the research that the innovator has done up to this point and encourages the innovator to complete the process. On the other hand, consumers might find the product too expensive, or their needs might have changed and the innovator can abandon the product before any additional costs are incurred.

Should the test market/trial sell be successful, the innovator can initiate the trail production phase.

Step 15: Trial production/Plant scale-up

At this point of the process, the innovator is ready to move onto full-scale product development and it is essential to have a trail production. This is done to assess whether the current facilities, technology and machinery as well as the skill set of the employees are sufficient to produce the intended product (Cooper and Kleinschmidt, 1986).

Furthermore, roll-out equipment needs are evaluated and the product is manufactured in large enough quantities to identify “bugs” and problems. Additional product performance and quality tests are also run during this stage to ensure that every part of this process works as it is supposed to (Davis and Moe, 1997: 346).

Once the trial production/plant scale up is completed, the innovator moves on to the pre-commercialization step.

Step 16: Pre-commercialization

Pre-commercialization is the final stop before production and sale of the innovation can begin on a full scale. Many innovators tend to omit this step in the innovation process as prototype development and in-house testing have already been done. However, this is an immense mistake as the small amount of extra time this step will take can save an entrepreneur all the expenses should an error be identified (Cooper and Kleinschmidt, 1986).

During pre-commercialization the challenge for the innovator is to question the entire innovation process up to this point again. It is vital to ensure that everything is in order

for production start-up and market launch. Innovators can also start to develop the marketing campaign that they will implement during the launch of the product.

Once the innovator made sure the product that is offered is correct and the production processes are in place, the full-scale production of the product can commence.

Step 17: Production start-up

In the production start-up step, the full scale or commercial production of the product starts (Cooper and Kleinschmidt, 1986).

The product will now be manufactured in large enough quantities to satisfy the needs of the target market(s) and the product will be distributed to the various locations where it will be sold.

When this step is complete, the innovator can initiate the market launch.

Step 18: Market launch

The market launch of the product entails that the product is launched and sold on a full-scale and/or commercial basis. The innovator must ensure that a set of marketing activities specific to this product is in place (Cooper and Kleinschmidt, 1986).

The market launch consists of all the advertising media and marketing communication that the innovator has planned to reach the specific target market in order to sell the product that was produced. The importance of this step is that innovators must make sure that the market launch is successful in order to ensure that the product will be successfully absorbed into the market once commercialization commences.

The next step is the commercialization of the product.

Step 19: Commercialization

During the commercialization step, the product is launched and the distribution pipeline is filled with the product. A product is successfully commercialized when the product is absorbed in the market. This implies that the product is used repeatedly and that the consumers are satisfied with the product (Darso, 2001:103).

At this stage of the innovation process the innovator achieved success. Only once the product idea was turned into a product with which consumers are satisfied and therefore regularly purchase, the innovator has successfully moved through the innovation process.

What is essential at this stage is to determine whether everything went as planned in step 2 (Planning and direction setting) and what lessons can be learned for future innovations. The next step therefore is post-launch check-up.

Step 20: Post-launch check-up

During this phase the entrepreneur needs to determine whether the goals set during the planning and direction setting step where achieved. It is important that the innovators determine whether the new product yielded the returns that where anticipated, whether the consumers are truly satisfied with the product and what they could have been done more efficiently or differently all together (Davis and Moe, 1997: 347).

Many innovators tend to omit this step, as they believe that if they were successful in commercializing an innovation once, they will always remain successful. This is a fallacy and innovators should always learn from past, completed product projects. There can always be a lesson to learn on how to improve the process or how to avoid certain mistakes in the future.

It is vital that innovators realize that although following the steps in the innovation process will improve their chances of success, there is no guarantee that the product idea will be a success. There are a variety of factors that influence successful innovation and commercialization of that innovation and innovators must be aware of these factors.

A tool referred to as the "P" diagram was developed to explore the factors that influence innovation. A discussion of the "P" diagram follows in the next section.

2.6 Product innovation – controlling factors

A useful tool that has been developed to explore the factors that have an effect on innovation is called the "P" diagram. The "P" diagram plots the innovation process in such a way that the important parameters that can have an influence are highlighted (Cumming, 1998).

Figure 2.4 shows the configuration of the "P" diagram. In this diagram, the system is shown as having three factors acting upon it. These factors are signal, control and noise. The two potential outputs associated with this diagram are response and error (Cumming, 1998).

Each of these components will be discussed in more detail below.

- Signal: This is the input that causes the system to function. In other words, the signal is the idea, a customer want that can be shown to be correctly addressed by this idea, and an understanding that the development of this idea is compatible with the corporate strategy.

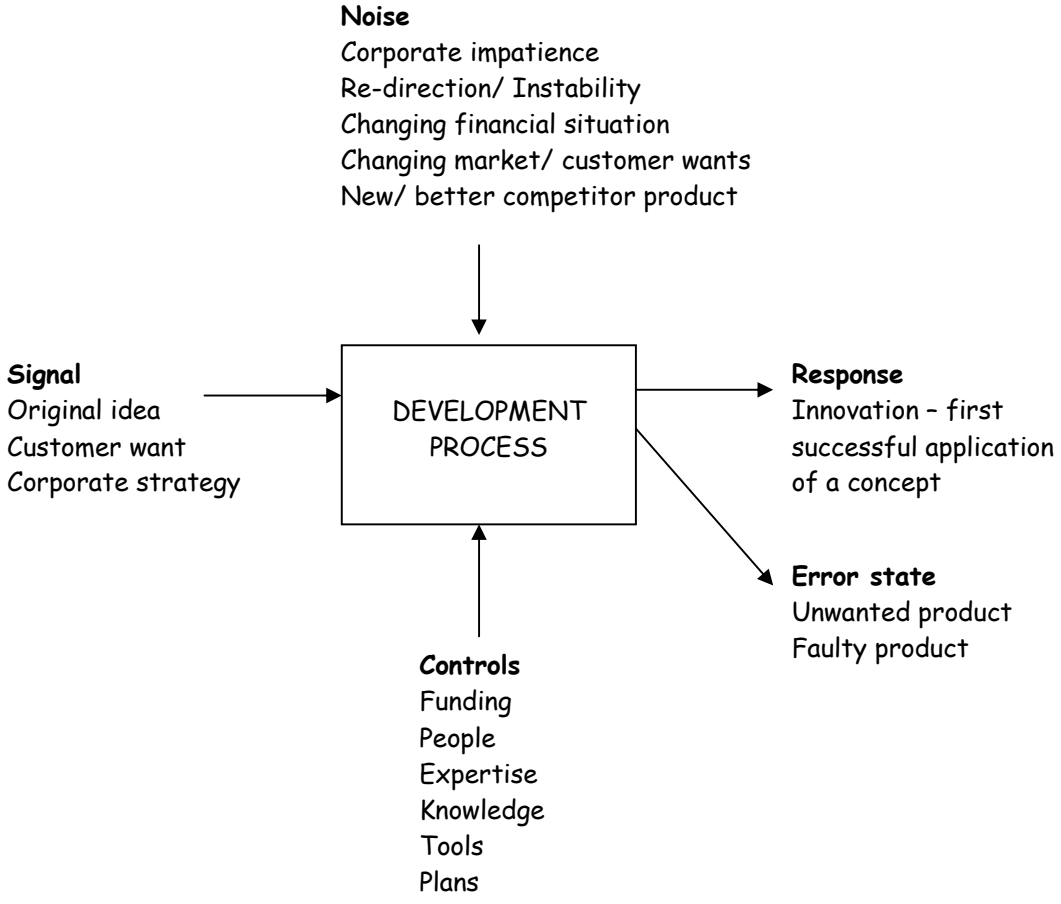
- Controls: These are the features in the system that can be controlled. It is the resources that can be used to transform an idea into an innovation. Examples of controls include finances, people and equipment. Failure is likely when one of these aspects is missing or inadequate.

- Noise – Noise involves the factors that influence the system, but over which an entrepreneur has no or little control. Examples of internal noise factors include failing confidence in the innovation, concern over the cost and waning support. The environment in which the entrepreneur operates contributes to the external noise factors. Examples of these noise factors include changes in customer needs and wants, changing/improving technologies and legal requirements.

- Response – This is the desired outcome. The ideal response is the successful commercialization of an innovation, in other words, the successful adoption of a product.

- Errors – These are possible unwanted outcomes, for example, a faulty product (Cumming, 1998).

Figure 2.4: The "P" Diagram



Adapted from Cumming, 1998.

As commercializing innovation is a tiresome process with such a wide variety of factors influencing successful commercialization of a product, many authors have identified guiding principles for innovation. These principles will not provide innovators with a fail-proof plan; it will, however, improve their chances of success – especially if it is incorporated in the innovation process as mentioned above.

2.7 Guiding principles for innovation

For innovators to commercialize an innovation successfully it is important that they keep the following guiding principles in mind as they go through the process.

Firstly, failure is an intrinsic part of innovation. Keeping the high failure rates of new innovations in mind, it is clear that one will fail numerous times before one successfully commercialize an innovation (Davis and Moe, 1997: 338 – 361).

Secondly, innovators who follow a strategy in commercializing their innovations are more successful than those who do not. Knowing where one is heading with an innovation and identifying the important aspects to help one achieve that, is paramount to one's success. A systematic, well-defined and commonly understood new product development process is a given for successful innovation (Davis and Moe, 1997: 338 – 361).

Thirdly, innovators who continuously monitor their expenditures and planned vs. actual performance will achieve better success than those who do not. It is important to measure the return on investment as one moves through the process to ensure that it remains worth the while to commercialize the innovation (Davis and Moe, 1997: 338 – 361).

Fourthly, previous research warns that innovators should not start the innovation process with idea generation. Too easily innovators will be impressed by their own thinking without ensuring that there truly is a need for the innovation. It is best to start the process with consumer or customer "problem identification". In this way innovators know that there is a need that their innovation can satisfy (Davis and Moe, 1997: 338 – 361).

To add to this list, Drucker (1995:123 – 125) identified several actions that innovators should take for successful innovation. Firstly, innovation begins with the identification and analysis of opportunities. All the sources of innovation should be studied; it is not sufficient to only be alert to these sources. Successful innovators build on their strengths. They identify all the opportunities and then determine which one will fit their set of strengths the best. The importance of building on one's strengths lies in the fact that commercializing an innovation entails many risks and an entrepreneur should be knowledgeable (Drucker, 1995:126 – 127).

Secondly, Drucker (1995:123 – 125) argues that innovators must determine what the innovation must be to satisfy the opportunity, but also what the customer's needs and wants are. The innovation can only be a success when the financial and technical side as well as customer satisfaction is in place. Innovation is aimed at satisfying customer needs and to ensure that one is accurately satisfying the needs, it must be market-driven (Drucker, 1995:125-126).

Thirdly, for an innovation to be successful it should not be too complicated, but rather, simple and focused. In other words, an innovation should not attempt to be everything for everyone, but rather to satisfy a given need in an identified group of customers. Innovations have to be handled by ordinary human beings; anything too clever, whether in design or execution, is likely to fail (Drucker, 1995:125-126).
Furthermore, innovations that lose their focus become dispersed and are bound to remain ideas and not become innovations (Drucker, 1995:125-126).

Fourthly, innovations should start small and not require too much capital, time or people. In this way, changes can be made to the innovation without suffering great financial losses.

Fifthly, an innovation should aim at leadership. Starting small does not imply small profits or market share. In order to create a winning innovation the entrepreneur must aim at market leadership in the given market (Drucker, 1995:123 – 125).

Lastly, Drucker (1995, p. 125 – 126) advises that innovators should not aim at innovating for the future. They should, instead, focus on the present needs and capabilities.

It is important to remember that innovation demands hard work and diligence and in the absence of these no innovation, regardless of how novel it is, will succeed. There are numerous examples of innovators who had wonderful product ideas, but because they lacked the knowledge or discipline to closely follow the steps in the innovation process and take note of the factors influencing the innovation, they were unable to achieve success.

2.8 Summary

In this chapter the importance of innovation was once again highlighted. Economic growth, the successful competition of organizations and the creation of wealth for individuals are all examples of the benefits of successful innovation. Apart from the benefits of innovation, there is also pressure on organizations and individuals alike to produce a steady stream of innovations in order to remain competitive. However, the successful commercialization of innovation remains a big problem for innovators.
Although there is a wide variety of research available on innovation, the rate of successful innovation remains very low. It was argued that some factor(s) must be missing from the current available research and therefore, an innovation process was

created by combining the steps of several innovation processes in order to help innovators improve their chances of success.

Furthermore, factors that influences innovation as well as guiding principles for innovation was identified to further inform innovators on aspects that they should take note of. The innovation process, as outlined in this study, as well as the identification of factors influencing innovation along with the guiding principles will not guarantee success to innovators. However, if innovators follow these steps and take note of the external factors that influences them during the innovation process, they can significantly increase their chances of successful innovation.

Chapter 3

Commercialization

3.1 Introduction

The timely discovery and successful application of new products are vital for economies, organizations of any size and individuals that wish to compete and prosper in the 21st century global economy. The importance of introducing new products to the market can be seen in the fact that it builds a sustainable competitive advantage for organizations and individuals. Furthermore, these new products does not only lead to profits for individuals and organizations, but it also improves the quality of life of all individuals and generate further economic opportunities (Chapter 4 - Moving forward on the Priorities of Canadians – The Importance of Knowledge and Commercialization, 2004; Innovation and Commercialization, 2001).

A key challenge for owners/managers of all organizations and individuals is to take new products through the process of value creation and to produce economic returns. This implies that the main challenge is not so much invention (coming up with the new knowledge), but successful commercialization, as very few inventions become a commercial success (Vercauteren 2009). The importance of commercialization is also underscored through this as ideas or inventions cannot generate economic returns for the innovator. Only when the invention is successfully absorbed into the marketplace can profit be derived from it.

However, globally the failure rates of new products are especially high, preventing innovators from gaining financial benefits. New product failure rates are estimated at between 50-80% and even major companies with sufficient resources evaluate 58 internal proposals for new inventions of which only 12 ideas will pass initial screening. Of the 12 remaining ideas, only one successful new product will emerge. Further research found that from 100 ideas submitted for evaluation by innovators, 85 ideas had too many faults to even consider and can be eliminated immediately. From the remaining 15 ideas it is estimated that only five will be produced and only one of the five ideas might be a success (Can You Make Money With Your Idea or Invention, 2007).

The high failure rates of inventions can be attributed to a wide variety of factors, including limited access to resources, failure of innovators to sufficiently protect their inventions or weak marketing efforts, among others. One such reason for failure, however, is the fact that innovators are unsure about the steps to follow in commercializing an invention. Innovators either take false steps and waste valuable time, or they leave out critical steps in the process.

It is important for innovators to know what the steps in the commercialization process are and to follow them, in order to ensure that they follow a logical process, plan for all

the important aspects regarding commercialization and are aware of what will be required of them at the different stages in the process.

Before the commercialization process can be discussed, it is important to define the term commercialization. The next section focuses on the definition and description of the term commercialization.

3.2 Commercialization defined

Commercialization is the process whereby new research discoveries are developed into new products, services or technologies and brought successfully to the marketplace (Chapter 4 - Moving forward on the Priorities of Canadians – The Importance of Knowledge and Commercialization 2004; Courtois, 2004). Thus, an invention must be taken from idea phase, to prove of product, to successful application in the market.

While the importance of successful commercialization is not contested, it is a daunting task to identify a truly new and unique invention, enlist the support needed and to commercialize the invention successfully. Innovators tend to be skeptical about new ideas given the high failure rates of innovation and the fact that commercialization is a very intricate process. Furthermore, the commercialization challenge is a complex one as it is a process that is haphazard with risks and uncertainty (Can You Make Money With Your Idea or Invention, 2007; Courtois, 2004).

In addition, the highly competitive and rapidly changing environment has resulted in the trend to shorter product life cycles and this puts additional strain on the commercialization process, as it has become an immense challenge to keep up with the faster pace of commercialization. The fact that SMMEs are vulnerable to environmental factors, as they have less market power than large organizations, increased the necessity for SMMEs to innovate and successfully commercialize these innovations in a timely manner (Pellikka and Virtanen, 2004).

To overcome the abovementioned challenges, knowledge regarding the factors influencing commercialization and the commercialization process is vital. In order to get an innovation successfully to the market, it is not sufficient to create an invention, one has to ensure that the invention meets a genuine market need. In other words, knowledge on the market and the needed technology must be integrated in order to satisfy the real needs and preferences of customers (Vercauteren, 2009).

Keeping the abovementioned in mind, it is crucial to find not only a faster route to commercialization, but to construct an encompassing commercialization process that will improve an innovator’s chances of success.

In the next section the literature regarding the commercialization process is discussed.

3.3 The commercialization process

Developing products rapidly and moving them into the marketplace efficiently is imperative for long-term success for organizations and individuals. The commercialization process, if understood and managed efficiently, enables organizations and individuals to introduce innovations to the market in a timely manner. This will enable organizations and individuals to obtain a sustainable competitive advantage in the marketplace (Rogers, Lambert and Knemeyer, 2004).

However, while the importance of the commercialization process is clear, the path from idea generation to commercial success remains a relative mystery for all innovators. No existing roadmap, process or model provides the all-in-one guidance that is necessary to use resources efficiently to transform inventions into commercial success as the problems of commercialization and their connections with the process of commercialization are a rather uncharted research field (Pellikka and Virtanen, 2004; Technology commercialization framework, 2004).

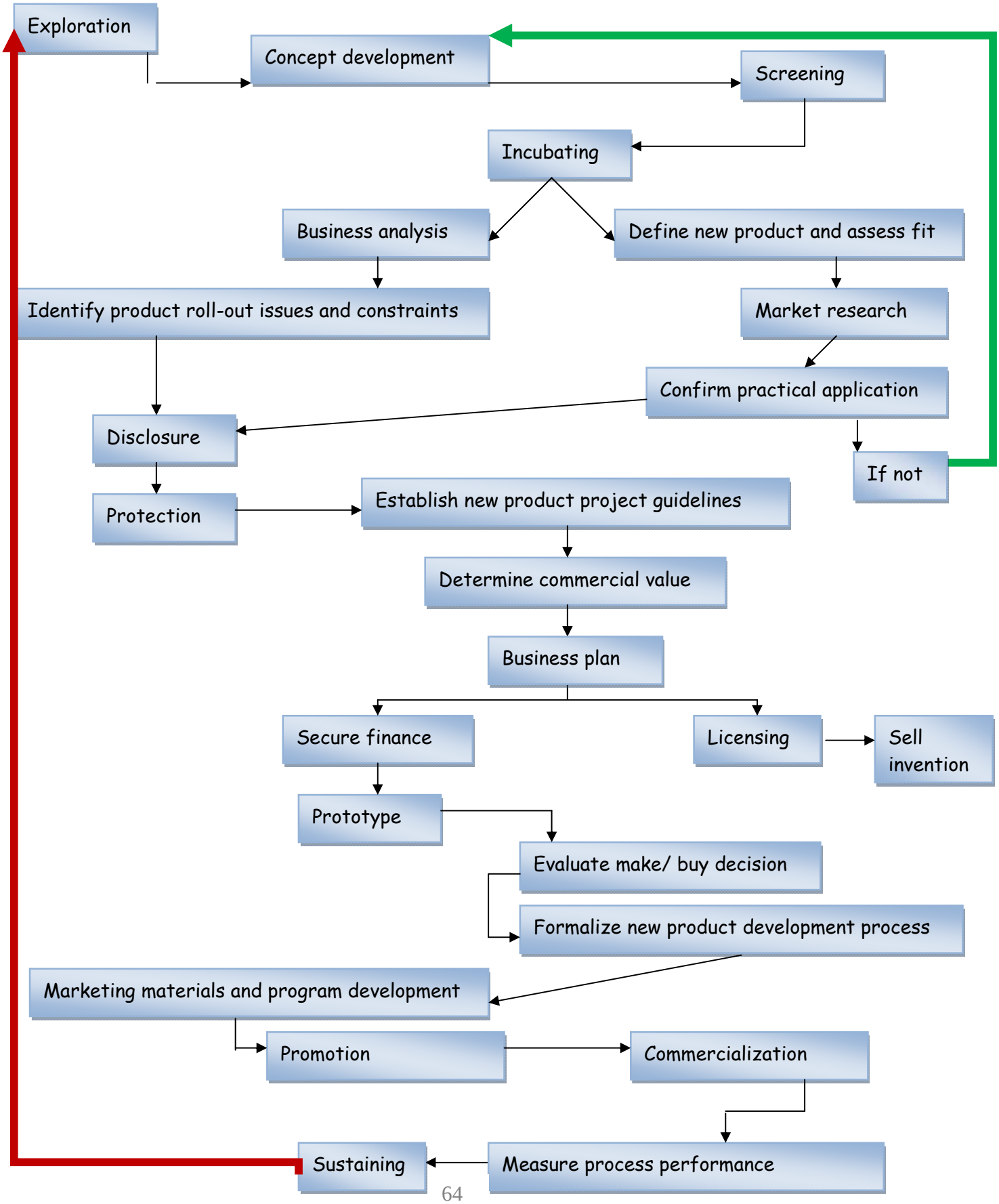
It should be noted that a large number of models and methods have been introduced to improve innovators' performance of commercializing innovation, but regardless of these models, the commercial success rate of new products is still very low. New product models and methods may help to identify problems at an early stage and assist in directing the commercialization effort in the right direction, but the use of new product models and methods in themselves will not guarantee success (Nijssen and Lieshout, 1995: 27 – 28).

Innovators typically have very limited financial and human resources and often the innovators start the process with only their personal savings and no employees to help achieve success. On average, these innovators cannot afford to make mistakes in the commercialization process and to start over. Therefore, it remains a crucial challenge to enhance the commercialization process and to help innovators commercialize their invention successfully.

In the following section a new commercialization process, which is a combination of the work of several researchers, is proposed. Through research done it is clear that there is very little agreement among researchers on what steps should constitute the commercialization process. While there are several steps in the different processes that are overlapping, it often happens that certain steps are omitted by one researcher, but included by others.

The relevance of this proposed process is that it combines several different approaches to ensure that the steps that were omitted in one model are included and that an innovator implementing this process can be sure that all the relevant steps of the commercialization process are included. Each of the steps of this commercialization process is outlined in figure 3.1 (Author's own construction) and will be discussed in greater detail in the subsequent section.

Figure 3.1: A schematic illustration of the commercialization process



3.3.1 Discussion of the commercialization process

The commercialization process as outlined in figure 3.1 will now be discussed in greater detail.

Step 1: Exploration

In this step the search for invention ideas is launched. Once the innovator has identified a concept it is crucial that research is done on the concept, the technology needed to produce the concept and the market opportunity for which the concept is developed. Through this the "proof of principle" must be generated, which implies that there is a need, as well as the technology, for the concept that was generated and further exploration is demanded.

Innovators must consider the commercialization potential early in the discovery process. Even at this early stage in the commercialization of invention it is important to determine how the invention will be accepted in the market and to build the voice of the customer into the invention.

The outputs of this step are objectives that will drive the concept development and screening procedures. In other words, if, after the invention underwent screening and there is a need for the invention, the concept can then be developed further (Rea and Kerzner, 1997: 159 – 160; Technology commercialization framework, 2004).

Once several inventions have been identified, the innovator must move to the next step in the commercialization process, i.e. concept development, where the potential of an invention is placed under scrutiny.

Step 2: Concept development

During this step, the commercial potential of an invention must be further researched. While investigating the commercial potential of an invention, it is important that the innovator does not make public disclosures regarding the innovation, as the invention is not yet protected.

It is important to create a concise description of the opportunity in this step. The product or service that will be sold, the target market, value proposition and distribution channel must be determined in great detail.

To ensure that there is sufficient market potential for one's invention - in other words, whether the market size is sufficient to make the invention profitable - a feasibility analysis of the invention must be conducted.

According to the University of Oregon's Innovation Centre, the areas and factors that should be considered when determining the commercial potential of an invention can be divided into 33 areas. These 33 areas that each invention may be submitted in order to determine whether it has commercial merit are summarized in table 3.1.

Table 3.1: Areas for determining the commercial merit of an invention

Factor	Description/remark
Legality	Will there be legal problems commercializing your invention?
Safety	Are there safety issues that may scare away licensing companies?
Environmental impact	Will your invention have a positive or negative effect on the environment, and how will this affect the commercial potential?
Social impact	Will your invention have a positive or negative effect on society and how will this affect the commercial potential?
Potential market	Who will buy your invention?
Product life cycle	Does your invention's usefulness diminish over time?
Usage learning	How long does it take to learn how to use your invention?
Product visibility	Will your product have a distinctiveness so as to stand out in the marketplace?
Service	Will your product provide a valuable service?
Durability	How sturdy is your invention? Will it require frequent maintenance?
New competition	What is the likelihood of new competitors appearing once invention is commercialized?
Functional feasibility	How workable is the functional aspects of your invention?
Production feasibility	How practicable is it to produce your invention for sale?
Stability of demand	Will demand for your invention die off over time?
Consumer/user compatibility	Will consumers find that your invention is compatible with their needs of lifestyle?
Marketing research	What does marketing research indicate?
Distribution	How can your invention reach consumers? What types of distribution are available?
Perceived function	What do you perceive as the invention's primary function? Will consumers perceive this as its function as well?
Existing competition	What competition exists now?
Potential sales	Do you have any way of estimating potential sales?
Development status	In what stage of development is your invention?
Investment costs	What type of start-up expenses do you anticipate in order to manufacture the device?
Trend of demand	What do consumer trends indicate for the demand for your invention?

Product line potential	Is there a potential to expand your invention into a line of products?
Need	Is there a need for your invention?
Promotion	What type of promotion is needed to sell your invention?
Appearance	Does your invention's appearance add to its commercial appeal?
Price	Is your invention affordable to the relevant market?
Protection	What forms of legal protection are available for your invention?
Payback period	How long will it take to receive a payback on your invention?
Profitability	What is the margin between the cost and the sale price?
Product interdependence	Is your invention dependent on or related to another device or product?
Research and development	Is further research and development necessary before your sell the invention?

After the innovator answered the questions in table 3.1 it can be assumed with more certainty that the invention can be a commercial success if the innovator completes the rest of the steps in the process thoroughly.

Furthermore, it is vital that innovators ensure that their idea is original. Once it has been established that there is a need for the invention in the market and that the technology exists to produce the invention, it is important to ensure that there is not a better or even similar product as the invention on the market. This can be done by commencing a patent search. Patent searches can be done via the internet, in stores and catalogues, trade shows, in business and the popular press as well as trade associations and trade publications, or by performing an abstract search of the Patent and Trademark Office/s or patent lawyers (STC.UNM Connecting the marketplace and the University of Mexico, n.d.; The Commercialization Handbook: An introductory guide for researchers; Can You Make Money With Your Idea or Invention, 2007; Rensselaer Office of Technology Commercialization, n.d.).

At the end of this stage it is possible that the innovator could have several inventions that meet the listed criteria. To then decide which of these inventions to pursue further, the innovator must move on to the next step, namely screening. Should an innovator have only one invention that conforms to the criteria, the screening step can be omitted and the innovator can move directly to the incubation step.

Step 3: Screening

After the innovator identified potential inventions, the screening process must begin. Screening entails an analysis to determine which inventions have commercial potential and merit further research and poor, unsuitable, or unattractive ideas are weeded out from further actions.

It should be noted that there are several opportunities during the commercialization process to abandon an invention should it prove to have insufficient potential, but individual innovators cannot afford to incur costly product development failures. Thus, an invention with insufficient potential must be avoided at all costs and not merely cut after costs were incurred.

After inventions with sufficient potential are identified, these inventions must be screened. In today's competitive environment many organization implement a new-product screening checklist for preliminary evaluation of the invention. There are several examples of new-product screening checklists available, however, the innovator should resist implementing a standardized checklist. Instead, the innovator should include the new-product attributes that the innovator views as the most important and compare each invention with these attributes (Rogers, Lambert and Knemeyer, 2004; Rea and Kerzner, 1997: 159 – 160; Winning at new products: Accelerating the process from idea to launch, n.d.).

Once the screening process is completed, the inventions with the most potential moves to the incubation stage where the technical and market validation of the inventions starts.

Step 4: Incubating

Once the inventions with sufficient market potential have been identified, the incubating step commences. During this step several activities must be completed and these include:

- Definition of technical and product performance specifications. This entails clearly stating what technical requirements must be adhered to and exactly what the product will do.
- Validation of technical capabilities in terms of the performance specifications. Thus the performance specifications must be producible given the technical capabilities that are available to produce the product.
- Further validation of the market and related commercial concept/business plan. In other words, the innovator must validate the opportunity given the commercial concept, the needs of the market and the capabilities of the innovator.

After these activities had been performed it is possible that several inventions will once again be eliminated due to insurmountable technical and/or market obstacles or because the resources of the innovator are limited.

Even after an invention(s) moved through the incubation step successfully, it is no guarantee that this invention will be a success. The risk involved in this invention is still enormous, but in order to progress to the next steps in the commercialization process the need for capital increases. This is a major problem for innovators, as their invention must still generate proof to attract investors and money is needed to create the proof needed (Technology commercialization framework, 2004).

At the end of this step the focus of the process temporarily moves slightly from the invention to the business/innovator to ensure that the innovator has sufficient resources (which include people and money) to continue this process.

Step 5: Business analysis

During this step the basic invention must be transformed into a concrete business recommendation. The analysis in this step is much more detailed than in the screening step and the product features, financial analysis, risk analysis, market assessment, and a program for the product must be determined.

The factors that should be in the business analysis stage include demand projections, cost projections, competition, required investment and profitability. When demand projections are determined, the innovator establishes the potential size of the market to which the invention will be sold. Cost projections entail estimating what the expenditures will be to create and commercialize the invention. When the competition is analyzed, innovators must identify every product that can compete directly and indirectly with their invention for market share. When the required investment and profitability are determined, the innovator must predict what profit potential of the invention is allocated to the demand, cost and competition projections.

During this step the fit of the product with the organization or innovator must also be established. There must be certainty that the organization or innovator has the needed skills, resources and knowledge to pursue this invention further (Rea and Kerzner, 1997: 159 – 160).

If at the end of this step, after a thorough financial, market and risk analysis, the innovator is convinced of the commercial merit of the invention and the next step in the process can begin. During this step the product's fit in the current market setting is established.

Step 6: Define new product and assess fit

At this stage in the commercialization process, the inventions are already generated, screened and the invention that can successfully be pursued by the innovator and satisfy a market need, has been identified.

Further market research should now be done to determine the fit of the invention with existing channels, manufacturing, and logistics. It is important to do this in collaboration with key role players such as customers and suppliers (Rogers, Lambert and Knemeyer, 2004).

It should be noted that inventions that demand a completely new way of manufacturing, distributing, etc. must be scrutinized again, as the risk involved in such an invention is very high. Inventions that can easily fit into the current market setting can move to step 7 where product roll-out issues and constraints are identified and addressed.

Step 7: Identify product roll-out issues and constraints

During this step, the pinch points that will impede the invention development or commercialization process are determined and solutions to these problems must be generated. The pitfalls that may hamper successful commercialization must be identified to ensure that the invention is introduced to the market in a way that will ensure success.

The market must be scrutinized, the promotion efforts must be planned and inventory must be accumulated and the deployment thereof planned. Furthermore, the innovator must do capacity planning and if a sales force will be necessary, they must receive the needed training.

At this stage of the commercialization process, there needs to be close contact with the customers to determine how the invention will impact key customers and whether the invention will be accepted. Thus, it is important to develop formalized customer feedback programs (Rogers, Lambert and Knemeyer, 2004).

The interaction with customers to determine how the invention will be accepted in the market is the beginning of market research. In the next step, in-depth market research must be done to determine the true commercial value of the invention.

Step 8: Market research

Kotler and Keller (2006, p. 102) defines market research as “the systematic design, collection, analysis, and reporting of data findings relevant to a specific marketing situation facing the organization”. Market research can identify specific problems and opportunities for innovators.

During the market research step, the technical and commercial analysis of the invention is performed. This generally includes patent and literature searches, and may include confidential discussion with internal and external experts. The information gathered in the market research step is vital to the innovator as the need for the product is confirmed and the uniqueness of the invention is definite.
After the market research has been done, the size, growth, and profit potential of each market opportunity must be measured and sales forecasts can be made. If the market research is not up to standard, poor forecasts will be made which can lead to either excess inventory or inadequate inventory.

It is important to determine the size of the market the invention will be sold to. In order to determine the size of the market the innovator must distinguish between the different markets that exist:

- The potential market
  - A group of people who expressed a sufficient level of interest in the invention, but the interest is not enough to define a market.
- The available market
  - The set of consumers who have interest, income and access to the specific invention.
- The target market
  - This is comprised of the part of the available market that the innovator focuses on
- The penetrated market
  - The set of consumers who are buying the invention (Rensselaer Office of Technology Commercialization n.d.; Kotler and Keller, 2006:102; Kotler and Keller, 2006: 125).

During the market research step the consumer is presented with a proposed product and attitudes and intentions are measured at this early stage. This is a quick and inexpensive way of measuring consumer enthusiasm. It asks potential consumers to react to a picture, written statement, or oral description of a product. This enables a firm to determine initial attitudes prior to expensive, time-consuming prototype development. When this step of the commercialization process is completed, the innovators can be sure whether or not a market exists for the invention. From this point the invention must be transformed into a product, as the interest in the market is sufficient to justify the costs that will be incurred.

Step 9: Confirm practical application

The research findings must now be further developed to confirm the practical application of new technologies, products or processes. This implies that the idea-on-paper is turned into a product-in-hand.

This product is demonstrable and producible and problems that were not anticipated by the innovator while the product was still in the invention phase, can now be identified and corrected before a faulty product is sold to the target market. In some instances, the problems that are identified cannot be overcome and the invention must be rejected (Rea and Kerzner, 1997: 159 – 160).

In the next step this demonstrable and producible product can be disclosed to the Patent Administration Office.

Step 10: Disclosure

An invention must be disclosed as soon as the invention is clearly conceptualized or it is confirmed to be a demonstrable and producible product. Before the innovator talks about the invention, whether it is in publications or conversations, even if it only contains part of the whole invention, it is essential that the innovator first disclose the invention.

When an invention disclosure form is completed, the innovator must ensure that a complete description of the invention, dated signatures of all inventors, dated signatures of witnesses who understand the invention, and the dated signature of the department chair is included in the disclosure in order to develop a patent application. Because the disclosure is the initial formal record of a discovery, it must be completed as thoroughly as possible.

Innovators must be aware of the fact that should someone else find out what the invention could be used for due to improper public disclosures of the innovator, and pursue the opportunity, it can prevent an innovator from gaining an issued patent (STC.UNM Connecting the marketplace and the University of Mexico, n.d.; Rensselaer Office of Technology Commercialization, n.d.).

In the next step the innovator must legally protect the invention to prevent others from stealing the invention or producing something similar to it.

Step 11: Protection

Once an invention with significant commercial potential is identified, it is essential to prohibit others from making or selling the invention by protecting the intellectual property. Even though protecting the intellectual property behind an invention and introducing it to the marketplace requires a significant investment of time and resources, it is the only legal way to protect an invention and therefore worth the expenditure.

The decision to pursue patent protection is based upon the following three factors 1) Scientific and technical merit of the invention, 2) marketability and commercial potential of the invention and 3) patentability and ability to enforce the patent.

Innovators should note that ideas or suggestions cannot be patented. For an invention to be patentable, it must meet the following main criteria:

- It must be novel. In other words, the innovator must be the first and only person to think of and pursue such an invention.
- The invention must be non-obvious. The invention must be a new combination of features and/or give new and non-obvious results compared to known approaches.
- Utility. The invention must be useful to be patentable. The invention must perform a function, do what it says it does and have some benefit.

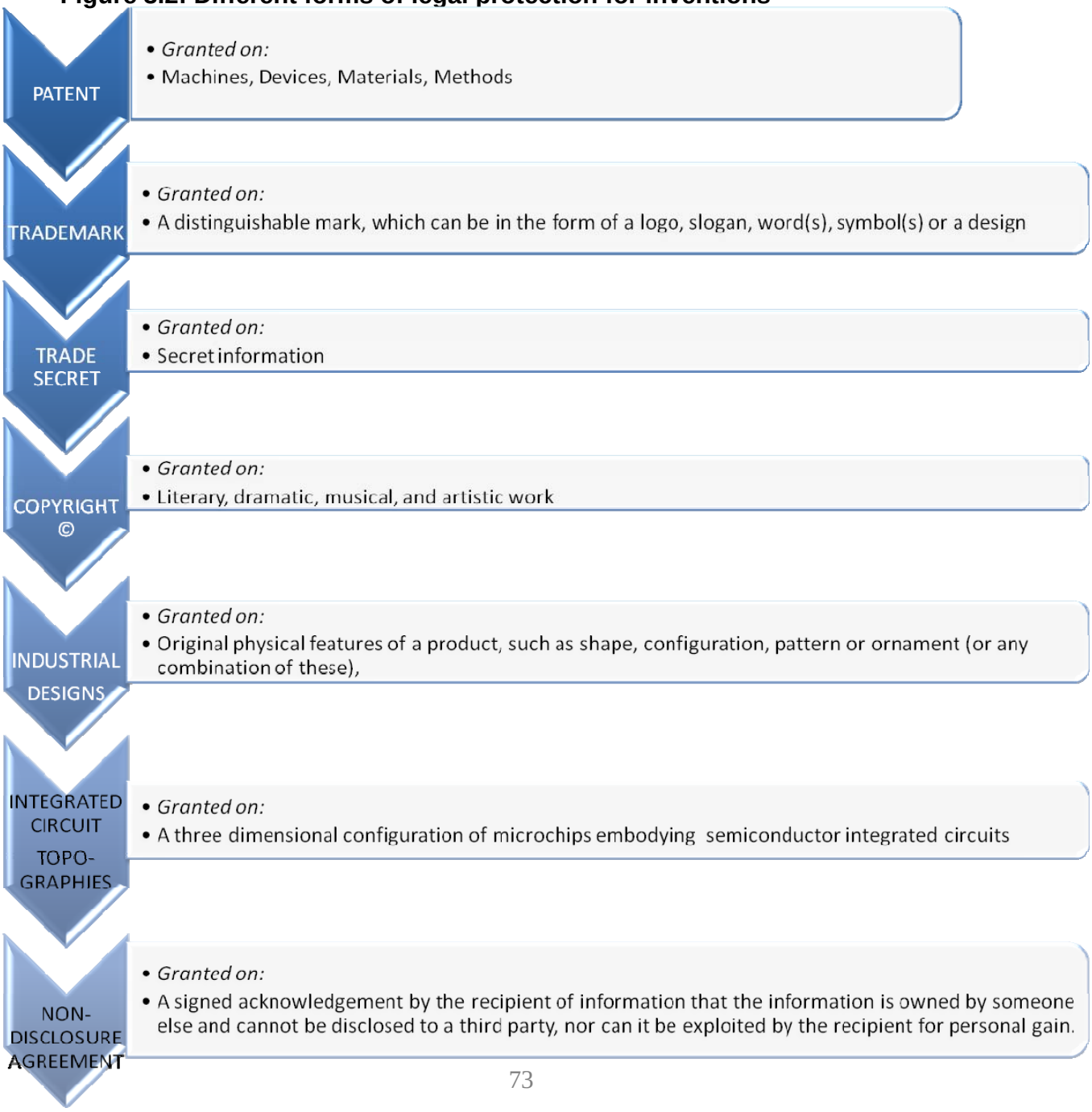
In order to protect the intellectual property of an innovator, an outside firm may be contracted to do the filing and prosecution of the application. Innovators should note that their co-operation is vital for the successful filing and prosecution of intellectual

property as the innovator must ensure that all the relevant detail and the function of the invention is accurately protected.

Once the invention has been successfully protected, the innovator can continue on the commercial process, knowing that the invention is safe. The next step is to establish product project guidelines.

Most innovators consider patenting to protect intellectual property; however, there are several means available to protect intellectual property successfully. In figure 3.2 the different forms of protection along with a brief description of each can be found (Rensselaer Office of Technology Commercialization n.d.; Intellectual Property 2008; The Commercialization Handbook: An introductory guide for researchers).

Figure 3.2: Different forms of legal protection for inventions



Step 12: Establish product project guidelines

Expectations of how the invention will perform in the market are now established.
During this step it is essential to determine the following:

1) The potential profitability of the invention. This includes the time needed to achieve profit as well as projections on how much profit to expect.
2) Timeline guidelines. As already mentioned, the time to profitability must be determined, but the time-to-market including when certain phases of product development must be completed, must also be determined.
3) Implications for human resources. The innovator might assume that he/she will be able to manage the process alone, but once the estimations regarding the invention was made, realize that additional human resources are needed.
4) The budget. The innovator must determine how much money, and other resources, will be needed at each stage of commercialization.
5) Initial sales. The innovator must anticipate how the target market will react to the invention when it is first introduced to them.

The outcome of this step provides the blueprint for the implementation of the commercialization process (Rogers, Lambert and Knemeyer, 2004).

At this phase procedures for analyzing the total cost of product development and commercialization are developed and the impact of new products are analyzed. Once the innovator has the insurance that the invention can be a success given the resources (both financial and non-financial) needed and the time to profit, the next step, where the commercial potential is validated, can commence.

Step 13: Commercial value

As mentioned, the commercial value of the invention is confirmed in this step of the commercialization process. Production, service, distribution, sales and marketing are the activities that must be in place during this step.

At this stage, the invention is offered for sale in one or more selected areas and the actual performance is monitored. The purpose of this step is to evaluate the performance of the invention, but also to pre-test marketing efforts in a real setting (Technology commercialization framework, 2004).

Should the opportunity generate positive business results during this step, the innovator can move to the next step in the commercialization process in order to introduce the invention to the full target market.

Step 14: Business plan

A business plan is an essential element of the business development process. It involves a significant amount of research concerning the costs, pro-forma revenues, customers, competitors, economic conditions, marketing, milestones, partners, and employees.

When an innovator creates a business plan, the following needs to form part of the document:

- a description of the business concept;
- the products or services of the business-to-be;
- the possible market for such products or services;
- the operational and financial plans for the new venture;
- a description of the management team; and
- a schedule for the implementation of the plan.

Business plans are used for various purposes such as to determine the chances of business success, to raise capital, and as a schedule for the business start-up and growth.

According to Van Aardt et al. (2008:154) further reasons for developing a business plan includes:

- The process of formulating a business plan helps the innovator to work efficiently, as thorough planning is needed to create a business plan.
- The business strategy is developed and updated as the efficacy of ideas and approaches are constantly assessed.
- The goals that the innovator sets in the business plan motivates the innovator to show progress
- The innovator acquires an understanding of everything that needs to be done in order to manage the business effectively.

A business plan is essential to ensure that the innovator has thought trough the process as well as all the advantages and disadvantages of the invention and the commercialization thereof. It helps the innovator avoid false steps or losing focus.

Step 15: Licensing

There are many routes that can be pursued to commercialize an invention. These include selling the invention to big national companies, producing the invention and selling it from home, or taking the invention to small and medium-sized businesses.

An innovator can decide which route to pursue to commercialize an invention based on many factors. These factors include:

- The stage of development of the invention
- The state of the industry
- The number of markets to which the invention may be applicable
- The marketplace conditions
- Attributes of the technology
- The expertise of potential entrepreneurs
- The availability of funds
- The applicability of the invention to be a foundation for a larger product stream
- Type of intellectual property protection that can or should be pursued
- The applicability of an invention as the basis for a new company (vs licensing)

- The inventor's goals and interest with respect to the invention (Innovation and Development Corporation n.d.; Can You Make Money With Your Idea or Invention, 2007).

The innovator should note that large companies are rarely interested in, for example, an invention that is only in the idea phase of development or inventions that require new or unique technological features. And therefore, in some instances, it is the characteristics of the invention rather than the intentions of the innovator that determine the best route to commercialization.

Step 16: Secure finance

Money is critical for commercializing an invention and an innovator can obtain access to funds either internally or externally.

Internal sources of funding include when innovators use their own capital contributions, investments by shareholders or co-founders or when innovators sell shares of their invention in order to obtain funding.

The other source of finance is external sources, which are obtained from sources outside the enterprise. The external sources include long or short term loans from financial institutions, for example commercial banks, start-up grants from business development agencies, leases, trade credit from suppliers or bank credit.

In order to determine the financial needs, the innovator will have to forecast the future. There are three steps involved in predicting the financial requirements, namely: 1) project the sales, revenues and expenses over the planning period; 2) estimate the levels of investment in current and fixed assets that are necessary to support projected sales and 3) determine the financing needs throughout the planning period (Van Aardt et al. 2008: 7; 192; Nieman and Nieuwenhuizen, 2009: 172).

It is important that the innovator do the financial forecasting as accurately as possible to avoid applying for too much finance and being rejected or applying for too little finance to be able to commercialize the invention.

Once the innovator has access to sufficient money to finance prototype development, the next step in the process can begin.

Step 17: Prototype

Prototypes are made to generate technical and market proof of an invention. Prototypes are mock-ups of the actual inventions and are created to help the innovator identify any errors that might be in the design or application of the invention. It is much less expensive to create a prototype and identify and rectify possible mistakes, rather than develop the actual product and selling a faulty product to the market.

Working prototypes, performance according to commercial specifications, manufacturability within defined cost and quality standards and generating evidence

that customers will buy the product characterize the goals of this step (Technology commercialization framework, 2004; Rea and Kerzner, 1997: 159 – 160).

Once the innovator is satisfied that the working prototype is good enough to start production, the next step can begin. During the evaluation of the make/buy decision, the innovator must decide whether the entire invention will be produced or whether certain aspects of the invention will be bought.

Step 18: Evaluate make/buy decision

Once the prototypes have been evaluated, the decision needs to made whether the product will be manufactured in-house, whether the whole product must be bought from suppliers or whether portions of the product will be bought from suppliers. In most instances the costs involved in the process or the need to retain product knowledge influences the decision of the innovator (Rogers, Lambert and Knemeyer, 2004).

After the innovator has decided what routes to follow to produce the product, the development process can begin. If an innovator decides to produce only parts of the invention in-house, the development process will differ drastically from when the innovator decides to produce the entire invention in-house.

Step 19: Formalize the development process

The development process is formalized when the innovator decides what methods, machinery and/or technology is needed to efficiently develop the invention (Rogers, Lambert and Knemeyer, 2004).

During this step it is important that the innovator takes the available resources, knowledge and time into account. The development process chosen must complement the situation and the innovator. In most instances several possible technologies, methods and machinery are available to produce an invention. The key to successful commercialization is that the innovator, keeping the metrics of time-to-market and time to profit in mind, decides on the best possible way to develop the invention into a viable product. When this important step is completed, innovators must turn their attention to the marketing of the invention.

Step 20: Marketing materials and program development

Kotler and Keller (2006: 16) emphasize that: ”The marketing concept holds that the key to achieving goals consists of the company being more effective than competitors in creating, delivering and communicating superior customer value to its chosen target markets.”

In order to achieve the abovementioned, it is important that innovators focus on several factors during the marketing material and program development. These factors include:

- The needs (basic human requirements), wants (specific objects to satisfy the need) and demands (wants for a specific product backed by the ability to pay) of the target market.

- Identifying market segments, which entail dividing the total market into distinct groups of buyers who might prefer or require their product.
- A value proposition needs to be created. Thus, the needs of the target market must be met by the set of benefits the invention offers.
- The marketing channels. In order to reach the target market three types of marketing channels must be determined and used, these are the communication channels, the distribution channels and the service channels.
    - Communication channels deliver and receive messages from target buyers
    - Distribution channels to display, sell or deliver the physical product or service to the buyer or user
    - Service channels to carry out transactions with potential buyers
- Competition. Competition includes all the substitutes and similar products that potential buyers might consider. It must be noted that the innovator must take the entire task environment, as opposed to only the competition, into account when developing a marketing program. The task environment is made up of customers, suppliers, distributors and labour force. Furthermore, the general environment, which includes economic, demographic, technological, international, political-legal and socio-cultural forces, must also be considered.
- The supply chain. The supply chain describes a longer channel stretching from raw materials to components to final products that are carried to final buyers (Kotler and Keller, 2006: 24 – 27; Courtois, 2004).

The marketing/planning process consists of analyzing marketing opportunities in terms of the needs and wants of the potential markets, segmenting the markets in order to identify the target markets, compiling the value proposition, establishing and maintaining all the relevant channels and focusing on the environments that will influence the commercialization process. After the innovator is sure that these factors are in place, the promotion step, where the invention is actively promoted in the target market, can commence.

Step 21: Promotion

Once all the relevant marketing materials are in place, the invention must be promoted in order for the technology to be adopted (Vercauteren 2009).

During the promotion step, the invention is not only introduced to the target market, but the target market is constantly reminded of the invention and purchases of the invention are stimulated through the positive image that promotion creates for the invention. The main goal of the promotion step is to convince the target market to purchase the invention.

Step 22: Commercialization

Commercialization entails full scale production and sale of the product and committing one's reputation and resources. Should innovators continue with commercialization, they will face the largest costs up to date.

During this step, innovators must answer the when, where, to whom and how questions. When entails the timing of commercializing an invention. The innovator must determine when the best time will be to introduce the invention to the market and this is a critical consideration. The invention must be commercialized early enough to get the first mover advantage, but not too early when, for example, production issues have not yet been sorted out or the marketing program is not thoroughly prepared.

When the question of 'where?' is answered, the innovator must decide whether the invention will be introduced in several target markets or only one target market and whether the invention should be sold internationally or kept local. It is important that the innovator notes that the decisions made is this phase focus on the initial sales of the invention and once the invention has proved its merit, the decisions can (and should) be adapted.

The question of to whom the invention will be sold was already answered when the marketing materials and program was established, however, in this phase, the innovator must decide to whom the product will be sold first. In other words, the innovator must determine who the early adopters (see section 2.4, page 27) are and promote the invention to them.

The how question in answered when the innovator develops a plan for introducing the new product into the roll-out markets (Rea and Kerzner, 1997: 159 – 160).

The commercialization of an invention is the highlight of the entire process. This is the end to which every innovator work when they identify a new invention. It is important that innovators realize that while a great deal of the work has already been done, this is not the end of the process. It is now the task of the innovator to measure the performance of the commercialized invention, and if satisfied, sustain the performance of the invention.

Step 23: Measure performance

The innovator must now measure the performance of the invention that was introduced to the target market. The performance is measured using the metrics developed earlier in the process. Thus, the profit that is generated from the invention is calculated in order to determine whether sufficient profit was yielded given the initial capital investment of the innovator. Furthermore, the time-to-market is scrutinized and lessons learned should be documented for future inventions and the impact of the commercialization of the invention of the human and financial resources must be determined to confirm that the invention is truly profitable (Rogers, Lambert and Knemeyer, 2004).

After the innovator has measured the performance in terms of all the metrics that were identified and the innovator is satisfied with the performance of the invention on the market, the next crucial step can begin. The innovator must now ensure that the performance of the invention is sustained in order to generate enough capital from the invention.

Step 24: Sustain

The innovator must identify ways and means to ensure that the performance of the invention will remain on the current level. It is especially important for the innovator to be aware of new competing products, the possibility of new target markets that might evolve and changes in the task and general environment that might influence the success of the commercialized invention (Vercauteren, 2009).

This encompassing commercialization process does not guarantee success to innovators, as no matter what invention one is selling to what market, there will always be uncertainty and a several factors influencing the commercialization of innovations. This process does give an innovator the opportunity to identify mistakes, problems or barriers early in the process before they can turn into costly faults. In the next section, the factors that influence the commercialization of innovations are discussed to further aid innovators in the commercialization process.

3.4 Factors influencing the commercialization of innovations

Rapidly changing environments in terms of severe competition, swiftly developing technologies and radically shifting marketplaces imply that success remains an elusive goal for innovators. As a result, innovators are forced to improve the efficiency of the process followed to commercialize an invention (Cooper, 1994).

New product success remains an elusive goal for too many innovators and businesses and as a result, a wide variety of research and literature focus on the product development process. Hence, the importance of the commercialization process has been highlighted in this study. However, the problems surrounding commercialization and the process of commercialization represent a rather uncharted research field and no formula exists that ensures successful commercialization (Cooper, 1999; March-Chorda, Gunasekaran and Lloria-Aramburi, 2001; Pellikka and Virtanen, 2004).

Regardless of the research regarding factors that apparently drive success, there is still a lack of empirical studies that identify the critical success and failure factors - especially in SMEs, as innovators still seem to fall into the same traps as their predecessors. Moreover, there is little evidence that success rates of commercialization have improved over the last few years (Cooper, 1999; March-Chorda, Gunasekaran and Lloria-Aramburi, 2001; Technology commercialization framework, 2004).

The question can be asked whether innovators have been blind to the success factors listed in literature, or whether researches have been blind to the true problems

confronting innovators - focusing on the wrong problems, of communicating poorly, or of not making the success factors more visible? In the tables that follow the success factors for commercialization that has been cited most often in literature are discussed.

In table 3.2 the success factors that must be present in terms of the invention that the innovator aims to commercialize is discussed. These are the characteristics an invention must have in order to ensure the successful commercialization of the invention.

Table 3.2: The success factors concerning the invention.

Factor	Description
Function	*An invention must function as the innovator have designed or intended it to and work better than the alternatives.*
Production	*The invention must be produced at a reasonable and beneficial cost.*
Product development and planning process	*The innovator must know what resources will be needed at which phase of the development process and how much is needed.*
Prove of concept/ Prototype	*The innovator must be able to prove that the invention works.*
Doing the right projects	*The innovator must determine the characteristics of the new product's market, technologies, and competitive situation, along with the ability to leverage internal competencies.*
Description of the product concept and the benefits to be delivered	*Customers must know exactly why they should buy a product – what are they buying and how will they benefit from it?*
Definition of the product's requirements, features, attributes and specifications.	*The innovator must not fail to identify the optimal functionality of the new technology-based product.*
Product superiority	*Inventions must offer unique features; provide good value-for-money, meet customer needs better, have higher relative product quality, boast superior price/performance characteristics, have benefits perceived as useful highly visible.*
Safety	*The innovator must ensure that the invention is not dangerous, even when it is used properly.*

Appearance	*How does the customer judge the appearance of your product versus the alternative?*
Durability	*The innovator must ensure that the invention will last longer than others.*
Service	*The innovator must ensure that the invention will require less routine service than that of the competitors.*
Development Potential	*The innovator can benefit if the invention can result in a family of products from which the innovator can profit.*

Table 3.3 indicates the skills and characteristics that an innovator must have in order to go through the commercialization process successfully. The innovator can acquire all the factors listed in table 3.3 and therefore it is not necessary to be born with this set of characteristics.

Table 3.3: The success factors concerning the innovator.

Factor	Description
Technical knowledge	*Innovators must determine their know-how and skills capacity and, when needed, acquire technical knowledge from outside sources to supplement a narrow base. It is vital that they access the right expert and the right time.*
Errors	*Ability to rapidly learn and to reduce mistakes and misunderstandings.*
Ignorance	*Some innovators simply do not understand what is required to make new products successful. That is, the innovators lack a complete and balanced perspective on what the important tasks and events are.*
Lack of skills	*Today's complex projects require a multitude of technical and people skills to be an effective. One recurring problem is the lack of experience and/or education of innovators.*
Too confident	*The most frequently omitted activities in new product process are the early market assessment and market research tasks along with other activities in the homework phases of the project. But consistently, a lack of good market information and inadequate homework are cited as the number one reasons for new product failure.*
Control	*No matter which commercialization path innovators follow, they will need to collaborate and communicate with others who may have different perspectives.*
A lack of discipline	*One of the problems in product innovation is that many of the prescribed actions in a well-run project are discretionary or optional. And because these actions are optional, they can be deleted or omitted too easily.*
	The fact that the product must be to market as quickly as possible is a compelling reason to take some chances, cut corners or collapse

In just too big a hurry	*activities. Innovators who emphasize doing the up-front homework, doing the necessary market studies, building in the voice of the customer, getting sharp, early product definition based on facts, and practicing quality of execution not only achieve a higher success rate, their time performance is the best.*
Evaluation of inventions	*Often innovators identify too many inventions, but they do not have sufficient resources. Innovators must be able to evaluate all the inventions to focus on those with the most potential.*
Decisions	*The innovator must be able to make the critical decisions, from the best idea selection to the management of the sustaining and extrication activities of the product.*
Risk	*The innovator must have the ability to evaluate and react to risk well.*
Set standards	*Innovators must set the measures of commercialization*
Resources	*Innovators must not fail to acquire and manage multi-functional resources.*
Partnerships	*Innovators must not fail to form collaboration and partnerships when it is in their best interest.*
New market opportunities	*Innovators must not fail to exploit the new market opportunities rapidly*

In table 3.4 the focus is on the upfront research that must be done before the invention can be commercialized. The factors in this table is of great importance, as it will indicate to innovators whether there truly exists a market for the inventions they want to sell and help them ensure that the needed elements are present in the invention.

Table 3.4: The success factors concerning the marketing.

Factor	Description
Marketing	*The innovator should guard against poor market research, inadequate market analysis, weak market studies, test markets and market launch, and inadequate resources devoted to marketing activities. Errors and omissions in these vital activities can and often do spell disaster later in the project.*
Seek differentiated, superior products	*Starting in the research phase, the innovator must ensure that a differentiated product with unique customer benefits and superior value for the user will be delivered.*
Demand sharp, stable and early product definition	*A failure to define the product – its target market, the concept, benefits and positioning, and its requirements, features and specs – before development begins is a major cause of both new product failure and serious delays in time-to-market.*
Continuing	*The innovator must continuously validate the invention through the*

validation	*acquisition of new, smart and meaningful investment.*
Up-front homework	*Too many projects move from the idea stage right into development with little or no assessment or up-front homework, such as determining the potential size of the market.*
Focus	*Much sharper evaluation and decision points are required in the process. This ensures that innovators will avoid the trap of too many projects, and simply not enough time, money or people to do each one well.*
Build in the voice of the consumer	*New product projects that feature high quality marketing actions – preliminary and detailed market studies, customer tests, field trials and test markets, as well as market launch – are blessed with more than double the success rates and 70% higher market shares than those projects with poor marketing actions*
Specification of the target market	*The innovator must know exactly who the intended users are and ensure that the invention will meet their needs. A detailed analysis of the needs of a potential user is vital in adjusting the process of creativity and development of the new product to the real used needs that are insufficiently covered by existing products.*
Legality	*The innovator must determine whether the invention is subject to any laws that limit, restrict, control, regulate or ban such things as production, ownership, distribution, or operation of the product.*
Analyze market requirements	*It is necessary to implement a profound analysis to determine the real needs of the market. A rigorous and realistic analysis of the time needed to distribute the product to the market should be analyzed. And, finally, this group of factors requires a reliable estimate of the size of the potential market for the new product.*
Not every invention warrants the creation of a new company.	*Some markets, quite simply, will be too small to warrant company creation or markets may be controlled by large and mature companies that would make it difficult to compete.*
Customer information	*The innovator must not fail to access, gather and exploit the market and the customer information in order to build and market a superior product.*
Price	*Innovators can improve their chances of success when they have a price advantage over existing competition or substitutes.*
Existing Competition	*Innovators must determine whether there is a serious competitive threat in the market already. Innovators must also use access to market information more precisely to evaluate competitive offers.*
New Competition	*The innovators must answer whether they can you anticipate significant, new competitive elements in the near future.*
Protection	*The innovator must ensure that there is the potential to protect the invention through patents, trade secrets or other means in a way that is commercially worthwhile.*
Learning	*It is important that customers can easily understand the correct use of*

	the product.
Need	*The invention cannot be a success if it does not solve a pressing problem or fill an urgent need for the customer.*

The factors that must be present to ensure effective marketing of the invention in other words, ensuring that the right invention is offered to the right market at the right time and price, are discussed in table 3.5.

Table 3.5: The success factors concerning the research.

Factor	Description
Build international orientation into product process	*It is the norm to introduce an invention to the local market in the first place and later the invention can expand into international markets. However, the international orientation must be built into the invention from concept phase.*
Marketing and technological synergies	*The innovator must identify inventions that build on in-house development technology, utilize inside engineering skills, and use existing manufacturing resources and skills, and products with a strong project/company fit in terms of sales force, distribution channels, customer service resources, advertising and promotion and market intelligence skills and resources*
Potential	*The innovator must ensure that the share of the total market is adequate for viable business activity.*
Price	*If an innovator can reasonable anticipate price stability for the invention it is a competitive advantage.*
Penetration	*The innovator must determine whether there is adequate revenue potential in a reasonable time frame to justify the effort required to commercialize the invention.*
Predictability	*It is important to establish whether changes in market demands will be evident in time for adequate management decisions.*
Dependence	*Innovators must answer whether their invention depend on the sale of other products to be a success. Or, if demand for their invention will fade if that other product was removed from the market.*
Demand Curve	*It is important that the demand for the invention lasts long enough to enable innovators to make a reasonable profit.*
Compatibility	*Several activities should be performed by the innovator at this point. Firstly, the innovator must determine whether the invention harmonizes with current behavior patterns and ways of doing things; secondly, customers must be involved in the development of the invention in order to build in the voice of the customer and lastly, market-sourced information must be evaluated to design the innovations according to market needs.*
	The advantages and benefits of the invention must be self-evident

Visibility	*when the customer hears about your product.*
Promotion Cost	*The cost of promoting the invention must be reasonable in relation to production cost.*
Distribution	*The invention must be able to fit easily into established distribution networks. Innovators must have efficient access to external networks and efficient mechanism to share information*
Stimulation of existing market	*Innovators must look for an invention that stimulates a market that already exists, rather than creating a new market for the invention and taking on additional risk in the process.*
Plan and resource market launch	*The innovator must know when, where and how the invention will be launched. It is of vital importance that the market launch of the invention is a success in order to create awareness and a favourable reaction to the invention. Innovators must guard against failing to recognize the right timing of marketing efforts.*
Rapidly changing environments and radically shifting marketplaces	*In the environment where there is constant and rapid change, it is very important that the innovator is aware of these changes, the impact that these changes will have on the innovator and the invention and that the innovator did thorough succession planning.*
Severe competition	*Regardless of the invention an innovator sells, there will always be fierce competition. Even if an innovator introduces a completely new invention to a completely new market, it will be a matter of time before competitors copy the invention and also enter the market. Innovators need to be aware of who their competitors are, what they are offering at what price in order for them to stay competitively relevant.*
Market attractiveness	*Specifically the market size, market growth, degree of market need, and purchase importance are important elements that the innovator must consider. Furthermore, the absence of intense competition, lack of price competition and weak competitive products ensures an attractive market.*

The success of the commercialization process is related to the financial resources. Sufficient financial resources enable innovators to do cost effective business and to capture the new markets. However, at the same time, limited financing can threaten the firm's existence. The financial aspects of commercializing an invention (discussed in table 3.6) are crucial as if there is insufficient capital at any stage it will hamper successful commercialization, regardless of the potential of the invention.

Table 3.6: The success factors concerning the finance.

Factor	Description
Adequate financial resources	*The innovator must guard against failing to mobilize the adequate financial resources that are needed to commercialize the invention and thus have limited finance during commercialization process.*
Manage financial resources efficiently	*Once the financial resources have been secured, the innovator must manage the financial resources efficiently to assure that there will be sufficient resources at the various stages of commercialization.*
Venture capitalists	*Should innovators need venture capitalists to commercialize the invention they must ensure that the venture capitalists have managerial and industrial experience.*
Payback Period	*Innovators must ensure that the time required to recover their investment is shorter than the peak demand threshold.*
Profitability	*Innovators must be sure that there is real potential to generate adequate profits to make the venture viable.*

The process an innovator follows in the commercialization of an invention is crucial to the success of the invention. In too many instances the innovator has an invention with significant market potential, but implements a process that is ridden with errors and omissions and therefore the invention fails. In table 3.7 the critical elements that must be considered when designing or choosing the commercialization process are discussed.

Table 3.7: The success factors concerning the process.

Factor	Description
Quality of execution	*Through consistency of purpose*
Build tough go/kill decision into the process	*In too many instances, inventions move far into development without serious scrutiny: once a project begins, there is very little chance that it will ever be killed. The result is many marginal projects approved, and a misallocation of scarce resources.*
Process	*The product innovation process in plagued with errors of omission, with pivotal activities, such as market studies and business analysis, simply omitted altogether. It is also a process plagued by errors of commission: poor quality of execution for too many crucial activities that make the difference between winning and losing – activities such as detailed market studies, business and financial analyses, test market or trial sell and initial screening.*

Best practices	*Innovators should constantly redesign the innovation process around best practices in order to continuously improve the process.*
Commercialization strategy	*These are roadmaps, blueprints or game plans for driving new products to market. They lay out the key steps and activities, stage by stage; they define decision points or gates, complete go/kill and prioritization criteria, and they build in best practices.*
Accelerating the development process.	*Earlier product introduction may improve profitability by extending the product's sales life, creating an opportunity to charge a premium price and allowing cost advantages in development and manufacturing*

Table 3.8 identifies the factors that must be present or scrutinized during the actual commercialization of the invention. Regardless of how far the invention has come, if the implementation is not done efficiently, the invention cannot be a commercial success.

Table 3.8: The success factors concerning the commercialization.

Factor	Description
The decision to license	*Innovators must determine whether their inventions have more potential and greater returns in the form of royalties or assignment fees, than from selling it themselves.*
Networks	*Innovators must have efficient access to external networks of resource providers to ensure successful commercialization*
Existing Business	*If an innovator already has an established business, it must be determined whether the invention can be suitably commercialized from within the existing business.*
New Business	*Regardless of whether innovators have established businesses or not, they must decide how commercial advantages can be secured if the inventions were used to establish a new business.*
Part-Time	*Innovators must ensure that they can effectively manufacture and sell their invention on a part-time basis in order to be able to focus attention of the marketing activities as well or to still earn an income from another job.*
Information	*Innovators must have an efficient mechanism to share information with all the potential resource providers.*
Local institutions.	*Innovators must scrutinize the availability and content of the support and development services provided by the local institutions.*
Infrastructure	*Infrastructure of the local technology business environment must be examined.*
Sufficient resources	*Innovators must acquire sufficient resources for*

	commercialization. This entails not only financial resources, but any resources that are needed to successfully commercialize an invention.
Employees	*If it is needed, the innovator must secure skilled employees during the commercialization of the invention.*
Environment	*The innovator must ensure that there is an attractive environment for SMEs. In other words, the political-legal, economic and technological environments, to name a few, must be positive to commercialize the specific invention.*

(Sources of Table 3.1 – 3.8: Critical assessment factors for new products, 2007; Technology commercialization framework, 2004; Carayannis et al., 2006: 419 – 443; Cooper, 1999; March-Chorda, Gunasekaran and Lloria-Aramburi, 2001; Cumming, 1998:21 – 29; Pretorius, Millard and Kruger, 2006: 2 – 13; Waarts, van Everdingen and van Hillegersberg, 2002: 412 – 423).

Should an innovator incorporate these factors into the commercialization process, the chances of successful commercialization of innovations will significantly increase. However, it must be noted that this cannot be regarded as a sure fire way to sucessfully commercialize, as it only serves to enhance the commercialization process for all innovators.

3.5 Summary

In this chapter the importance of successful commercialization for the prosperity of economies, organizations and individuals are highligthed again. With regard to the high failure rates of commercialization, it is argued that some factors to improve innovators' chances of successful commercialization must still be missing from current literature. Therefore, a "new" commercialization process, which is a combination of the work of several researchers, is proposed.

The relevance of the suggested commercialization process is that it combines several different commercialization appraoches in order to ensure that steps which were omitted by one researcher is included by the next. Several success factors were also mentioned with specific reference to the innovator as such, the invention generated, the research done on the invention, marketing of the invention, the available finance, the commercializaiton process followed and commercialization itself.

The common thread of chapter 2 (Innovation) and chapter 3 (commercialization) is that there should be a combination of several of the available processes in order to ensure an encompassing process to innovation and commercialization. What has been noted, however, is that there is a vast amount of duplication between the innovation and commercialization processes. But, should an innovator choose only one of these processes, several of the core steps will be omitted.

Chapter 4

The combined Innovation and commercialization process

4.1 Introduction

A vast variety of research focuses on the successful commercialization of inventions and as a result ample literature exists on both the innovation and commercialization process. However, regardless of the accumulated knowledge regarding innovation and the commercialization of inventions, the failure rates of new products are still very high and it seems that successful commercialization remains a daunting task for most innovators.

This commercialization-problem necessitated that further research be done in order to improve the process and to guide innovators to successful commercialization. The problem with the current literature, however, is that they view these two processes (innovation and commercialization processes) as two separate processes. The need for implementing both these processes, as complementary processes, is never discussed, thus creating the expectation for innovators that they can implement either one of these processes to commercialize their invention.

It is the belief of the author that neither the innovation process nor the commercialization process is complete when viewed in isolation. It is only when these two processes are combined that it becomes clear that although there are several overlapping activities, there are steps that the innovation process include and the commercialization process excludes and vice versa. When innovators omit certain steps because they choose to follow either the innovation or commercialization process, as literature suggests they should, their chances of success diminishes as they miss crucial steps that enable them to ensure that their innovation truly is appropriate for the relevant market.

From a theoretical perspective, only when these two processes are combined it becomes clear that the innovator, when commercializing an invention, will miss several steps if it is decided to follow either the innovation or the commercialization process and not both the innovation and commercialization processes.

In figure 4.1 below, the innovation and commercialization processes are combined to outline a detailed approach to successful commercialization. It is not argued that following this process will guarantee success, however, it is claimed that innovators' chances of success will increase dramatically if they understand the process to follow to introduce their inventions to the market.

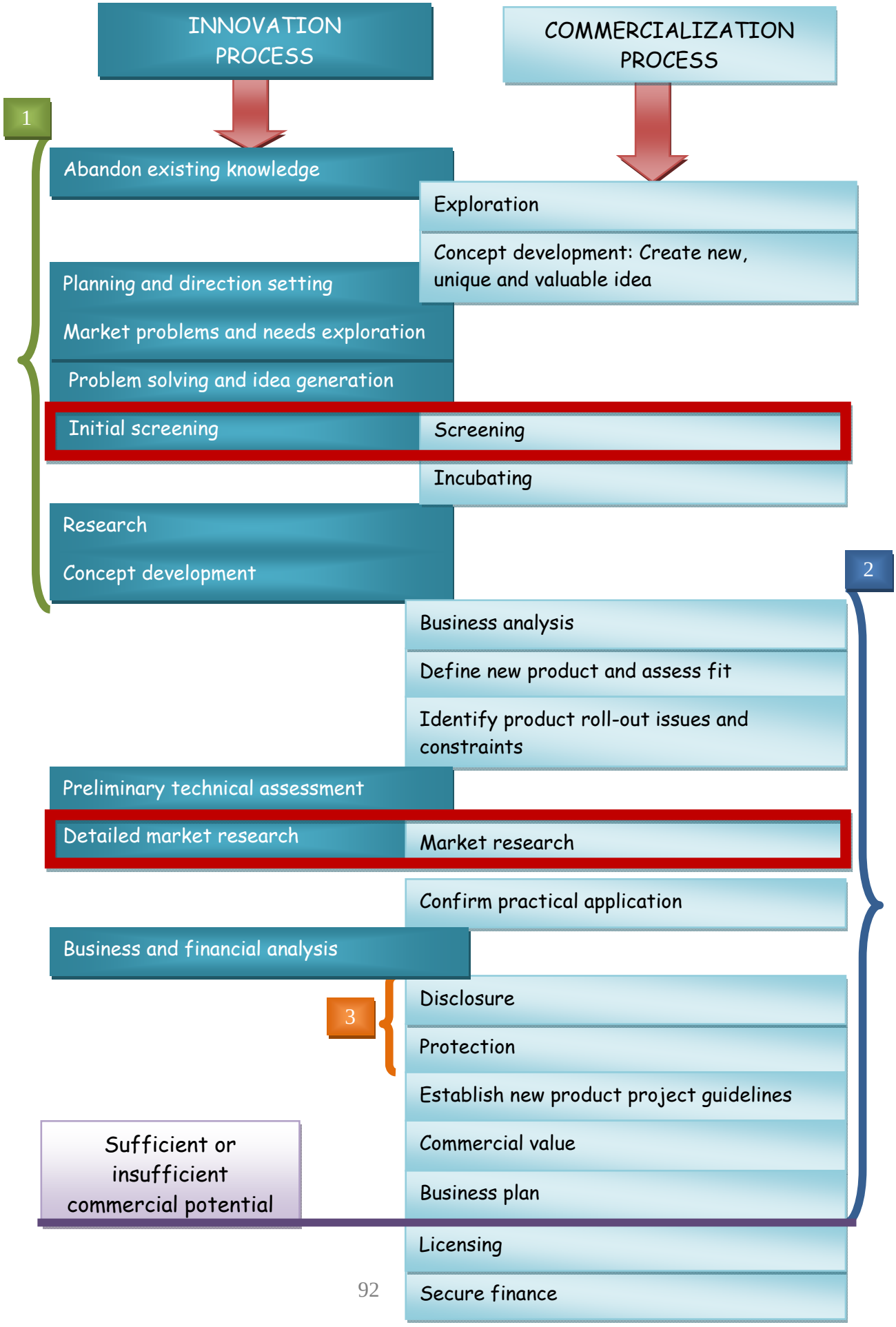
In figure 4.1, the innovation process is listed on the left hand side of the figure and the commercialization process is shown on the right hand side of the figure. In figure 4.1 the

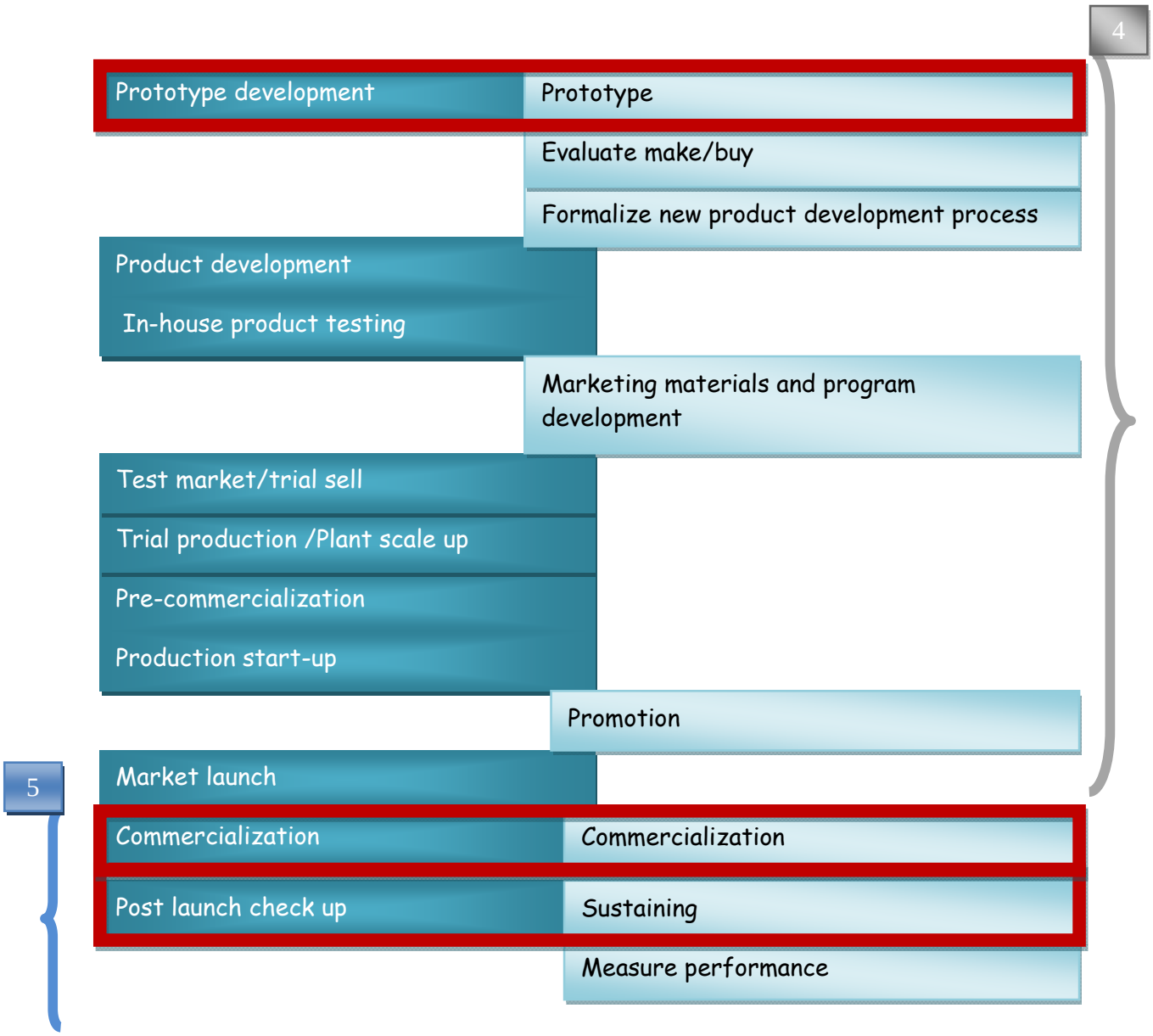
complementary nature of the two processes can be seen clearly. The steps of both the processes are kept in the order as suggested in the theory, but voids in the innovation process is filled with certain steps in the commercialization process and vice versa. The steps in the innovation and commercialization processes that overlap are indicated with a red rectangular block around the activities. Form the overlapping activities it can be seen why innovators argue that they can follow either the innovation or commercialization process, as idea screening, prototype development, commercialization and post-launch check-up seems like encompassing steps that cover every activity that should be completed through the process of taking an innovation to the market. However, when innovators gain sufficient knowledge of both the innovation and commercialization process, they will realize the great extent of shortcomings in this manner of reasoning.

Although many of the steps as listed in figure 4.1 may seem tedious, or obvious to the innovators, it is important that they note that each of these activities, when done thoroughly, will increase their chances of success. Innovators who moved through the combined innovation and commercialization process had ample opportunity to identify the true potential of the invention, determine the market needs and size, obtain funding as well as several prospects of making kill/go decision to avoid costly mistakes, to name only a few.

In figure 4.2, the traditional commercialization process is shown and the different stages of this process are numbered 1 – 5. The different steps in the combined innovation and commercialization process were grouped and also numbered from 1 – 5. This was done to further accentuate the importance of an all encompassing process of bringing innovation to the market. Past researchers listed a step in the commercialization process as “Innovation is generated”, however, the combined innovation and commercialization process list 10 different steps that all make up the idea generation phase. It is argued that innovators think they understand what idea generation entails, but without a clearly indicated path to follow, they will omit certain important steps and their chances of success will diminish.

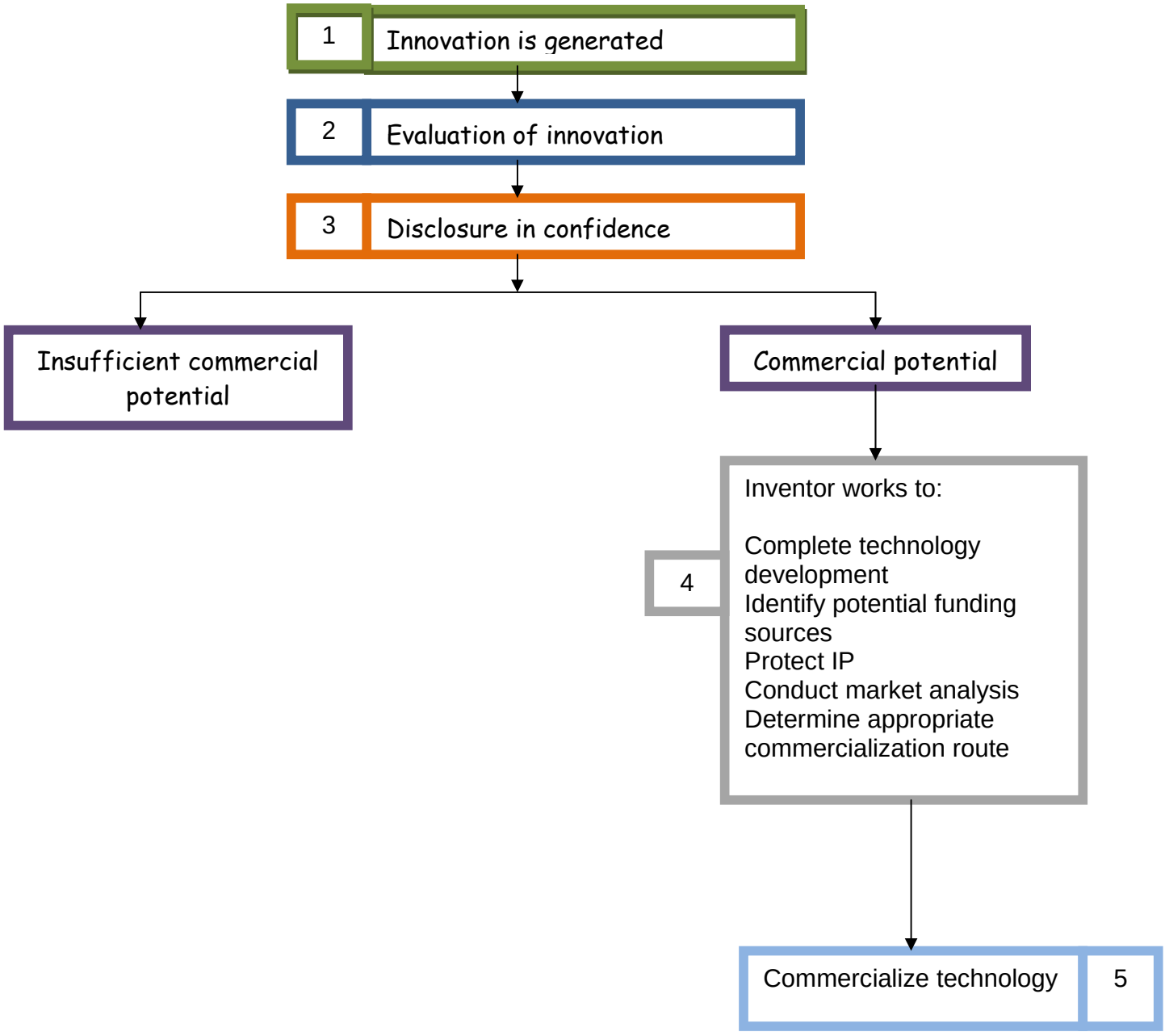
Figure 4.1: The combined innovation and commercialization process
(on page 92).


INNOVATION PROCESS
COMMERCIALIZATION PROCESS
1
Abandon existing knowledge
Exploration
Concept development: Create new, unique and valuable idea
Planning and direction setting
Market problems and needs exploration
Problem solving and idea generation
Initial screening
Screening
Incubating
Research
Concept development
2
Business analysis
Define new product and assess fit
Identify product roll-out issues and constraints
Preliminary technical assessment
Detailed market research
Market research
Confirm practical application
Business and financial analysis
3
Disclosure
Protection
Establish new product project guidelines
Sufficient or insufficient commercial potential
Commercial value
Business plan
Licensing
Secure finance



(Source: author's own construction)

Figure 4.2: The traditional commercialization process



Adapted from Evaluating Technology Disclosed 2007.

Innovators that follow the innovation process will miss critical steps such as protecting their idea or securing finance, while innovators who follow the commercialization process will omit vital steps such as the preliminary assessment of the invention.

In both instances it could be argued that it is logical to perform these steps and creating a formal procedure to outline the steps is not necessary. However, it should be kept in mind that any person, including those without formal training or those too busy with their current job to research the process of commercializing an invention, can create excellent inventions and should be able to successfully commercialize these inventions.

4.2 Summary

The research of this thesis is not grounded on just one of the two processes (either the innovation process or the commercialization process), but on a complete and encompassing process as is indicated in chapter 4.

The reason for this that the researcher wanted to determine which important steps are omitted by innovators as they move through the process of commercializing their inventions, as the steps as spelled out in the combined innovation and commercialization process (as indicated in chapter 4) did not exist before theoretically.

The main motivation for the creation of the combined innovation and commercialization process is to prove as the final conclusion that the completeness and order of the proposed steps in the innovation and commercialization process has a significant impact on the successful commercialization of an invention.

Chapter 5

Results

5.1 Introduction

A wide variety of research has been done on the steps of the innovation and commercialization processes as well as the factors that affect the success or failure of the commercialization of innovations (chapter 1, page 6). However, when the high failure rates of commercialization are kept in mind, it is clear that the current literature on the commercialization of inventions are not sufficient or that crucial steps in the innovation and commercialization processes are not addressed/adequately addressed in the current literature. On the other hand, innovators/entrepreneurs do not always have the necessary knowledge regarding the steps in the commercialization process, or they simply do not follow the steps in order to commercialize their inventions.

The examination of the innovation and commercialization processes is therefore necessary to understand the possible causes of the high failure rate of innovations in South Africa. The different commercialization processes that innovators follow could have certain consequences that could lead to negative outcomes for the innovators and their inventions. These outcomes may quite possibly reduce the success rate of the innovator and have negative economic consequences for both the innovator and the greater economy.

This chapter is dedicated to compare the critical steps as identified in the literature concerning the process respondents follow as well as the factors that lead to inventions becoming stagnant or failing. The scrutiny of this process can help to identify the critical success factors to implement in the innovation process as well as the elements that hinder success and should be avoided or handled early on in the process. Individuals' perceptions and behaviours concerning the innovation process will be aligned against the status of their innovation (whether the innovator has moved through the commercialization process, is still in the process or has become stagnant somewhere in the process). Specific reference to demographic factors such as age, gender and qualifications are also included in this chapter.

Frequency tables were created for all the questions in the questionnaire in order to determine where during the commercialization process the respondents encountered barriers or difficulties. The reasons most often cited by the respondents for becoming stagnant are identified and the differences between the respondents who managed to commercialize their inventions successfully vs. those who are still in the porcess or have become stagnant are highlighted.

The respondents of the study were grouped into one of three categories, namely 1) those who ***finished*** the process, i.e. successfully commercialized their invention; 2)

those who are still ***busy*** in the commercialization process and 3) those who have become ***stagnant*** in the commercialization process.

In this section of the study the critical steps in the commercialization process are identified as well as the factors that lead to inventions becoming stagnant or those that failed, and the results will be presented to better appreciate the magnitude of the forthcoming tendency to either follow no process at all or the incorrect commercialization process.

5.2 Sample selection

To recapitulate, the aim of PDTS and CRPM centres at the Central University of Technology, Free State, is to assist entrepreneurs with an invention to get to the proof of concept stage. Most of the entrepreneurs who contact the PDTS and CRPM at the Central University of Technology, Free State have a rough idea of the product they would like to create, but no market research, very little legal advice and more often than not, a small amount of money. In other words, these individuals represent the entrepreneurs for whom this research study is conducted in order to help them get from idea to successful commercialization, as they also do not have the backing in terms of money, skills, etc. of large organizations.

The research population of this study consisted of the clients of PDTS and CRPM at the Central University of Technology, Free State from 2005 – 2010. The CRPM has been operational since 2001. However, the sample of the study will only focus on the customers from 2005 to 2010. As was pointed out before, the reason for this is that the entrepreneurs who contacted the CRPM in 2005 has had enough time to work with their inventions in order to get market share and make a success of their product (they are through the process of getting an idea to the market) and can provide valuable insights on the typical problems and success factors they have experienced en route. It has also been possible to determine the success rate of these ventures. The individuals from 2010 could share their fears and the obstacles they had to overcome thus far.

Since the researcher conducted personal interviews with each of the respondents to ensure that the questionnaires are completed thoroughly and accurately, only the individuals on the client name list of PDTS and CRPM (for the period 2005 to 2010) in the Bloemfontein area were identified and amounted to 120 innovators. To determine whether the innovators would partake in the research study they were contacted telephonically. From all the innovators contacted, 60 agreed to complete the research questionnaire and these 60 innovators became the sample and respondents of the study. Table 5.1 depicts the sample size of the study.

Table 5.1: The sample size of the respondents

Total population	Total population in Bloemfontein	Total population in Bloemfontein (%)	Total number of respondents	Percentage of Bloemfontein population	Percentage of total population
209	120	57.4%	60	50%	28.7%

5.3 Methodology used to obtain data

The method of using self-rating questionnaires as a measure of data collection was applied to obtain information regarding the respondents' perception and knowledge of the commercialization process. The questionnaire aimed to determine the steps in the commercialization process that each innovator followed or to establish why they did not take a certain step or action. The majority of the questions in the questionnaire consisted of several listed statements that asked the innovator to indicate whether the steps was completed or not, and if not, why the step was not done or completed. The researcher conducted personal interviews with each of the respondents in order to complete the questionnaires thoroughly and accurately. Each of these interviews took approximately an hour to complete. Please note that the methodology used in this study to obtain data is thoroughly described in Chapter 1, pages 8 to 12.

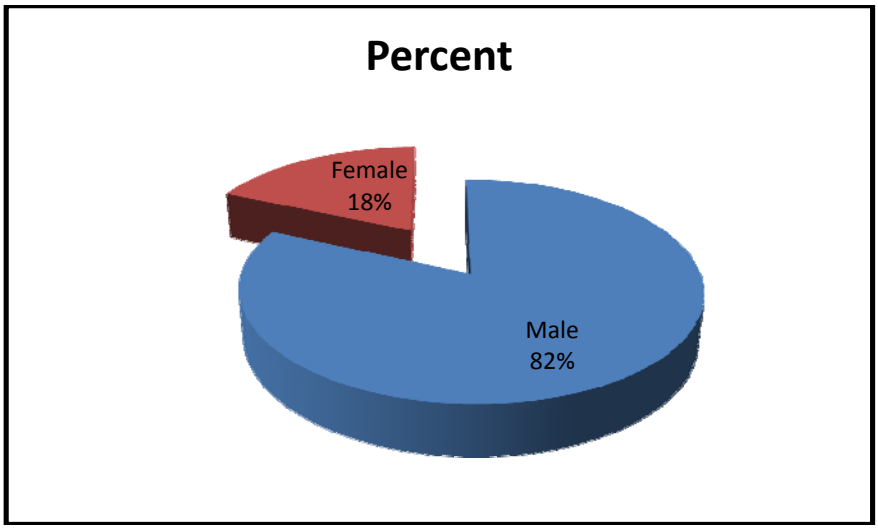
In the next section, the empirical results of the study are discussed. The empirical results determined the profile of the respondents and tested the degree of knowledge regarding the commercialization process. Factors that hinder successful commercialization and the crucial steps in the process were also identified. Particular consideration was given to the difference in the process followed amongst the innovators who had successfully commercialized and those who either became stagnant in the process or failed.

5.4 Profile of the respondents

The following section illustrates the demographics of the participating respondents. No comparisons were made regarding the similarities or differences in the different demographic groups and the commercial process followed.

Figure 5.1 reflects the gender profile of the respondents:

Figure 5.1: Gender profile of the respondents



The figure indicates that there were significantly more (81.67%) male innovators than female innovators (18.33%) in the sample.

In a society has been male dominated for so long, one expects to see more male innovators than female innovators. With all the focus on the empowerment of women it will be interesting to determine the number of female innovators after some time.

Table 5.2 shows the different age groups that participated in the study.

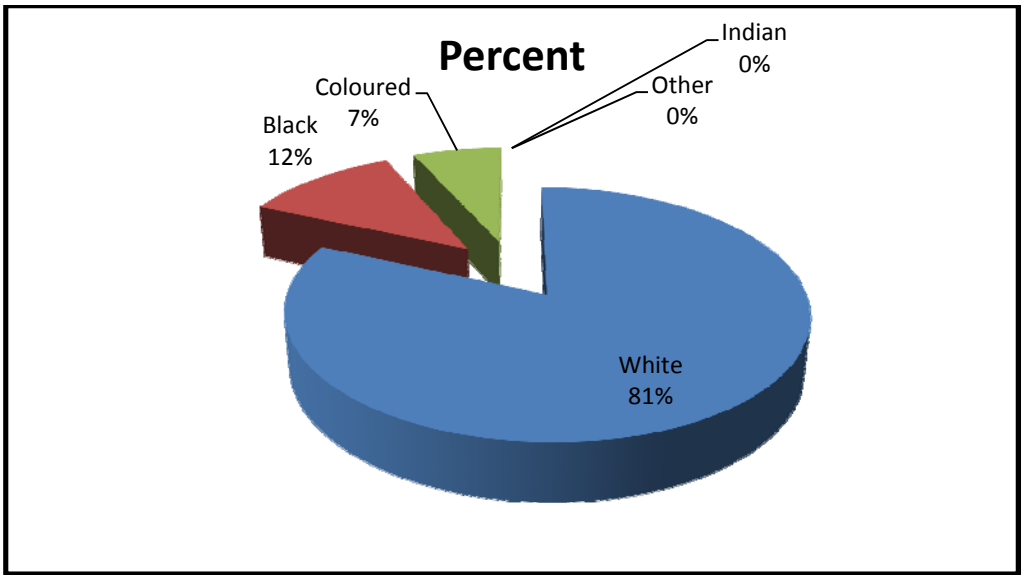
Table 5.2: Age evaluation of the respondents

Minimum	Median	Maximum	Mean	Std Dev
22	38	64	40.27	10.71

The majority of the respondents (37) were between the ages of 30 and 50. Only ten of the respondents were younger than 30 (with the youngest being 22) and 14 of the respondents were older than 50 (with the oldest being 64). Theoretically, a good age to start as an entrepreneur is between the ages of 26 and 35 years. From the results it can be concluded that being young is not necessarily a prerequisite for being innovative.

Figure 5.2 reflects the representation of the respondents in terms of race.

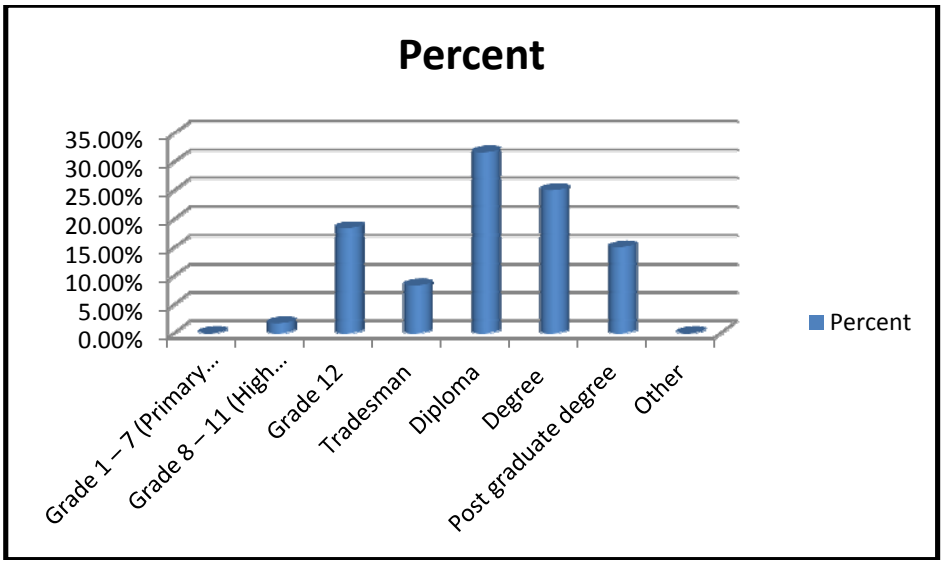
Figure 5.2: Race of the respondents



The majority of the respondents (81.67%) were white. Only 11.67% of the innovators who agreed to participate in the study were black and 6.67% were coloured.

Figure 5.3 illustrates the qualifications obtained by the respondents involved in the study.

Figure 5.3: Qualification profile of the respondents



The greater part of the respondents (56.67%) has either a university degree or a diploma, bringing about that the majority of the individuals involved are highly educated (white-collar workers). Of the respondents, 18.33% only have a grade 12 certificate and

23.33% of the individuals that took part in the study have no other acclaimed qualifications, i.e. they have grade 11 or less.

To summarize, the majority of the respondents were white males, between the ages of 30 to 49, with a degree or a diploma.

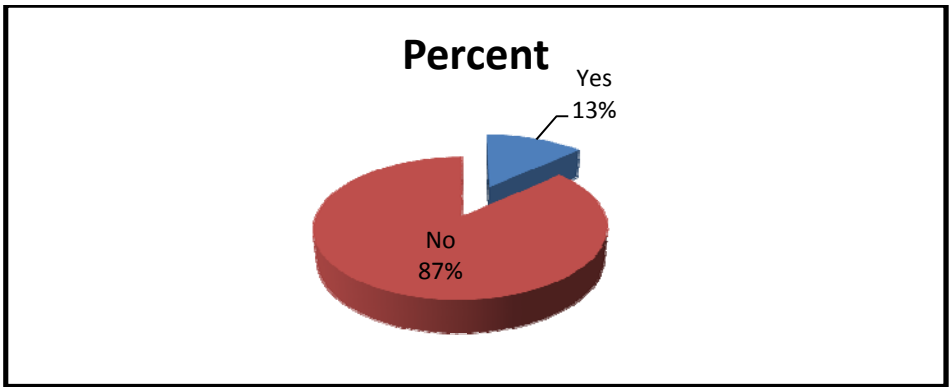
5.5 Intention for innovation generated

In the next section of the questionnaire, the respondents were asked whether they had already established a business as a result of an invention.

- In the case where the innovator had already established a business, the operational years had to be listed.
- If the innovator had not yet established a business, the innovator had to indicate what the plans are regarding the invention.

Figure 5.4 illustrates both the number of innovators who had started business as a result of their inventions and those who have not yet started a business.

Figure 5.4: Businesses started

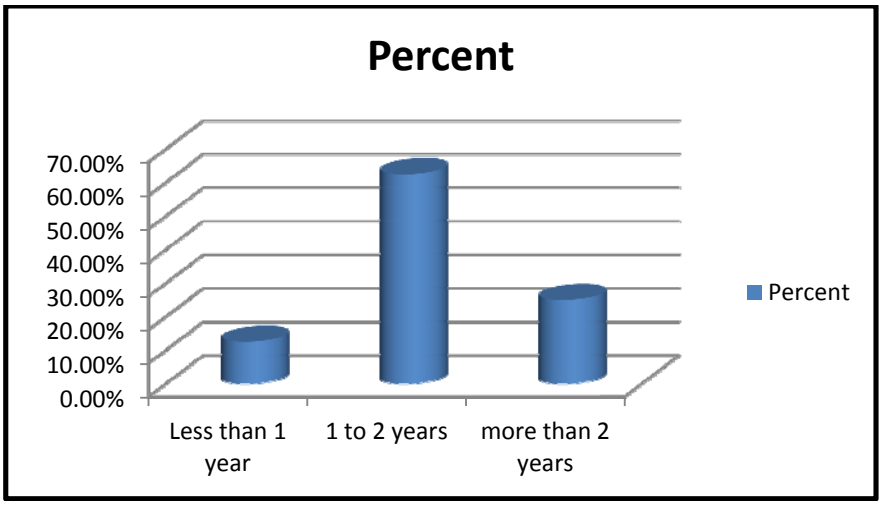


Of the respondents interviewed, 52 (86.67%) had not started their own business as a result of the invention while only 13% had successfully started their own business. In a later section of this research study more detail will be given as to why so few of the respondents had managed to start their own business successfully.

The secondary data consulted indicated that in South Africa the TEA (Total Entrepreneurial Activity) rate was 7.8% in 2008; in other words, for every 100 adults in SA an estimated 7.8 owned either start-up or new businesses. In 2009 this rate dropped and a TEA of 5.9% was recorded in SA (see page 4). The findings of this research study again accentuate the shortage of innovators who manage to turn their innovation into profit-generating business ventures. The result of so few innovators successfully starting their own business is that South Africa is missing out on economic wealth- and job creation.

Figure 5.5 illustrates the operational years of businesses that were started as a result of an invention.

Figure 5.5: The operational years of the respondents who started their own businesses



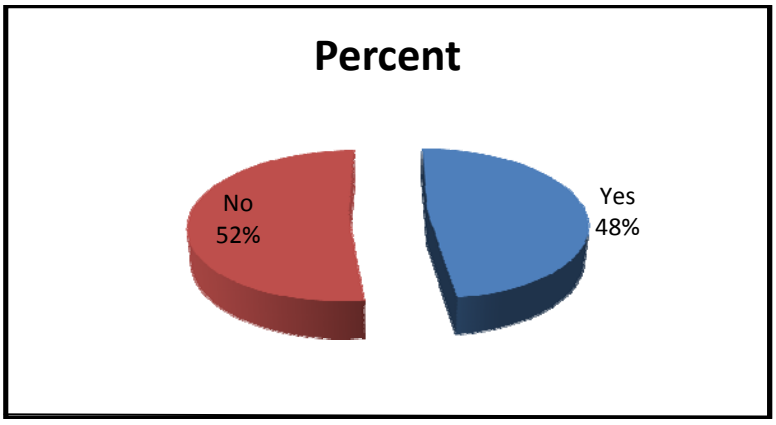
It follows from figure 5.5 that the majority of the businesses started were still new businesses, as 62.50% was only 1 to 2 years old. Only a quarter of the businesses had been operational for more than two years. The population of the study can be a reason for this as the oldest business can only be 5 years old (the sample drawn from the PDTS and CRPM database is only from 2005 – 2008)

Of the 13% of the respondents who did start their own business, the majority of these businesses (62.5%) were still very new as their operational years were only 1 to 2 years, and only 2% of these respondents indicated operational years of more than 2 years.

According to the Global Entrepreneurship Monitor of 2005 (Von Broembsen, Wood and Herrington, 2005:20), South African start-up businesses are least likely of all the developing countries sampled to mature to the new firm stage. This implies that even though these respondents managed to start their own businesses, there are still various risks involved in maintaining the business.

Figure 5.6 indicates whether the innovators who had not yet started a business as result of an invention still plans to establish a business or not.

Figure 5.6: Plan to establish a business



The innovators who plan to start their own business as a result of an invention and those who do not plan to establish a business are approximately evenly distributed. The innovators who would like to still start their own business represent 48.08% of the population who have not yet established a business. The remaining 51.92% of the innovators do not want to start their own business.

Just more than half (52%) of the respondents did not plan to start their own business and the majority of these respondents (25) would prefer to sell the patent and obtain royalties (that is, the percentage of money that the innovators obtain from sales after they sold their invention to another person/institution). However, it seems that these respondents fail to realize that large companies are rarely interested in an invention that is only in the idea phase of development and that their chances on selling the innovation in order and obtain royalties, are very slim (see page 63).

Table 5.3 indicates what the innovators who do not want to start their own businesses plan to do with their invention.

Table 5.3: Aim with the invention if the respondent does not plan to start a business

IF NO, AIM WITH THE INVENTION	Frequency	Percent
Not applicable	31	51.67%
Sell the patent outright	2	3.33%
Sell the patent and obtain royalties	25	41.67%
Licensing	1	1.67%
Produce the invention, but let someone else market it	1	1.67%
Commercialize the invention yourself	0	0%

The majority of the respondents (31 of the 60 respondents) indicated that this question is not applicable to them, as they have either already started their own business or still plan to start their own business.

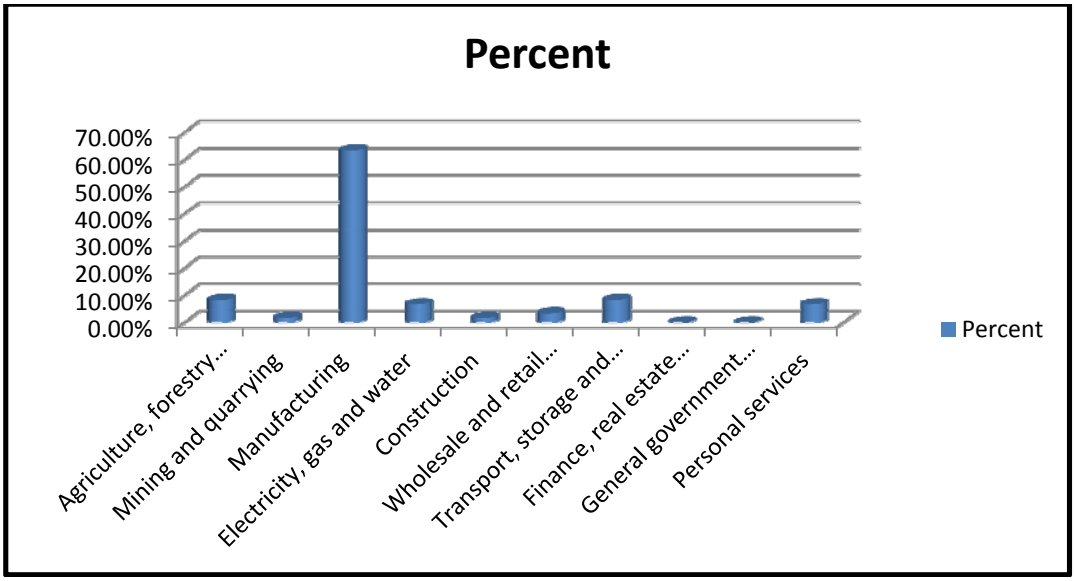
Many of the respondents (25 of the 60 respondents) are planning to sell the patent to someone else and obtain royalties from the sales generated by the invention. In other words, these respondents plan on selling their idea to a large institution, other individual, or government agency, have them do the work of producing and commercializing the invention and simply obtain a percentage of the sales over a period of time when the invention is successfully commercialized.

5.6 Type of innovation

In the following section, more information was gathered regarding the innovation itself. The respondents were asked to identify the industry in which their invention falls as well as whether they view their invention as a radical (a completely new product or service idea) or an incremental (an improvement or extension on an existing product line) invention.

Figure 5.7 shows the industry in which the inventions fall.

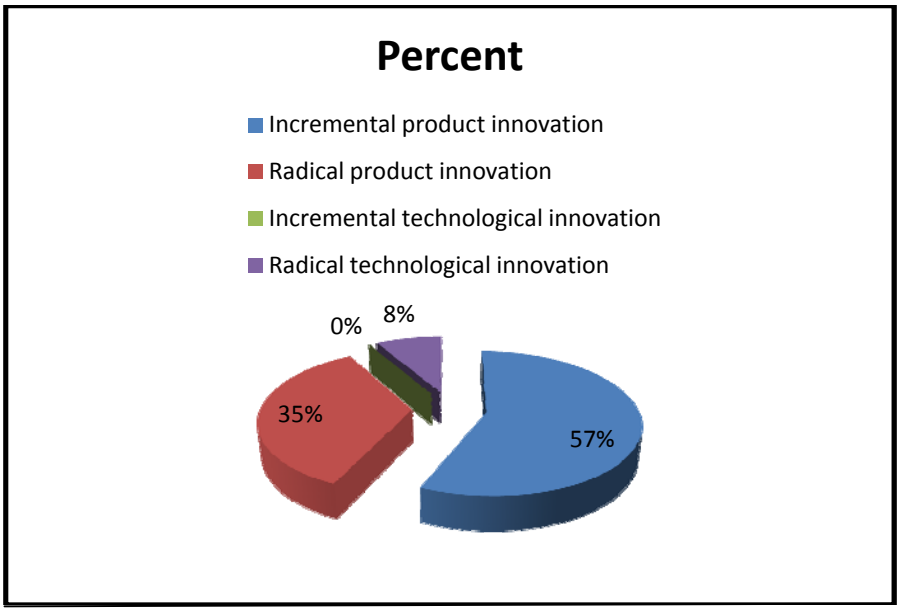
Figure 5.7: Industry in which the invention falls



The majority of the inventions (63.33%) fall in the manufacturing industry. This was expected as the group from which the sample was drawn was received from the Centre for Rapid Prototyping and Manufacturing and, in other words, most of the innovators needed to manufacture their invention. The complete list of all the Technology Station as well as the different services these institutions offer are listed in Chapter 1 of this study on page 8 – 9.

Figure 5.8 indicates the type of innovation the innovators think they have.

Figure 5.8: Type of invention (Radical vs. Incremental)



It should be noted that there is not such a significant difference, as is usually expected, between the incremental innovations and the radical innovations. A total of 56.67% of the respondents indicated that they have an incremental innovation, while 35.00% indicated that they are developing a radical innovation.

From the literature consulted it is argued that incremental innovations are low risk-low reward innovations, which implies that the innovator assumes very little risk as the basic technology is preserved, but the rewards/returns that the innovation will yield will be low as well.

Radical innovations on the other hand, are high risk-high reward innovations, which implies that the innovator assumes a great deal of risk in commercializing this ground-breaking innovation as the reaction of the market is unknown and cannot be accurately predicted. The innovation can be rejected by the market or find only limited use, which will mean huge financial losses for the innovator. On the other hand, the innovation may be a great commercial success and the innovator can expect vast financial returns for the risk he/she assumed.

Even though the chances of success for a radical innovation are much higher (33% chance of success) as opposed to incremental innovations, new-to-the-world product development is very scarce (Chapter 1, page 3). In 2005 only 1.8% of the owner-managers in South Africa managed to differentiate themselves from their competitor's offerings (Chapter 1, page 3).

The next table (table 5.4) that will be discussed indicates whether the respondent is in the process of commercializing their first invention, whether they had previously

successfully commercialized an invention and whether they had previously failed at commercializing an invention.

Table 5.4: The different innovators

	Yes	% Yes	No
This is the first invention I aim to commercialize	52	86.7%	8
I have already successfully commercialized several inventions	5	8%	55
I have already failed at commercializing inventions	12	20%	48
If other, please specify	0	0%	0

The vast majority of the respondents (86.7%) indicated that this is the first invention that they aim to commercialize. Merely 8% of the respondents have already succeeded in commercializing their inventions, but 20% have already failed at commercializing their inventions.

These results are in line with the theory, as the failure rate of all innovations is exceptionally high and from other research done, it was argued that approximately 80% of new products fail (Chapter 1, page 3).

The respondents were now asked to indicate the month and year in which they moved through the different phases in the commercialization process. This was done to determine how fast the average innovator moves through the process of commercialization and to indicate the phases in the process were innovators spend more time, i.e. struggle. Therefore, these phases can be regarded as barriers to successful commercialization.

Table 5.5: The month and year in which the respondents moved through the different commercialization phases

	Idea generation				
	2000 to 2005	2006 to 2007	2008 to 2009	2009 to 2010	TOTAL
Sample size	14	14	17	15	60
Legally protect invention	57.14%	35.71%	23.53%	33.33%	36.67%
Prototype development	92.86%	71.43%	76.47%	66.67%	76.67%
Market research	42.86%	50.00%	35.29%	46.67%	43.33%
Identify potential funding opportunities	57.14%	50.00%	35.29%	46.67%	46.67%
Commercialize	0.00%	28.57%	17.65%	33.33%	20.00%

It is striking that 33.33% of the respondents who generated their idea between 2009 and 2010, and in other words, moved through the process quickly, managed to commercialize their invention successfully. This reinforces what the consulted theory

postulated. The speed at which an innovation is diffused plays a crucial role in successful commercialization (Chapter 1, page 5).

None of the respondents who generated their ideas between 2000 and 2005 managed to commercialize their inventions successfully, although they did manage to move through the other phases of the commercialization process. Please note that the population of this study is innovators who contacted the CRPM and PDTS during 2005 to 2010. The individuals mentioned here only generated their inventions between 2000 and 2005, but contacted the CRPM and PDTS at a later stage only to build a prototype and therefore still form part of the population of this study.

It can be noted that 28.57% of the respondents who generated their inventions between 2006 and 2007also commercialized their inventions successfully.

In today's rapidly changing environment, not introducing an innovation to the market in a timely manner may mean that the need the innovation was supposed to address has already changed again. The diffusion speed plays an important role in creating and sustaining a competitive advantage, because earlier introduction implies a longer product life cycle, cost advantages in development and manufacturing and pricing of the product.

The next table (table 5.6) that will be discussed indicates the source of the invention from which the respondents generated the invention.

Table 5.6 : The source of the invention.

Q14: The source of the invention			
	Yes	% Yes	No
Work and work-related factors	20	33.3%	40
Individual related-aspects	38	63.3%	22
Technology and related aspects	3	5.0%	57
Research	4	6.7%	56
The market	21	35.0%	39
Average Response	47	28.7%	

The majority of the respondents (63.3%) got the idea for their invention from individual-related aspects. In other words, the innovators identified a need/problem that they are experiencing and invented a solution for it.

In chapter 2 of this research study (page 28 – 32), 27 sources of innovation are listed. The majority of the respondents indicated that their individual needs/preferences started them on the process of commercialization and it can be argued that these individuals (especially) must conduct thorough market research to confirm that there truly is a need for the innovation in the market and that they are not blinded by their own preferences.

The respondents also listed the market (35%) as a source of ideas for inventions, which is an excellent source as one can be certain that there is a need for the invention that is to be produced and commercialized.
Many of the respondents (33.3%) indicated that they got the idea for their invention from their work or work-related factors. These inventions therefore either solve a need or problem that the respondents experience or present an option for a better way of doing the current work.

Please note that Question 12 (Please indicate which of the following statements are applicable to you. The is the first invention I aim to commercialize; I have already successfully commercialized several inventions and I have already failed at commercializing inventions) and Question 13 (Please indicate the month and year in which you went through the following steps: Idea generation; Legally protect the invention; Prototype development; Market research; Identify potential funding opportunities and Commercialize) will be discussed in a later section of this chapter, i.e. 5.4.5. entitled Demarcation of the study.

5.7 Idea generation to commercialization

The next table (table 5.7) that will be discussed are the responses of the innovators in terms of the idea generation phase of the commercialization process.

Table 5.7: The idea generation phase of the commercialization process.

Q15: Indication of the aspects that were completed during the idea generation phase of the commercialization process.			NO			
	Yes	% Yes	Not important	I don't know about it	Any other reason	N/A
Exploit new market opportunities rapidly.	**24**	**40.0**	**0**	**1**	**35**	**0**
Ensure early product introduction into the market.	**14**	**23.3**	**0**	**1**	**45**	0
Create a plan of action (i.e. follow a strategy).	37	61.7	4	6	13	0
I know what the steps in the commercialization process are and will follow these steps.	**18**	**30.0**	**9**	**10**	**22**	0
Explore the market problems and needs.	52	86.7	0	0	7	1
I generated several ideas to solve the problem in the market.	53	88.3	0	0	7	0
Through initial screening I eliminated ideas that are not useful and focused on those with the most potential.	53	88.3	0	0	2	5
I created a new, unique and valuable idea.	55	91.7	0	0	5	0
I know there is a gap in the market for the invention.	59	98.3	0	0	1	0
I ensured that the innovation is not too complicated.	54	90.0	0	0	6	0
I confirmed that the invention has benefits perceived as useful and the benefits are highly visible.	60	100.0	0	0	0	0
I acquired good market information and did adequate homework on the invention	31	51.7	0	0	29	0
I confirmed the practical application of the invention	55	91.7	0	0	4	1
I ensured that the invention works better than the available alternatives	56	93.3	0	0	4	0
I identified product roll-out issues and constraints	**23**	**38.3**	**4**	**23**	**8**	0
I made sure that the invention will require less routine service than the competitors.	53	88.3	0	0	3	4
Ensure higher relative product quality	54	90.0	0	0	6	0
Average Response	44	73.6				

During the idea generation phase of the commercialization process the respondents generally performed well, as an average “YES” response of 73.6% was noted for all the relevant questions.

With regard to “Create a plan of action” (61.7%) and “I acquired good market information and did adequate homework on the invention” (51.7%), the respondents had an average performance. Only a few of the respondents considered this as unimportant, or did not know about it.

Merely 38.3% of the respondents identified product roll-out issues and constraints. As many as 23 of the respondents indicated that they did not know about this step. It is deplorable to note that so many of the respondents do not even know that it is vitally important to identify the issues and constraint of the invention one aims to commercialize. In other words, it is possible that these respondents will progress through the commercialization process, investing time and money, only to find out later that there is a critical flaw in their invention.

Only 30% of the respondents indicated that they know what the steps of the commercialization process entails. This is a very low percentage as knowledge on the commercialization process is vital to innovators. Knowledge enables innovators to understand what should be in place before they can start the commercialization process or move on to from one phase to the next. It can be noted that ten of the respondents did not know about the steps in the commercialization process at all.

The respondents performed very poorly on “Exploit market opportunities rapidly” (40%) as well as “Ensure early product introduction into the market” (23.3%). None of the respondents considered these two factors as unimportant; however, several reasons were noted for their poor performance in this regard.

Table 5.8 shows the reasons most often cited for not performing well in this phase of the commercialization process, as given by the respondents:

Table 5.8: Reasons given for not completing certain steps during the idea generation phase

Exploit new market opportunities rapidly	Lack of money No access to support in terms of government institutions or partners The innovation process is a long and frustrating process Lack of resources and knowledge
Ensure early product introduction	Lack of money The innovation process is a long and frustrating process Lack of resources and knowledge Divided attention as the respondents have to work and concentrate on their inventions
Create a plan of action	It doesn't work that way in the market I don't have the knowledge
I know what the steps in the commercialization process are	It doesn't work that way in the market I only have limited knowledge of the process I don't have the knowledge
I acquired good market information	I only did informal research as I don't have time for formal research I don't need market research as I see the need from my work or experience I don't have enough time, resources or knowledge A big institution is interested in my invention and therefore I don't need market research
I identified product roll-out issues and constraints	I do not have the knowledge

As can be seen from table 5.8 above, a lack of resources, knowledge and support were the main barriers to the respondents during the idea generation phase.

The next table that will be discussed are the responses of the innovators in terms of the disclosure phase of the commercialization process.

Table 5.9: The disclosure phase of the commercialization process.

Q 16: Indication of the aspects that were completed during the disclosure phase of the commercialization process.			NO			
	Yes	% Yes	Not important	I don't know about it	Any other reason	N/A
Disclosure:	32	52.5				0
Did you obtain a non-disclosure agreement?	41	68.3	5	7	5	0
Did you complete the form correctly?	41	68.3	3	7	5	0
Did you let everyone in contact with your invention sign a disclosure form?	**23**	**38.3**	**15**	**8**	**10**	0
Did you disclose your invention before you spoke about it to anyone?	**21**	**35.0**	**13**	**9**	**13**	0
Protection:	25	41.0				0
Did you obtain protection for your invention?	**21**	**35.0**	**0**	**0**	**38**	0
Did you ensure that your invention can be protected?	31	51.7	0	0	26	0
Did you obtain the help of a qualified professional?	**25**	**41.7**	**0**	**0**	**31**	0
I ensured that all the relevant detail and the function of the invention is accurately protected.	**20**	**33.3**	**0**	**0**	**26**	0
Are you aware of the different forms of protection that are available?	26	43.3	2	7	22	0
Options:	26	43.3				
Patent	**19**	**31.7**				
Trademark	0	0.0				
Trade secret	0	0.0				
Copyright	1	1.7				
Industrial design	4	6.7				
Integrated circuit topographies	0	0.0				
Non-disclosure agreements	2	3.3				

The average response during the disclosure phase was moderately positive as 52.5% of the respondents said YES, they did successfully disclose the invention. However, the core of protecting an invention, i.e. registration of, for example, a patent, was not successfully completed as only 41% had an overall positive response.

It is alarming to note that 35% - 38.3% of the respondents did not disclose their invention before talking about it. This implies that the respondents talk to other people about their invention without the necessary protection in place, not realizing that any of these individuals can then steal their idea and attempt to commercialize this invention. Furthermore, between 22% and 25% of the respondents did not think it is important to

disclose the invention before talking to anyone about is. The other reasons most often cited for this by the respondents are that they either trust people or did not think it is important.

Regarding the protection of an invention, the respondents performed very poorly as very few of the respondents (only 35%) obtained protection for their inventions; enlisted the help of a qualified professional (only 41.7%) or ensured that all the detail of the invention is accurately protected (merely 33.3%).

Table 5.10 shows the reasons most often cited for not performing well in this phase of the commercialization process, as given by the respondents:

Table 5.10: Reasons given for not completing certain steps during the disclosure phase

Did you let everyone in contact with your invention sign a disclosure form?	I trust people
Did you disclose your invention before you spoke about it to anyone?	I trust people
Did you obtain protection for your invention?	I do not have enough money Product development institution says it cannot be patented I am not there yet
Did you obtain the help of a qualified professional?	I do not have enough money Product development institution says it cannot be patented Make money and step out I am not there yet
I ensured that all the relevant detail and the function of the invention is accurately protected.	I do not have enough money Make money and step out I am not there yet

From table 5.10 it can be seen that the respondents fared poorly in the disclosure phase of the commercialization process because they view legal advice as too expensive or they trust people not to steal their invention.

Table 5.11 indicates the responses of the innovators in terms of the evaluation phase of the commercialization process and will be discussed next.

Table 5.11: The evaluation phase of the commercialization process.

Q 17: Indication of the aspects that were completed during the evaluation phase of the commercialization process.			NO			
	Yes	% Yes	Not important	I don't know about it	Any other reason	N/A
I established new product project guidelines, i.e. expectations of how the invention will perform in the market.	45	75.0	3	7	5	0
I conducted a preliminary, non-scientific market assessment; offering a first and quick look at the market.	54	90.0	0	1	5	0
I did an initial, preliminary appraisal of the technical merits and difficulties of the invention.	55	91.7	0	0	5	0
I completed detailed market research.	**9**	**15.0**	**0**	**0**	**51**	**0**
I drew a reasonable sample of respondents for the research.	**9**	**15.0**	**0**	**0**	**49**	**1**
I have a formal research design.	**10**	**16.7**	**0**	**0**	**49**	**1**
I ensured a consistent data collection procedure.	**9**	**15.0**	**0**	**1**	**49**	**1**
I developed a business plan to ensure that I have thought through the process as well as all the advantages and disadvantages of the invention and the commercialization thereof.	**20**	**33.3**	**1**	**0**	**39**	0
I started the invention small to not require too much capital, time or people.	30	50.0	0	0	11	19
I know what resources and how much will be needed at the different phases of the development process of the invention.	34	56.7	0	0	26	0
I have decided how commercial advantages can be secured if the inventions were used to establish a new business.	59	98.3	0	0	0	1
Average Response	30	50.6				

During this phase the respondents performed very poorly on the market research related activities. Approximately 15% - 16.7% of the respondents completed detailed market research; drew a reasonable sample of respondents; had a formal research design; or a consistent data collection procedure. It is interesting to note that none of the respondents viewed these steps as unimportant; however, other reasons prohibited them from doing accurate market research. These reasons will be discussed in table 5.12.

Merely 33.3% of the respondents developed a business plan and in the theory employed this is regarded as one of the most important steps to complete in the commercialization of an invention.

Table 5.12 shows the reasons most often cited for not performing well in this phase of the commercialization process, as given by the respondents. As the respondents listed the same reasons for not completing the activities related to market research, these activities are grouped under the term “Good market research”.

Table 5.12: Reasons given for not completing certain steps during the evaluation phase

I did good market research	I do not have the resources, time or knowledge I can see the need from my work or personal experience I am convinced it will work from the informal research I am not at this part of the process yet
I developed a business plan	I do not have the resources, time or knowledge Divided attention as I have to work and focus on the invention

According to the information from table 5.12, the main barrier to completing market research or developing a business plan is a lack of knowledge, resources and time.

The responses of the innovators in terms of the technology development phase of the commercialization process are listed in table 5.13 and will be discussed thereafter.

Table 5.13: The technology development phase of the commercialization process.

Q 18: Indication of the aspects that were completed during the technology development phase of the commercialization process.			NO			
	Yes	% Yes	Not important	I don't know about it	Any other reason	N/A
I made prototypes to generate technical and market proof of the invention.	41	68.3	0	0	17	2
I studied the availability and content of the support and development services provided by the local institutions	37	61.7	0	0	23	0
I decided whether the invention will be manufactured in-house, or if the whole product, or parts of it, must be bought from suppliers.	53	88.3	1	1	3	2
I moved on to product development, i.e. the complete development of the product	**15**	**25.0**	**0**	**0**	**41**	**4**
I ensured that the invention can be effectively manufactured and sold on a part-time basis in order to focus attention on marketing activities and to still earn an income from another job.	46	76.7	1	0	12	1
Initially, I tested the product in the lab or under controlled conditions rather than with customers.	**17**	**28.3**	**5**	**0**	**28**	**9**
I considered whether the inventions have more potential and greater returns in the form of royalties or assignment fees than from selling it myself.	47	78.3	0	0	13	0
Average Response	37	61.0				

During the technology development phase of the commercialization process, the respondents performed much better. This was expected as the client base of a product development institution was obtained as the sample for this study. However, from the 60 respondents, only 15 (25%) moved on to complete product development, listing a variety of reasons (which will be reflected in Table 5.14) for this.

Very few of the respondents tested their invention in a lab or under controlled conditions, rather than on the customers (only 28.3%). Five of the respondents who did not test their invention stated that they believed this was not important and for the remainder a variety of reasons (reflected in Table5.14) were given.
Table 5.14 shows the reasons most often cited for not performing well in this phase of the commercialization process, as given by the respondents.

Table 5.14: Reasons given for not completing certain steps during the technology development phase

I moved to product development	I am not at this part of the process yet I do not have the money Lack of support from government institutions I do not have the time or knowledge
I tested the product in a lab or under controlled conditions	I am not at this part of the process yet I know the invention will work I do not have the time or money to do this

Table 5.14 indicates that the majority of the respondents who did not complete this step were simply not at this part of the process yet, or did not have the resources to the step.

The next table that will be discussed are the responses of the innovators in terms of the funding phase of the commercialization process.

Table 5.15: The funding phase of the commercialization process.

Q 19: Indication of the aspects that were completed during the funding phase of the commercialization process.			**NO**			
	Yes	**% Yes**	**Not important**	**I don't know about it**	**Any other reason**	**N/A**
I secured sufficient resources for the commercialization. This entails not only financial resources, but any resources that are needed to successfully commercialize an invention.	**18**	**30.0**	**0**	**0**	**42**	0
I continuously monitor the money that I spend	58	96.7	1	0	1	0
I conducted a business and financial analysis	**26**	**43.3**	**0**	**4**	**29**	0
I ensured the invention can be commercialized from within the existing business, if one exists.	**18**	**30.0**	**0**	**0**	**2**	**40**
I ensured the invention can be produced at a reasonable and beneficial cost.	55	91.7	0	0	3	2
I ensured that there is a price advantage over existing competition or substitutes.	45	75.0	0	0	10	5
My invention is affordable to the relevant market	58	96.7	0	0	2	0
I guaranteed that the invention provides good value-for-money for customers	60	100.0	0	0	0	0
My invention is more expensive, but it is a better product.	20	33.3	0	0	4	36
Average Response	40	66.3				

During this phase the respondents performed very well in certain financial aspects, but poorly in others. The vast majority of the respondents continuously monitor the money they spend, ensured that their invention is affordable to the relevant market and provide good value for money.

The areas in which the respondents did not perform well is securing sufficient resources for the commercialization process (only 30% of the respondents did) and conducting a business and financial analysis (only 43% of the respondents did).

Very few of the respondents have an already established business and therefore the majority of the respondents marked this question as “Not applicable”.

Table 5.16 shows the reasons most often cited for not performing well in this phase of the commercialization process, as given by the respondents.

Table 5.16: Reasons given for not completing certain steps during the funding phase

I secured sufficient resources for the commercialization	I do not have sufficient money/resources Lack of support from government institutions
I conducted a business and financial analysis	I do not have the resources or knowledge I know it will work

Once again, the lack of resources is indicated as the main reason for not completing certain steps in the funding phase.

The following table (table 5.17) are the responses of the innovators in terms of the funding phase of the commercialization process.

Table 5.17: The funding phase of the commercialization process.

Q20: Statements regarding the financial aspect.	Yes	% Yes	No	Uncertain
Do you know how long it will take to receive payback on your invention?	**21**	**35.0**	**23**	**16**
Do you know what the margin between costs and sales price is?	**27**	**45.0**	**21**	**12**
Did you anticipate what the start-up expenses will be?	37	61.7	15	8
Can you anticipate what resources will be needed through the process?	33	55.0	13	14
Can you efficiently manage the financial affairs?	59	98.3	0	1
Do you have sufficient capital to commercialize the invention on your own?	**13**	**21.7**	**47**	**0**
Average Response	32	52.8		

Very few of the respondents have sufficient capital to commercialize the invention on their own as only 21.7% of the respondents indicated that they have the resources (this includes any type of resource that is needed to start a business). Altogether 39 of the 60 respondents were uncertain or did not know how long it will take to receive payback on their inventions. This was to be expected as 33 of the respondents do not know what the margin between costs and sales price is.

For this question in the questionnaire, the respondents could only answer YES, NO and UNCERTAIN. They were not given the opportunity to give any reasons when they answered NO or UNCERTAIN.

The respondents were thereafter asked where they will go to in order to obtain financial help if they do not have sufficient capital to commercialize your invention. These results are shown in table 5.18.

Table 5.18: Where the respondents will go to in order to obtain financial help.

Q 21: Indication of where the individuals will obtain financial help.	Yes	% Yes	No
Bank	6	10.0	54
Partner	30	50.0	30
Government institutions	22	36.7	38
Lisensing	7	11.7	53
Other	0	0.0	56
Average Response	13	21.7	

The majority of the respondents (50%) indicated that they would attempt to get financial support from a partner rather than any of the other listed options and 36.7% said they would ask a government institution for help.

Only 10% indicated that they would consider turning to a bank for financial support. Perhaps this indicates that the new loan policy of financial institutions can have a negative impact on SMME development in South Africa.

For this question in the questionnaire, the respondents could only answer YES, NO and UNCERTAIN. They were not given the opportunity to give any reasons when they answered NO or UNCERTAIN.

The next table that will be discussed are the responses of the innovators in terms of the pre-commercialization phase of the commercialization process.

Table 5.19: The pre-commercialization phase of the commercialization process.

Q 22: Indication of the aspects that were completed during the pre-commercialization phase of the commercialization process.			NO			
	Yes	% Yes	Not important	I don't know about it	Any other reason	N/A
After the prototype was produced I sold the product to a limited or test set of customers.	**10**	**16.7**	**10**	**0**	**39**	**1**
I secured skilled employees during the commercialization of the invention, if needed.	**12**	**20.0**	**0**	**0**	**47**	**1**
I promoted the invention in order for the technology to be adopted.	**13**	**21.7**	**1**	**0**	**45**	**1**
I formalized the development process in terms of deciding what methods, machinery and/or technology is needed to efficiently develop the invention	30	50.0	0	0	29	1
I ran a trail production to determine whether the current facilities and skill set of employees are sufficient to produce the intended product.	**12**	**20.0**	**2**	**0**	**45**	**1**
I determined roll-out equipment needs and manufactured the product in quantities large enough to identify problems	**19**	**31.7**	**1**	**0**	**39**	**1**
I analyzed marketing opportunities in terms of the needs and wants of the potential markets and segmented the markets in order to identify the target markets.	49	81.7	0	0	11	0
I ensured that there is an attractive environment for SMEs. In other words, the political-legal, economic, technological etc. environments must be positive to commercialize the specific invention.	59	98.3	0	0	1	0
I commenced with the full scale or commercial production of the product.	**11**	**18.3**	**0**	**0**	**48**	**1**
I started the market launch, in other words the launch of the product, on a full-scale and/or commercial basis.	**12**	**20.0**	**0**	**0**	**48**	**0**
Average Response	23	37.8				

During the pre-commercialization phase of the commercialization process the respondents performed very poorly as the average overall positive response of this phase was only 37.8%.

The respondents did not sell their invention to a test set of customers and apart from the other reasons given (see table 5.20) 10 of the respondents did not think it is important to do this.

Although only 20% of the respondents secured skilled employees, it should be noted that the majority of the respondents indicated that it is not applicable to them as they will start their invention small. The majority of the respondents did not promote the invention, ran a trial production, determined the roll-out equipment needs, commenced with full scale production or started the market launch, simply as they are not at this part of the process yet.

Table 5.20 shows the reasons most often cited for not performing well in this phase of the commercialization process, as given by the respondents.

Table 5.20: Reasons given for not completing certain steps during the pre-commercialization phase

After the prototype was produced I sold the product to a limited or test set of customers.	I am not at this part of the process yet I know it will work I do not have the time
I secured skilled employees during the commercialization of the invention, if needed.	I am not at this part of the process yet I do not need other employees
I promoted the invention in order for the technology to be adopted.	I am not at this part of the process yet
I ran a trail production to determine whether the current facilities and skill set of employees are sufficient to produce the intended product.	I am not at this part of the process yet I know it will work
I determined roll-out equipment needs and manufactured the product in quantities large enough to identify problems	I am not at this part of the process yet I do not have enough money BEE at government institutions meant that I did not qualify for money or support
I commenced with the full scale or commercial production of the product.	I am not at this part of the process yet I do not have the time BEE at government institutions meant that I did not qualify for money or support
I started the market launch, in other words the launch of the product, on a full-scale and/or commercial basis.	I am not at this part of the process yet I do not have the time BEE at government institutions meant that I did not qualify for money or support

During the pre-commercialization phase of the commercialization process, the main reason why the respondents did not complete certain steps were merely because they are not at this part of the process yet.

The next table (table 5.21) that will be discussed are the responses of the innovators in terms of the commercialization phase of the commercialization process.

Table 5.21: The commercialization phase of the commercialization process.

Q 23: Indication of the aspects that were completed during the commercialization phase of the commercialization process.			NO			
	Yes	% Yes	Not important	I don't know about it	Any other reason	N/A
I know what I want to achieve during each phase of the commercialization process.	26	43.3	16	6	11	0
I constantly compare the performance planned to achieve with the actual performance.	**18**	**30.0**	**1**	**0**	**41**	**0**
I have identified ways and means to ensure that the performance of the invention will remain on the current level.	**12**	**20.0**	**0**	**0**	**48**	**0**
I aim at market leadership in the given market.	42	70.0	2	0	16	0
Average Response	25	40.8				

Many of the respondents (approximately 41) indicated that they were not at the commercialization phase of the commercialization process yet, and therefore they could not compare the planned performance against the actual performance as there was no performance thus far. This implies that they could not yet have identified ways to ensure that the performance of the invention remains on the current level.

The minority of the respondents (16 of the 60 respondents) think that it is not important to know what one wants to achieve during each phase of the commercialization process; 70% aim at market leadership in the given market, regardless of whether they have already introduced their inventions to the market or not.

The responses of the innovators in terms of the market research phase of the commercialization process are indicated in table 5.22.

Table 5.22: The market research phase of the commercialization process.

Q 24: Indication of the aspects that were completed during the market research phase of the commercialization process.			NO			
	Yes	% Yes	Not important	I don't know about it	Any other reason	N/A
I devoted adequate resources to marketing activities.	11	18.3	0	0	49	0
I ensured that there are people who will buy my product.	59	98.3	0	0	1	0
I defined the product (the target market, concept, benefits and positioning, and its requirements and features) before development began.	59	98.3	0	0	1	0
Consumers will find that my invention fits in with their needs and lifestyle.	59	98.3	0	0	0	0
I know that my invention will be useful for a long time.	60	100.0	0	0	0	0
The invention I want to sell will stand out in the marketplace	59	98.3	0	0	1	0
I have built several kill/go decision points into the commercialization process.	21	35.0	7	17	15	0
I implemented high quality marketing actions	12	20.0	0	0	46	0
I know who the intended users are and ensure that the invention will meet their needs.	59	98.3	0	0	1	0
I determined whether the invention is subject to any laws that limit, restrict, control, regulate or ban such things as production, ownership, distribution, or operation of the product.	59	98.3	0	1	0	0
I determined that the market will not be too small to warrant company creation	50	83.3	4	3	2	0
I ensured a superior (better/unique) product by accessing, gathering and exploiting the market and the customer information.	59	98.3	0	0	1	0
I have determined whether there is a serious competitive threat in the market already.	60	100.0	0	0	0	0
I anticipate that new competitors will appear once the invention is commercialized.	56	93.3	0	1	3	0
I ensured that the customers can easily understand the correct use of the product.	59	98.3	0	0	0	0
Average Response	49	82.4				

The respondents performed very poorly in terms of marketing related activities as only 18.3% - 20% of the respondents devoted adequate resources to marketing activities or implemented high quality marketing actions.

Merely 35% of the respondents built kill/go decision points into the commercialization process and the two reasons given for this is: 1) I do not know about it and 2) I know this invention will work.

Table 5.23 shows the reasons most often cited for not performing well in this phase of the commercialization process, as given by the respondents.

Table 5.23: Reasons given for not completing certain steps during the market research phase

I devoted adequate resources to marketing activities.	I do not have the resources or knowledge I am not at this part of the process yet I only did it on an informal basis, I do not have time for formal marketing activities
I have built several kill/go decision points into the commercialization process.	I know it will work
I implemented high quality marketing actions	I am not at this part of the process yet I do not have the resources or knowledge I only did it on an informal basis, I do not have time for formal marketing activities

From table 5.23 it can be seen that the main reasons why the respondents did not take certain steps during the market research phase are a lack of resources and knowledge, not being at this part of the process yet and confidence that their invention will work.

The respondents were now asked why they did not complete market research, if applicable. Table 5.24 show the responses of the innovators in terms of the market research phase of the commercialization process discussed.

Table 5.24: The market research phase of the commercialization process.

Q 25: Indication of the reasons why the respondents did not complete market research	**Yes**	**% Yes**	**No**	**Any other reason**
I am afraid someone will steal my idea	3	5.0	48	0
Market research is too expensive	25	41.7	27	0
I do not know how to do market research	12	20.0	40	0
I rely on and trust my gut feel	5	8.3	47	0
Market research does not give a true reflection of the market needs and wants	5	8.3	47	0
Other:	0	0.0	34	16
Average Response	14	23.7		

The two main reasons why the respondents did not do market research are firstly, that they believe market research is too expensive and secondly, that they do not know how to do market research. Only 5% of the respondents indicated that they did not do market research because they are afraid that someone will steal their idea.

The following question the respondents had to answer was how they completed their market research, if they have done market research. Part of their responses are shown in table 5.25.

Table 5.25: The market research phase of the commercialization process.

Q26: Indication of how the market research, if any, were done.				
	Yes	**% Yes**	**How?**	**N/A**
How did you do market research?	12	20.0		48

The respondents who did do market research obtained professional help or did internet searches on their own.

The next table (table 5.26) will discuss the response of the innovators in terms of how the innovators view themselves with respect to their overall entrepreneurial abilities.

Table 5.26: The innovator.

Q 27: Indication of whether the respondents believed the following statement to be applicable to them to a great extent, to a reasonable extent, not so much or not at all.	**To a great extent**	**To a reasonable extent**	**Neither applicable nor inapplicable**	**Not so much**	**Not at all**
I have the know-how and skills capacity and, if needed, I will acquire technical knowledge from outside sources.	**33 (55%)**	**26 (43.33%)**	0 (0%)	1 (1.67%)	0 (0%)
I have sufficient access to external networks of resource providers to ensure successful commercialization.	22 (36.67%)	13 (21.67%)	3 (5%)	**20 (33.33%)**	2 (3.33%)
I am prepared to/will form collaboration and partnerships when it is in my best interest.	**46 (76.67%)**	**10 (16.67%)**	0 (0%)	2 (3.33%)	2 (3.33%)
I ensured that I have the relevant experience and/or education.	25 41.67%)	30 (50%)	1 (1.67%)	3 (5%)	1 (1.67%)
I learn from and reduce mistakes and misunderstandings.	45 (75%)	15 (25%)	0 (0%)	0 (0%)	0 (0%)
I constantly redesign the innovation process around best practices in order to continuously improve the process.	28 (46.67%)	26 (43.33%)	5 (8.33%)	1 (1.67%)	0 (0%)
I take some chances, cut corners, collapse activities or omit certain steps in order to get to market as quickly as possible.	6 (10%)	16 (26.67%)	1 (1.67%)	**25 (41.67%)**	**12 (20%)**
I ensured the quality of execution of the commercialization process.	24 (40%)	32 (53.33%)	4 (6.67%)	0 (0%)	0 (0%)
I evaluate and react to risk well.	**21 (35%)**	**36 (60%)**	0 (0%)	3 (5%)	0 (0%)

Regardless of how the respondents performed during the commercialization process in terms of the questions previously asked in the questionnaire, the vast majority (59 of the 60 respondents) indicated that they believe they have the know-how and knowledge needed to succeed in the commercialization process; furthermore, 55 of the respondents indicated that they had the relevant experience and/or education. The respondents also indicated that they will acquire technical knowledge, such as prototype development, etc. from outside sources. However, when looking at the steps that the respondents omitted because they did not know about it or thought it to be unimportant, it can be argued that the respondents must re-evaluate their true skills capacity.

While most of the respondents (35 respondents) indicated that they did have sufficient access to external networks of resource providers it should be noted that these individuals all had access to the CRPM and PDTS to help with the technological development of their inventions. The 20 respondents who indicated that they do not have sufficient access to external networks of resource providers is the point of concern. Where will these individuals go to obtain help during this challenging process and if they cannot find timely and good help, will their inventions fail?

The majority of the respondents also indicated that they will:

- Form collaboration and partnerships when it is in their best interest (56 respondents)
- Learn from mistakes and misunderstandings (all 60 of the respondents)
- Constantly redesign the innovation around best practices in order to continuously improve the process
- Avoid taking changes, cutting corners or omitting certain steps to get to the market as quickly as possible (37 of the respondents)
- Ensure the quality of execution of the commercialization process
- Evaluate and react to risk well (57 of the respondents).

5.8 Demarcation of the study

Many innovators generate great new inventions, but very few of these inventions ever make it to the market and therefore there is a need to determine why or where in the commercialization process these inventions become stagnant or fail.

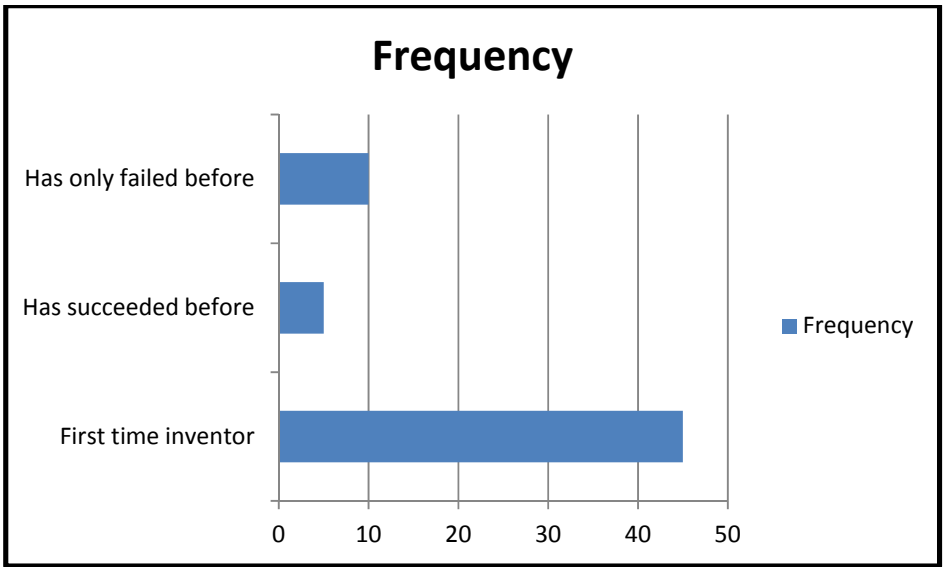
The focus of this study is to determine where the innovators became stagnant in the commercialization process. In other words, during which of the phases during the commercialization process did the respondents progress at a slower pace or made no progress at all. The intention was to identify factors that can become barriers to successful commercialization during the commercialization process.

The respondents were asked to indicate which of the following statements are applicable to them. They could mark more than one option:

- A:This is the first invention I aim to commercialize
- B: I have already successfully commercialized several inventions
- C I have already failed at commercializing inventions

From these results Figure 5.9 was created.

Figure 5.9: Inventor groups



From figure 5.9 it is clear that the vast majority of the respondents are currently in the process of commercializing their first innovation, while the innovators who have already succeeded in commercializing or failed at it are very few. The need for this study is accentuated when considering these statistics. There exists a great need to determine why the innovators failed during the process as well as why there are so few innovators who managed to commercialize their inventions successfully.

5.9 Composing the different groups

In order to successfully apply Anova and T-Test to the research study, the respondents were grouped into one of three groups, namely:

- Those who ***finalized*** the commercialization of their innovation;
- Those who are ***busy*** with the commercialization of the innovation and
- Those who have become ***stationary*** in the process of commercialization.

The respondents were asked to indicate the month and year in which they went through the following main phases of the commercialization process: Idea generation, Legally protecting their invention; Prototype development; Market research; Identify potential funding opportunities; and Commercialize their invention. From the information gained from this question in the research questionnaire, the abovementioned groups were formed.

- The ***finalized*** group was formed by the respondents who had successfully commercialized their innovation
- The ***busy*** and ***stationary*** groups were formed by determining the last year in which any progress was made by those respondents who had not yet commercialized their innovation.

Table 5.27 shows the frequency table of 'Finished commercializing invention' vs. 'Year of last progress made'

Table 5.27: 'Finished commercializing invention' vs. 'Year of last progress made'

		Finished commercializing invention	
		No	Yes
Year of last progress made	2002	2	0
	2005	2	0
	2006	10	0
	2007	6	1
	2008	9	1
	2009	11	8
	2010	8	2

Grouping	
Frequency	Group name
20	Stationary
28	Busy
12	Finalised

The following is an explanation of how the three different groups of respondents were created by using the abovementioned table (table 5.27)

- From the table above it can be seen that 20 of the respondents (2+2+10+6 = 20) have not made any progress since 2007 and therefore these individuals are grouped in the ***stationary*** group.
- Furthermore, 28 (9+11+8 = 28) of the respondents has made some progress since 2008. However, these individuals run the risk of becoming stationary if they do not keep up a steady tempo of moving through the commercialization process. These individuals were placed in the ***busy*** group.
- Only 12 (1+1+8+2) of the 60 innovators interviewed have commercialized their inventions successfully. These respondents form the ***finalized*** group. It is interesting to note that the innovators who went through the commercialization process successfully, moved rather quickly (maximum of two years from idea generation to commercialization), while the innovators in the Busy and Stationary groups moves at a much slower pace.

It should be noted that even though the sample of this study was drawn from the client base of the CRPM and PDTS from 2005 to 2010, the respondents could have generated their idea for the invention before they contacted the CRPM and PDTS to produce a prototype of their invention. Therefore, the reference to 2002 in table 5.27 is not incorrect; it is simply the year in which the respondents indicated that they generated the idea of their invention.

5.10 Completion of the different phases

The questionnaire of this research study was created by listing the different steps or phases in the commercialization process as indicated by the theory. Furthermore, the most often cited failure or success factors was also identified from the research and reformulated into a step in the commercialization process (the complete commercialization process as well as the success or failure factors can be found in Chapter 3 of this study). For example, one of the success factors mentioned is: "The invention must be produced at a reasonable and beneficial cost" is a factor of successful commercialization, and in the questionnaire it was listed as a step in the commercialization process, i.e. "I ensured that the invention can be produced at a reasonable and beneficial cost"

However, the order of the phases of the commercialization process, as suggested by the theory consulted, were not the same as the order of the phases that the innovators actually followed in commercializing their inventions.

Table 5.28 indicates the amount of time it took the respondents to complete a certain phase as well as the number of respondents who completed each phase in brackets.

The respondents who successfully commercialized their inventions started with identifying potential funding opportunities (4.29 months). Shortly after this, they moved to prototype development (4.50 months). Only after the prototype phase, did the respondents move to the market research phase (6.00 months). At this juncture the protection of the invention becomes important and they legally protected (9.00 months) their invention. From this point the successful respondents moved to commercialization (10.67 months).

It is interesting to note that on average, the respondents from the ***busy*** and ***stationary*** groups went through each of the phases at a much slower pace than those respondents who successfully commercialized their inventions.

Table 5.28: The amount of time (in months) it took the respondents to complete a certain phase as well as the number of respondents who completed each phase in brackets.

	Finished	Busy	Stationary
Legally protect invention	9.00 (5)	13.50 (8)	10.00 (9)
Prototype development	4.50 (10)	8.60 (20)	12.94 (16)
Market research	6.00 (6)	6.67 (12)	10.63 (8)
Identify potential funding opportunities	4.29 (7)	10.92 (12)	12.22 (9)
Commercialize	10.67 (12)	N/A (0)	N/A (0)

Consequently it is argued that the phases of the commercialization process are not in chronological sequence concerning how they were performed in this sample.

For this reason new phases were created resulting in a more chronological sequence in the commercialization process. These phases were created by re-grouping the questions that tested similar phases or steps in the questionnaire.

The questions in these phases were then used to create a score for each respondent indicating how thoroughly each phase was performed by each respondent. Therefore questions applicable to only a certain group of respondents were removed from the study, i.e. Question 15q, "I ensured higher relative product quality", as many of the innovators offered a much cheaper product of lower quality.
In order to create the new phase the following questions of the questionnaire were grouped into specific phases:

Phase 1: ***<u>Idea generation:</u>***

Q 15A	Q 15B	Q 15F	Q 15G	Q 15H	Q 15K	Q 15M
Exploit new market opportunities rapidly.	Ensure early product introduction into the market.	I generated several ideas to solve the problem in the market.	I confirmed the practical application of the invention	I created a new, unique and valuable idea.	I confirmed that the invention has benefits perceived as useful and the benefits are highly visible.	Through initial screening I eliminated ideas that are not useful and focused on those with the most potential.

Phase 2: ***<u>Preliminary research:</u>***

Q 15D	Q 15E	Q 15I	Q 15L	Q 15O	Q 17B	Q 17C
I know what the steps in the commercialization process are and will follow these steps.	Explore the market problems and needs	I know there is a gap in the market for the invention.	I acquired good market information and did adequate homework on the invention	I identified product roll-out issues and constraints	I conducted a preliminary, non-scientific market assessment; offering a first and quick look at the market.	I did an initial, preliminary appraisal of the technical merits and difficulties of the invention

Phase 3: ***<u>Planning:</u>***

Q 15C	Q 17A	Q 17H	Q 17J	Q 17K	Q 18B
Create a plan of action (i.e. follow a strategy).	I established new product project guidelines, i.e. expectations of how the invention will perform in the market.	I developed a business plan to ensure that I have thought through the process as well as all the advantages and disadvantages of the invention and the commercialization thereof.	I know what resources and how much will be needed at the different phases of the development process of the invention.	I have decided how commercial advantages can be secured if the inventions were used to establish a new business.	I studied the availability and content of the support and development services provided by the local institutions
Q 18E	**Q 18G**	**Q 19C**	**Q 23A**	**Q 24G**	**Q 24N**
I ensured that the invention can be effectively manufactured and sold on a part-time basis in order to focus attention on marketing activities and to still earn an income from another job.	I considered whether the inventions have more potential and greater returns in the form of royalties or assignment fees than from selling it myself.	I conducted a business and financial analysis	I know what I want to achieve during each phase of the commercialization process	I have built several kill/go decision points into the commercialization process.	I anticipate that new competitors will appear once the invention is commercialized.

Phase 4: ***<u>Legal protection:</u>***

Q 16A	Q 16A	Q 16B	Q 16B	Q 16B	Q 16C	Q 24J
Did you obtain a non-disclosure agreement?	Did you let everyone in contact with your invention sign a disclosure form?	Did you obtain protection for your invention?	Did you obtain the help of a qualified professional?	Are you aware of the different forms of protection that are available?	*Indicate the different options that you made use of to protect your idea.* Patent -Trademark -Trade secret -Copyright Industrial design -Integrated circuit topographies -Non-disclosure agreements	I determined whether the invention is subject to any laws that limit, restrict, control, regulate or ban such things as production, ownership, distribution, or operation of the product.

Phase 5: ***<u>Prototype development:</u>***

Q 18A	Q 18C	Q 18F
I made prototypes to generate technical and market proof of the invention.	I decided whether the invention will be manufactured in-house, or if the whole product, or parts of it, must be bought from suppliers.	Initially, I tested the product in the lab or under controlled conditions rather than with customers.

Phase 6: ***<u>Market research:</u>***

Q 17D	Q 17E	Q 17F	Q 17G	Q 19H	Q 22A	Q 22G	Q 22H
I completed detailed market research.	I drew a reasonable sample of respondents for the research	I have a formal research design.	I ensured a consistent data collection procedure.	I guaranteed that the invention provides good value-for-money for customers	After the prototype was produced I sold the product to a limited or test set of customers.	I analyzed marketing opportunities in terms of the needs and wants of the potential markets and segmented the markets in order to identify the target markets.	I ensured that there is an attractive environment for SMEs. In other words, the political-legal, economic, technological etc. environments must be positive to commercialize the specific invention.

Q 24B	Q 24C	Q 24D	Q 24E	Q24 F	Q 24K	Q 24L	Q 24M
I ensured that there are people who will buy my product.	I defined the product (the target market, concept, benefits and positioning, and its requirements and features) before development began.	Consumers will find that my invention fits in with their needs and lifestyle.	I know that my invention will be useful for a long time.	The invention I want to sell will stand out in the marketplace	I determined that the market will not be too small to warrant company creation	I ensured a superior (better/ unique) product by accessing, gathering and exploiting the market and the customer information.	I have determined whether there is a serious competitive threat in the market already.

Phase 7: ***<u>Resources:</u>***

Q 17I	Q 19A	Q 19B	Q 19E	Q 19G
I started the invention small to not require too much capital, time or people.	I secured sufficient resources for the commercialization. This entails not only financial resources, but any resources that are needed to successfully commercialize an invention.	I continuously monitor the money that I spend	I ensured the invention can be produced at a reasonable and beneficial cost.	My invention is affordable to the relevant market
Q 20A	**Q 20B**	**Q 20C**	**Q 20E**	**Q 22B**
Do you know how long it will take to receive payback on your invention?	Do you know what the margin between costs and sales price is?	Did you anticipate what the start-up expenses will be?	Can you efficiently manage the financial affairs?	I secured skilled employees during the commercialization of the invention, if needed

Phase 8: ***<u>Pre- commercialization:</u>***

Q 22C	Q 22D	Q 22E	Q 22F	Q 24A	Q 24H	Q 24O
I promoted the invention in order for the technology to be adopted.	I formalized the development process in terms of deciding what methods, machinery and/or technology is needed to efficiently develop the invention	I ran a trail production to determine whether the current facilities and skill set of employees are sufficient to produce the intended product.	I determined roll-out equipment needs and manufactured the product in quantities large enough to identify problems	I devoted adequate resources to marketing activities.	I implemented high quality marketing actions	I ensured that the customers can easily understand the correct use of the product.

Phase 9: ***<u>Commercialization:</u>***

Q 22I	Q 22J	Q 23B	Q 23C	Q 23D	Q 18 D
I commenced with the full scale or commercial production of the product.	I started the market launch, in other words the launch of the product, on a full-scale and/or commercial basis.	I constantly compare the performance planned to achieve with the actual performance.	I have identified ways and means to ensure that the performance of the invention will remain on the current level.	I aim at market leadership in the given market.	I moved on to product development, i.e. the complete development of the product

As mentioned, these new phases were created resulting in a more chronological sequence in the commercialization process, as the respondents of this study went through the process of commercialization. This was done to enable further statistical testing. From page 122 onwards the relevance of these new phases as listed above, as well as the statistical tests applied to these phases, will be discussed in great detail.

Table 5.29 shows the percentage of respondents who generated the idea in a specific time interval and completed the listed phase.

In other words, the percentage of respondents who generated the idea in a specific time interval, for example 2000 to 2005; 2006 to 2007, are shown along with the phases that they completed.

Table 5.29: Percentage of respondents who generated the idea in a specific time interval and completed the listed phase

	Idea generation				
	2000 to 2005	2006 to 2007	2008 to 2008	2009 to 2010	TOTAL
Sample size	14	14	17	15	60
Legally protect invention	57.14%	35.71%	23.53%	33.33%	36.67%
Prototype development	92.86%	71.43%	76.47%	66.67%	76.67%
Market research	42.86%	50.00%	35.29%	46.67%	43.33%
Identify potential funding opportunities	57.14%	50.00%	35.29%	46.67%	46.67%
Commercialize	0.00%	28.57%	17.65%	33.33%	20.00%

It is interesting to note that of the innovators who generated their invention between 2000 and 2005, in other words, several years ago, none have successfully commercialized their inventions yet. The innovators who generated the idea for their inventions between 2009 and 2010 have the highest rate (33.33%) of commercialization.

It must be noted that it is expected that many of the innovators had already developed a prototype, as the client base of the PDTS and CRPM (both of which are product development institutions) was used to obtain the sample for the study.

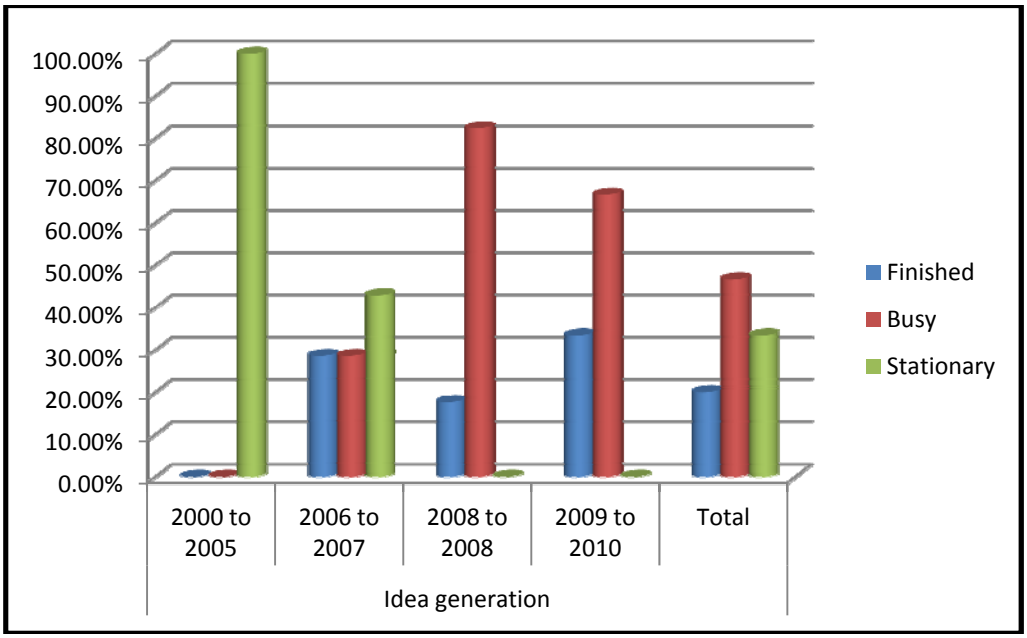
To further elaborate on the time spent to move from idea generation to commercialization, table 5.30 shows the average number of months from idea generation to phase completion (the number of respondents who completed the phase is shown in brackets)

Table 5.30: Average number of months from idea generation to phase completion.

	Finished	Busy	Stationary
Legally protect invention	9.00 (5)	13.50 (8)	10.00 (9)
Prototype development	4.50 (10)	8.60 (20)	12.94 (16)
Market research	6.00 (6)	6.67 (12)	10.63 (8)
Identify potential funding opportunities	4.29 (7)	10.92 (12)	12.22 (9)
Commercialize	10.67 (12)	N/A (0)	N/A (0)

From table 5.30 it is clear that the successful innovators move faster through all the different phases of the commercialization process than the ***busy*** or ***stationary*** group. The phase with the most significant difference between the finished group and the other two groups is the phase of identifying funding opportunities. The innovators who successfully moved through the commercialization process have done so in 4.29 months on average, while the group of innovators who are still ***busy*** used 10.92 months and the ***stationary*** group are far behind with 12.22 months. This table already indicates the importance of finance/resources for successful commercialization.

Figure 5.10: The grouping distribution of respondents who generated the idea in a specific time interval.



From figure 5.10 it can be seen that all the innovators who generated their invention between the years 2000 and 2005 have become ***stationary***. In other words, it has been a long time since these innovators made any progress in the commercialization of their invention. The majority of the innovators who have successfully commercialized their inventions generated the idea for their invention between 2009 and 2010, suggesting perhaps that the success of this process is located in the speed in which one can move through the different phases without sacrificing the quality of each phase.

5.11 Interpretation of the data

In order to distinguish between the different groups or respondents (***finalized, busy*** and ***stagnant)*** a score was then calculated for each group for each of the different phases in the commercialization process.

The score was calculated as follows: Firstly binary variables (that is, variables containing only 0's and 1's) were created for each applicable question where the binary variable had the value of 1 if the respondent answered 'YES' to the question and 0 if the respondent answered 'NO'.

For the question 'Indicate the different options that you made use of to protect your idea, for example Patent, Copyright, etc.' only one binary variable was created with a value of 1 if the respondent made use of at least one of the first 6 options and 0 if the respondent did not make use of any of the listed options. Only the first six options were

used, because the seventh option, Non-disclosure agreements, is already contained in the question ‘Did you obtain a non-disclosure agreement?

Next, the binary variables corresponding to questions in a specific phase were summed to get a score for each respondent for each phase. These scores were then divided by the number of questions in each phase to make them comparable, giving a value between 0 and 1 for each respondent on each phase.

An analysis of variance (Anova) can be performed in order to test for significant differences between two or more groups on a specific variable. In this study, Anova’s were performed in order to determine whether there exists a significant difference between the three groups of respondents (***finished, busy and stationary*** respondent groups of this study) for the nine phases as listed on pages 115 to 118.

An ANOVA (Analysis of variance) was performed on each 'phase score' to determine if there is any significant difference in the average 'phase score' between the three groups (***finished, busy, stationary***).

Table 5.31: Anova analysis

	Finished		Busy		Stationary		ANOVA test results			
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	DF	F-statistic	P-value	
IDEA GENERATION	0.8810	0.1910	0.7296	0.1472	0.7000	0.1599	(2,57)	5.18	0.0086	
PRELIMINARY RESEARCH	0.7024	0.1772	0.6888	0.2059	0.7214	0.1701	(2,57)	0.17	0.8409	
PLANNING	0.6667	0.1330	0.6280	0.2329	0.6292	0.2380	(2,57)	0.15	0.8644	*
LEGAL PROTECTION	0.4643	0.3558	0.4745	0.2962	0.6071	0.3207	(2,57)	1.23	0.3003	
PROTOTYPE	0.7500	0.2513	0.6071	0.2877	0.5500	0.2484	(2,57)	2.12	0.1296	
MARKET RESEARCH	0.7344	0.1438	0.6964	0.1002	0.7094	0.1134	(2,57)	0.47	0.6304	
RESOURCES	0.8583	0.0793	0.5857	0.1779	0.5400	0.1429	(2,57)	18.28	<.0001	
PRE COMMERCIALIZATION	0.7381	0.1592	0.3265	0.2545	0.2571	0.1944	(2,57)	19.91	<.0001	
COMMERCIALIZATION	0.8611	0.1858	0.1905	0.1617	0.1417	0.1355	(2,57)	91.61	<.0001	*

* Significant at the 0.05 level

*

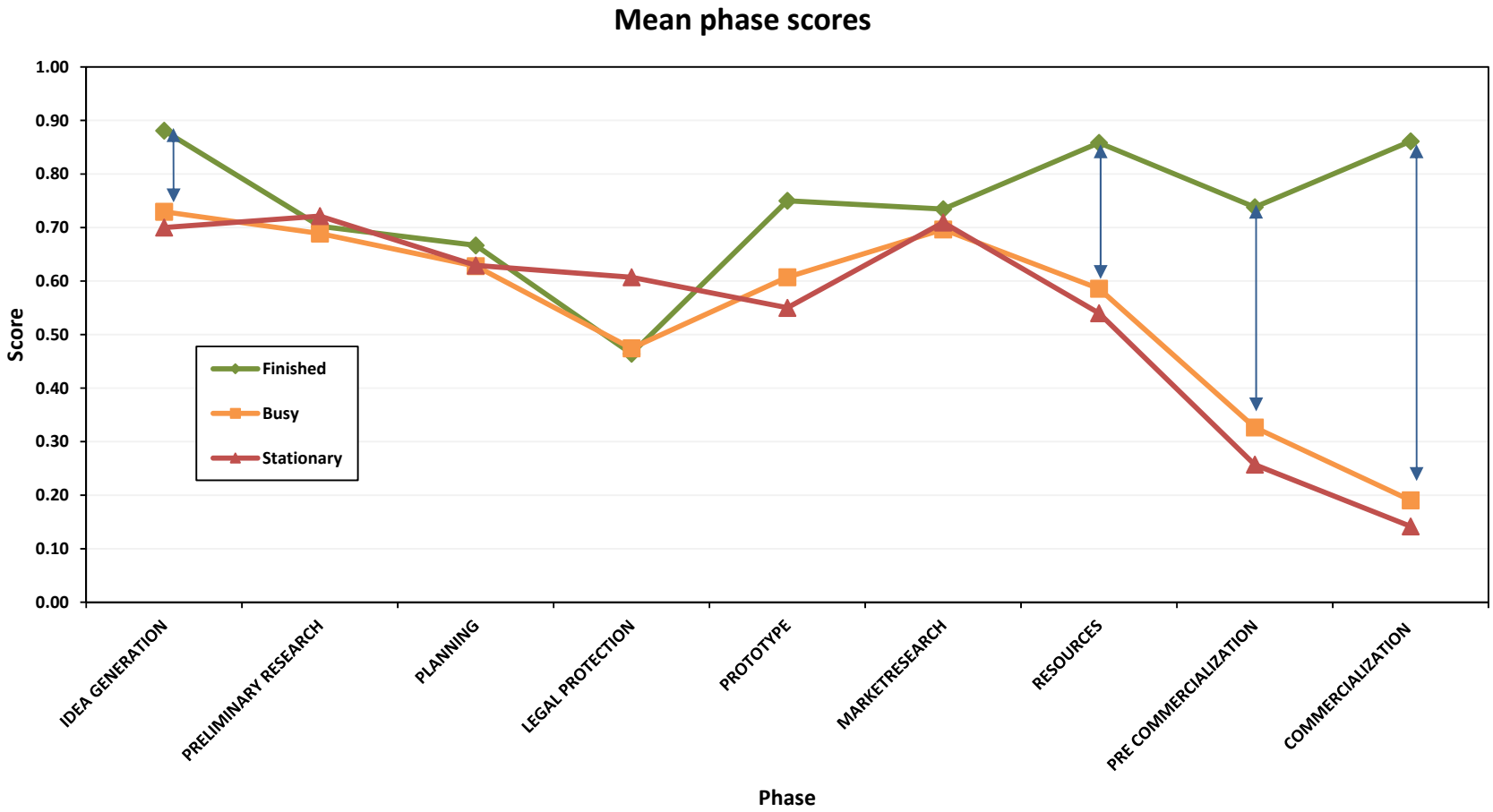
A significant difference was found in four of the phases: Idea generation, resources, pre-commercialization and commercialization. These phases refer to the phases that were created from pages 115 to 118.

After determining the phases with significant difference, Tukey's multiple comparison procedure was performed for each significant phase to determine where the difference was. This was done on a 0.05 significance level.

All four phases (idea generation, resources, pre-commercialization and commercialization) indicated a significant difference between the ***finished*** and ***busy*** group as well as between the ***finished*** and ***stationary*** group. There was no significant difference between the ***busy*** and ***stationary*** groups, as can be seen from figure 5.11.

The significant differences are indicated in figure 5.11.

Figure 5.11: The significant differences between the three groups, i.e. finished, busy, stationary



As can be seen from figure 5.11, there is a big difference in the way the respondents who are part of the ***finished*** group moved through the commercialization process, as opposed to the respondents from the ***busy*** and ***stationary*** groups. However, there was very little difference in the manner that the respondents from the ***busy*** and ***stationary*** groups moved though the commercialization process. Because there was no significant difference between the ***busy*** and ***stationary*** groups; and therefore it was decided to combine these two groups for the following analyses.

Subsequently, t-tests were applied to each of the phases in the commercialization process that had a significant difference, as it presents the opportunity to test for significant differences between the means of two groups (***finished*** vs. ***busy/stationary***). T-tests were performed on each question in the phases to determine whether a significant difference exists between the groups. Furthermore, for each t-test a Levene's test was used to test for equal variances to determine which t-test should be used as indicated by the "Variances assumed equal" column in the resulting tables.

The results of the t-tests will be discussed in the subsequent sections.

5.11.1 The idea generation phase in the commercialization process

The questions from the questionnaire that form part of the idea generation phase (see page 115) are indicated in table 5.32 in order to show where there are significant differences between the ***finished*** group of respondents and the ***busy/stagnant*** group of respondents.

Table 5.32: The idea generation phase in the commercialization process

	Busy and Stationary		Finished		T-test results				
	Mean	Std Dev	Mean	Std Dev	Variances assumed equal	DF	T-statistic	P-value	
Q15A Rapidly exploit opportunities	0.27	0.45	0.92	0.29	Yes	58	-4.73	<.0001	*
Q15B Early product introduction	0.10	0.31	0.75	0.45	No	13.7	-4.68	0.0004	*
Q15F Generated several ideas	0.92	0.28	0.83	0.39	Yes	58	0.85	0.3980	
Q15G Eliminated ideas	0.90	0.31	0.83	0.39	Yes	58	0.59	0.5542	
Q15H created a new, unique and valuable idea	0.94	0.24	0.83	0.39	No	13.2	0.88	0.3923	
Q15K Confirmed that the invention has benefits	1.00	0.00	1.00	0.00	N/A	N/A	N/A	N/A	
Q15M Confirmed the practical application	0.90	0.31	1.00	0.00	No	47	-2.34	0.0237	*

* Significant at the 0.05 level

A significant difference is indicated by a P-value at the 0.05 level and therefore there exists a significant difference between the two groups in terms of how rapidly they exploit market

opportunities, how early they introduce the product to the market and whether or not the practical application of the product was confirmed.

The group of respondents who successfully commercialized their inventions acted swiftly to exploit market opportunities, where the group of respondents who were either still ***busy*** in the process or have become ***stagnant*** did not manage to rapidly exploit opportunities. Not only did the successful respondents act quickly on an opportunity, but they also moved through the commercialization process rapidly (see table 5.30 for the different timeframes at which the respondents moved through the commercialization process) whereas the other group of respondents did not manage to do the same. Furthermore, the successful group of respondents confirmed the practical application of their inventions throughout the commercialization process and the group of respondents who were either still ***busy*** or have become ***stagnant***, did not ensure the practical application of their inventions.

5.11.1.1 Frequency tables for the idea generation phase in the commercialization process

Through the Anova analysis it was possible to determine where the significant differences were between the two groups of respondents; however, the reason for the significant differences are not addressed. Anova analysis enables only statistical analysis and there is no room for mentioning the reasons why the respondents did not complete certain steps. Thus, frequency tables were used to identify the reasons that the innovators cited for the progress or lack thereof.

Table 5.33 show the frequency table for the respondents' reaction to whether or not they exploited new market opportunities rapidly.

Table 5.33: Exploit new market opportunities rapidly.

	YES	NO					
		Did not know	Lack resources	Lack support	Not there yet	Not important	Market
Finished	11	0	0	0	0	0	1
Busy	8	1	8	8	1	2	0
Stationary	5	0	8	6	0	1	0
Total	24	1	16	14	1	3	1
Percent	40.00%	1.67%	26.67%	23.33%	1.67%	5.00%	1.67%

From the group of 60 respondents, only 24 stated that they did exploit market opportunities rapidly, which amounts to 40%. It should be noted that all, except one, of the respondents who have successfully commercialized their invention reacted quickly to market opportunities. The one respondent who successfully commercialized the invention regardless of not acting quickly on the market opportunity cited the reason that the market was not favourable at the time, which necessitated the respondent to wait until the conditions changed.

The remaining 36 respondents stated that they did not exploit the opportunities quickly. All of these respondents are in the group in which the busy and stationary innovators were classified. The reasons most cited by these innovators for not reacting quickly to market opportunities are 'Lack of support' with 26.67% of the respondents indicating this as the main reason. 'Lack of support' was also a major cause of the innovators failing to react quickly to opportunities. Lack of support entails support in terms of knowledge on what the respondents should do next in the commercialization process, a lack of financial or overall knowledge support and a lack of emotional support.

Table 5.34 shows the frequency table for the respondents' reaction in terms of whether or not they ensured early product introduction into the market.

Table 5.34: Ensure early product introduction into the market.

	YES	NO					
		Did not know	Lack resources	Lack support	Not there yet	Not important	Market
Finished	9	0	0	2	0	0	1
Busy	4	1	9	9	1	3	1
Stationary	1	0	12	6	0	1	0
Total	14	1	21	17	1	4	2
Percent	23.33%	1.67%	35.00%	28.33%	1.67%	6.67%	3.33%

In order for innovators to ensure early product introduction into the market, they must constantly move from one phase in the commercialization process to the next. Becoming stagnant in one or several phases will result in later product introduction into the market and possible failure.

Of the 60 respondents, 14 ensured quick product introduction to the market and 9 of these 14 respondents fall in the 'Finished' group. Only three of the respondents from the 'Finished" group did not manage early product introduction into the market. The reason most cited by this group of innovators is a lack of support. The lack of support entails support in terms of knowledge on the commercialization process itself, knowledge regarding the market and knowledge on what to do next. Once again unfavourable market conditions were also cited by one respondent in the 'Finished' group.

Only 5 of the respondents in the 'Busy and Stationary' group managed early introduction of their invention to the market. Twenty-four of the respondents in the 'Busy and Stationary' group indicated that they did not succeed in early introduction of their invention to the market. The two reasons for not introducing the product early were lack of resources and lack of support. As already mentioned, lack of support includes a wide spectrum of factors and lack of resources does as well. Lack of resources mainly entails financial resources, but also included is resources in terms of equipped employees, time and knowledge.

Table 5.35 shows the frequency table for respondents' reaction to whether or not they confirmed the practical application of the invention

Table 5.35: Confirmed the practical application of the invention.

	YES	NO		
		Lack resources	Not there yet	Not applicable
Finished	12	0	0	0
Busy	25	1	2	0
Stationary	18	1	0	1
Total	**55**	**2**	**2**	**1**
Percent	**91.67%**	**3.33%**	**3.33%**	**1.67%**

Altogether 91.67% of all the respondents ensured that their invention has practical merit. In other words, the vast majority of the respondents understand that without a product that is practically possible their invention can never be successful. Ensuring the practical application of an invention refers to determining whether the technology needed to create the invention does exists, that the invention can actually do what the innovator claims it can and that the invention can perform at the level that will be expected of the invention.

The five respondents who did not confirm the practical application of their invention listed three different reasons for not doing so. The lack of resources was indicated by 3.33% of the respondents as the factor that prohibited them from confirming the practical application of the invention. Furthermore, 3.33% of the respondents were innovators who simply were not at this part of the process yet and therefore could not have done it yet. Only one of the respondents indicated that it was not applicable for this respondent to confirm the practical application of the invention. The reason for this can be that the invention is an improvement on an existing product and thus the practical application of the invention is already confirmed or it is a service that the innovator wants to commercialize.

5.11.2 The resources phase in the commercialization process

The resources phase of the commercialization process contains all the questions as listed on page 115. T-test were applied to the listed questions in order to determine where there are significant differences between the ***finished*** group of respondents and the ***busy/stationary*** group of respondents.

Table 5.36: The resources phase in the commercialization phase

	Busy and Stationary		Finished		T-test results				
	Mean	Std Dev	Mean	Std Dev	Variances assumed equal	DF	T-statistic	P-value	
Q17I I started the invention small	0.44	0.50	0.75	0.45	Yes	58	-1.97	0.054	
Q19A I secured sufficient resources for the commercialization	0.15	0.36	0.92	0.29	Yes	58	-6.93	<.0001	*
Q19B I continuously monitor the money that I spend	0.98	0.14	0.92	0.29	No	12.4	0.73	0.4804	
Q19E I ensured the invention can be produced at a reasonable and beneficial cost.	0.92	0.28	0.92	0.29	Yes	58	0.00	1.0000	
Q19G My invention is affordable to the relevant market	0.96	0.20	1.00	0.00	No	47	-1.43	0.1595	
Q20A Do you know how long it will take to receive payback on your invention?	0.25	0.44	0.75	0.45	Yes	58	-3.52	0.0009	*
Q20B Do you know what the margin between costs and sales price is?	0.31	0.47	1.00	0.00	No	47	-10.17	<.0001	*
Q20C Did you anticipate what the start-up expenses will be?	0.52	0.50	1.00	0.00	No	47	-6.58	<.0001	*
Q20E Can you efficiently manage the financial affairs?	0.98	0.14	1.00	0.00	No	47	-1.00	0.3224	
Q22B I secured skilled employees during the commercialization of the invention, if needed.	0.17	0.38	0.33	0.49	Yes	58	-1.29	0.2031	

* Significant at the 0.05 level

A significant P-value is shown at a 0.05 level. Thus, the questions from the questionnaire with a significant P-value indicate where the two groups of respondents, in other words, the ***busy/stationary*** group and the ***finished*** group, had significantly different approaches to the commercialization process.

The first of these, with a significance level of <.0001, is whether or not the respondents secured sufficient resources for the commercialization process. This entails not only financial resources, but any resources that are needed to successfully commercialize an invention. The other questions in the questionnaire where a significant difference was noted were all

related to the financial aspect of commercializing inventions and included whether the respondents knew how long it will take to receive payback on their inventions; whether they knew what the margin between the costs and sales price of their invention is and whether or not the respondents could anticipate what the start-up expenses will be.

It is striking that the majority of the respondents who managed to commercialize their inventions successfully have a sound knowledge of what resources and how much of these resources will be required through each phase of the process. Furthermore, the group who managed to commercialize their inventions successfully either had sufficient resources to commercialize their invention on their own, or they knew where and how to obtain help. In other words, when innovators have insufficient funds to commercialize an invention on their own, they must ensure that they have access to a resource provider, otherwise their chances of success are very slim.

5.11.2.1 Frequency tables for the resources phase in the commercialization process

Table 5.37: Secured sufficient resources for the commercialization

	YES	NO		
		Lack resources	Lack support	Not there yet
Finished	12	0	0	0
Busy	5	17	6	0
Stationary	2	10	7	1
Total	18	27	13	2
Percent	30.00%	45.00%	21.67%	3.33%

The two main reasons why innovators in the ***busy/stationary*** group list as barriers to securing the needed resources for the commercialization process are 1) a lack of resources (45% of the respondents) and 2) a lack of support (21.67% of the respondents). In other words, the innovators who were part of this research study did not have the needed resources for the commercialization process, nor did they know where to obtain help or support in order to secure the needed resources.

These two barriers are external factors that influence the process of commercialization for the innovator; in other words, regardless of how hard the innovator work, if there are not sufficient resources or a person(s) or institution(s) willing to help, the innovator cannot move forward.

Table 5.38: How long it will take to receive payback on inventions

	YES	NO	UNCERTAIN
Finished	9	0	3
Busy	8	12	8
Stationary	4	11	5
Total	**21**	**23**	**16**
Percent	**35.00%**	**38.33%**	**26.67%**

Of all the innovators who successfully commercialized, only 9 was sure of how long it will take to receive payback on their invention. The rest of these innovators (3) were unsure of how long it will be to receive payback on their invention. A possible reason for this can be that they have recently commercialized their invention and still need to determine the payback on their inventions accurately.

The majority of the ***busy*/*stationary*** group (23 respondents) did not know how long it will be take receive payback on their invention. This could possibly be due to the fact that they are still too far away from commercializing their invention that it is impossible for them to determine the rest of the costs that will be incurred through the rest of the process or what the selling price of the invention should be to cover the costs.

There are 13 innovators from the ***busy*/*stationary*** group who were uncertain of how long it will be until their inventions show a profit, and again it can be argued that these individuals may have calculated some of the costs that will be incurred, but not yet all of it and therefore cannot determine the time to profit.

Table 5.39: Know what the margin between costs and sales price are

	YES	NO	UNCERTAIN
Finished	12	0	0
Busy	10	12	6
Stationary	5	9	6
Total	**27**	**21**	**12**
Percent	**45.00%**	**35.00%**	**20.00%**

All of the innovators who successfully commercialized their inventions knew what the margin between sales and costs price is. These innovators moved through the commercialization process, calculated all the costs incurred in the process and could therefore determine what the sales price of their inventions should be in order to generate sufficient profit.

Just more than half (55%) of the respondents from the ***busy*/*stationary*** group either did not know what the margin between the costs and sales price is or they were uncertain of it. This

is to be expected, as the accurate prediction of what the sales price of the invention should be can only be made once the innovator can be sure of what the costs of the commercialization process for the specific invention will accumulate to.

Table 5.40: Anticipate what the start-up expenses will be

	YES	NO	UNCERTAIN
Finished	12	0	0
Busy	16	8	4
Stationary	9	7	4
Total	**37**	**15**	**8**
Percent	**61.67%**	**25.00%**	**13.33%**

The innovators who successfully commercialized their inventions all knew what the start-up expenses were as they had already launched their inventions in the market.

For the ***busy*/*stationary*** group, the majority of the respondents (25 respondents) indicated that they knew what the start-up expenses associated with their invention will be and 23 of the respondents were either uncertain of what the start-up expenses will be or did not know at all.

5.11.3 The pre-commercialization phase in the commercialization process

During the pre-commercialization phase of the commercialization process, t-tests were performed on each question in the phase to determine whether a significant difference exists between the ***finished*** group and the ***busy/stationary*** group.

Table 5.41: The pre-commercialization phase in the commercialization process

	Busy and Stationary		Finished		T-test results				
	Mean	Std Dev	Mean	Std Dev	Variances assumed equal	DF	T-statistic	P-value	
Q22C I promoted the invention in order for the technology to be adopted.	0.06	0.24	0.83	0.39	No	13.2	-6.54	<.0001	*
Q22D I formalized the development process	0.40	0.49	0.92	0.29	No	29.3	-4.75	<.0001	*
Q22E I ran a trail production	0.13	0.33	0.67	0.49	No	13.6	-3.61	0.003	*
Q22F I determined roll-out equipment needs and manufactured the product in quantities large enough to identify problems	0.21	0.41	0.92	0.29	Yes	58	-5.62	<.0001	*
Q24A I devoted adequate resources to marketing activities.	0.15	0.36	0.42	0.51	No	13.8	-1.72	0.1075	
Q24H I implemented high quality marketing actions	0.15	0.36	0.42	0.51	No	13.8	-1.72	0.1075	
Q24O I ensured that the customers can easily understand the correct use of the product.	1.00	0.00	1.00	0.00	N/A	N/A	N/A	N/A	

* Significant at the 0.05 level

From table 5.41 it can be concluded that there were significant differences between the ***finished*** group and the ***busy*** or ***stationary*** group in several aspects. These include whether the innovator promoted the invention in order for the technology to be adopted; formalized the development process; ran a trail production or determined roll-out equipment needs and manufactured the product in quantities large enough to identify problems.

These aspects will be discussed in more detail in the following frequency tables (table 5.42 – 5.45).

5.11.3.1 Frequency tables for the pre-commercialization phase in the commercialization process

Table 5.42: Promoted the invention in order for the technology to be adopted.

	YES	NO					
		Not important	Lack resources	Not there yet	Lack support	Market	Not applicable
Finished	10	0	0	1	0	0	1
Busy	2	2	1	22	0	1	0
Stationary	1	0	3	15	1	0	0
Total	13	2	4	38	1	1	14
Percent	21.67%	3.33%	6.67%	63.33%	1.67%	1.67%	23.33%

The respondents who successfully commercialized their inventions promoted the invention in order for the technology to be adopted. Only one of the respondents in the ***finished*** group did not promote the technology and the reason for that is that the invention is a service and therefore the respondent felt that it was not necessary in this case.

Very few of the respondents (only 3) in the ***busy*** or ***stationary*** group managed to get to the stage of the process where it became essential to promote the technology. The majority of the respondents in this group indicated that they were not at this part of the process yet (63.335).

Only two of the respondents felt that it was not important to promote the invention in order for the technology to be adopted (in other words, to market the invention in order to create awareness and acceptation for the invention). Possible reasons for this can be that the respondents feel that the invention that they want to sell does not need any promotion as it is either easy to understand or a mere improvement on an existing product.

Table 5.43: Formalized the development process

	YES	NO				
		Lack resources	Lack support	Not there yet	Market	Not applicable
Finished	11	0	0	0	0	1
Busy	12	1	0	14	1	0
Stationary	7	0	1	12	0	0
Total	30	1	1	26	1	13
Percent	50.00%	1.67%	1.67%	43.33%	1.67%	21.67%

The respondents who successfully commercialized their inventions formalized the development process. Only one of the respondents in the ***finished*** group did not formalized

the development process and the reason for this is that the invention is a service and therefore it is not applicable.

The respondents in the ***busy/stationary*** group indicated that they are not at this part of the process yet and therefore they could not do this step. A lack of resources, lack of support and an unfavourable market to formalize the development process were also listed by individual respondents as the reason for their procrastination.

Table 5.44: Trail production

	YES	NO					
		Not important	Lack resources	Not there yet	Lack support	Market	Not applicable
Finished	8	3	0	0	0	0	1
Busy	6	0	1	20	0	1	0
Stationary	0	2	0	17	1	0	0
Total	**14**	**5**	**1**	**37**	**1**	**1**	**14**
Percent	**23.33%**	**8.33%**	**1.67%**	**61.67%**	**1.67%**	**1.67%**	**23.33%**

Eight of the respondents who successfully commercialized their inventions did run a trail production to confirm that everything, from the invention itself to the development process, work as planned. There were three of the respondents from the ***finished*** group who felt that it was not important to run a trail production and these individuals moved straight to the production of the invention.

Although eleven of the respondents from the ***busy/stationary*** group indicated that they have formalized the development process, only six of these respondents ran a trail production of their invention. Of the rest of the respondents in the Busy or Stationary group, 38 respondents indicated that they are not at this part of the process yet and therefore they could not do this step. A lack of resources, lack of support and an unfavorable market to formalize the development process were also listed by individual respondents as the reason for their procrastination.

Table 5.45: Determined roll-out equipment needs and manufactured the product in quantities large enough to identify problems

	YES	NO				
		Not important	Lack support	Not there yet	Market	Not applicable
Finished	11	0	0	0	0	1
Busy	6	1	0	20	1	0
Stationary	4	0	1	15	0	0
Total	**21**	**1**	**1**	**35**	**1**	**14**
Percent	**35.00%**	**1.67%**	**1.67%**	**58.33%**	**1.67%**	**23.33%**

All the respondents who successfully commercialized their inventions determined roll-out equipment needs and manufactured the product in quantities large enough to identify problems. Only one of the respondents in the ***finished*** group did not formalized the development process and the reason for that is that the invention is a service and therefore it is not applicable.

It should be noted that 10 respondents from the ***busy/stationary*** group managed to determine roll-out equipment needs and manufactured the product in quantities large enough to identify problems as the respondents in this group often cite a lack of resources as a reason for not moving through the phases in the commercialization process.

The vast majority of the ***busy/stationary*** group (35 of the respondents) did however, did note that they are not at this part of the process yet. A lack of support and an unfavourable market to formalize the development process were also listed by individual respondents as the reasons for their procrastination.

5.11.4 The commercialization phase in the commercialization process

In order to determine whether a significant difference exists between the ***finished*** and ***busy/stationary*** groups, t-tests were performed on each question in the phases.

Table 4.46: The commercialization phase in the commercialization process

	Busy and Stationary		Finished		T-test results				
	Mean	Std Dev	Mean	Std Dev	Variances assumed equal	DF	T-statistic	P-value	
Q22I I commenced with the full scale or commercial production of the product.	0.0208	0.1443	0.9167	0.2887	No	12.4	-10.43	<.0001	*
Q22J I started the market launch, in other words the launch of the product, on a full-scale and/or commercial basis.	0.0208	0.1443	0.9167	0.2887	No	12.4	-10.43	<.0001	*
Q23B I constantly compare the performance planned to achieve with the actual performance.	0.1667	0.3766	0.8333	0.3892	Yes	58	-5.45	<.0001	*
Q23C I have identified ways and means to ensure that the performance of the invention will remain on the current level.	0.0208	0.1443	0.9167	0.2887	No	12.4	-10.43	<.0001	*
Q23D I aim at market leadership in the given market.	0.7083	0.4593	0.6667	0.4924	Yes	58	0.28	0.7826	
Q18D I moved on to product development, i.e. the complete development of the product	0.0833	0.2793	0.9167	0.2887	Yes	58	-9.18	<.0001	*

* Significant at the 0.05 level

5.11.4.1 Frequency tables for the commercialization phase in the commercialization process

Table 5.47: Commenced with the full scale or commercial production of the product.

	YES	NO			
		Lack resources	Lack support	Not there yet	Market
Finished	11	0	0	1	0
Busy	1	2	1	23	1
Stationary	0	0	1	19	0
Total	**12**	**2**	**2**	**43**	**1**
Percent	**20.00%**	**3.33%**	**3.33%**	**71.67%**	**1.67%**

Only 20% of the respondents managed to progress to the stage where full-scale or commercial production of the product could take place.

The most common reason that the respondents listed for not reaching this phase of the commercialization process is that they are simply not there yet. In other words, they either came to an insurmountable barrier earlier in the process that hinders them from making progress or they are moving slowly through the commercialization process.

Only 3.33% of the respondents mentioned that they lack the resources, whether it is time, money or knowledge, to start with the full-scale or commercial production of the product. A further 3.33% said that a lack of support in terms of knowing where to go and what to do next was the biggest reason for their stagnation.

Table 5.48: Started the market launch, in other words the launch of the product, on a full-scale and/or commercial basis

	YES	NO			
		Lack resources	Lack support	Not there yet	Market
Finished	11	0	0	1	0
Busy	1	2	1	23	1
Stationary	0	0	1	19	0
Total	**12**	**2**	**2**	**43**	**1**
Percent	**20.00%**	**3.33%**	**3.33%**	**71.67%**	**1.67%**

As expected, the 20% of the respondents who commenced with the full-scale or commercial production of the product also started the market launch; in other words the launch of the product, on a full-scale and/or commercial basis.

The main reason given by the respondents for not moving on to this phase again was that they were not at this part of the process yet. The lack of resources and lack of support (3.33%

of the respondents for each of these factors) were also mentioned by a few of the respondents.

Table 5.49: Constantly compare the performance planned to achieve with the actual performance.

	YES	NO	
		Not important	Not there yet
Finished	10	1	1
Busy	4	1	23
Stationary	4	0	16
Total	**18**	**2**	**40**
Percent	**30.00%**	**3.33%**	**66.67%**

The importance of ensuring that the performance of the commercialized invention remains on the level that the innovator planned were addressed by 30% of the respondents as they are constantly comparing the performance planned to achieve with the actual performance.

The majority of the respondents (66.67%) have not progressed to a point where they can compare their current performance to what they planned to achieve as they have not managed to obtain a performance level yet.

Table 5.50: Identified ways and means to ensure that the performance of the invention will remain at the current level.

	YES	NO	
		Did not know	Not there yet
Finished	11	1	0
Busy	1	0	27
Stationary	0	0	20
Total	**12**	**1**	**47**
Percent	**20.00%**	**1.67%**	**78.33%**

All but one of the innovators who successfully commercialized their inventions have identified ways and means to ensure that the performance of the invention will remain at the current level. The one respondent who did not do this mentioned that he/she did not know about it.

The rest of the respondents are not at this part of the process yet and therefore has no performance level to attain.

5.12 CONCLUSION

The main objective of this chapter was to present, assess and examine the research results of the empirical study. Findings regarding the commercialization process, as well as the barriers that innovators experience throughout this process were reported and analysed.

The empirical data were presented in eleven segments. The first segment examined the profile of the respondents according to three demographic groups, namely gender, age and qualifications. The second segment discussed the intention of the innovator with the invention generated. The third part focused on examining the type of innovation that the innovators generated. The new demarcation of the study was discussed in the fourth section with the new groups that were created in the study in the fifth.

The completion of the different phases of the commercialization process was considered in the sixth section. The seventh segment offered data regarding the respondents' perception of their progress through the commercialization process as well as the main barriers to their progress through the commercialization process. Eight sub-segments were formed in which the progress and reasons for stagnation by the respondents through each phase of the commercialization process were discussed.

Chapter 6 will give an outline of the findings, as well as conclusions and the recommendations of the study.

Chapter 6

Conclusions

6.1 Conclusions from the secondary data

Innovation is essential for economic growth as 50 – 60% of all economic growth is attributed to innovation. Furthermore, the benefits of innovation are not limited to the economic growth of a country only; organizations can increase profit and ensure their success through innovation and individuals can generate an income through innovation. The key challenge is to take innovations through value creation and more often than not, the problem is not with innovation generation, but with the commercialization of this innovation.

Notwithstanding the importance and benefits of innovation, the success rate of commercialization, regardless of whether it is a big organization or an individual that innovates, remains exceptionally low. In an era of rapid changes, the process of taking an innovation from the idea phase to successful commercialization is haphazard with risk and uncertainty. There are extreme risks involved for the innovator as the speed of the diffusion of an innovation play a crucial role, along with shorter product life cycles, a highly competitive environment and a culture of zero tolerance.

SMMEs are highly vulnerable against environmental forces and for these individuals/institutions it becomes crucial to innovate and successfully commercialize in a timely manner. In order for SMMEs to overcome the challenges associated with commercialization, it is essential that they gain knowledge on the factors influencing commercialization as well as the commercialization process.

While the contribution of innovation to economic development is acknowledged, many innovators need help during the commercialization process as the path from idea generation to successful commercialization remains a relative mystery for innovators. The focus of past studies have been on critical success or failure factors, activities in the process of product development and recommendations related to aspects of the product development process. However, when considering that 40% of all innovations are still unsuccessful, it is clear that the true problems confronting innovators are overlooked.

If the commercialization process is understood and managed, it enables innovators to introduce innovations to the market in a timely manner, and therefore it is crucial to find a faster encompassing route to commercialization to improve the chances of success.

Furthermore, a variety of consequences, for example stagnation or failure of an innovation result from not following the correct commercialization process. Many innovators are convinced that they either know what the steps of the commercialization process are or that the steps are irrelevant when it comes to their commercialization, and often times, the prolonged processes that are described in the theory truly is not the process for them to follow.

The primary objective of this study is to determine what the problems and/or barriers confronting entrepreneurs in the commercialization process are, by determining how successful individuals and SMMEs were in commercializing their innovation.

A combined innovation and commercialization process was recommended in this study in order to improve the success rate of innovation for innovators. Through the questionnaire it was determined whether the innovators were aware of all the different steps involved in the commercialization of innovation, which of the steps they regarded as important and which of these steps they omitted completely.

From the results obtained through the questionnaire, specific problems confronting innovators as well as barriers to successful innovation could be determined. These factors, along with the success factors that innovators incorporated will be discussed in this chapter and recommendations will be made as to how innovators can better move from innovation to successful commercialization.

6.2 Conclusions from the primary data

6.2.1 Descriptive statistics

The primary objective of this study was to determine what the problems and/or barriers confronting entrepreneurs in the commercialization process are, by determining how successful individuals and SMMEs were in commercializing their innovations. It should be noted that the respondents of this study in Bloemfontein started their commercialization path at different time intervals (between 2005 and 2010) which makes it hard to compare the success rate of the innovators accurately. However, when considering that merely 8 of the 60 respondents managed to commercialize their invention successfully, it can be argued that there is a very low success rate in terms of commercialization in this group of respondents.

The success and failure factors that influence the successful commercialization of inventions were identified from the theory consulted. These success and failure factors were then rewritten to form part of the steps that should be included in the commercialization process. For example, if the theory stated that insufficient market research is a factor that could lead to failure, it was rewritten to state: “I have done sufficient market research” and was then considered a step in the commercialization process. All these factors along with the steps of the commercialization process, as recommended by the theory, were included in the questionnaire.
While the respondents managed to complete certain steps in the commercialization process as suggested in the questionnaire, a wide variety of steps were completed by a limited number of respondents or omitted altogether. These steps include:

Quick reaction to market opportunities:

- Exploit new market opportunities rapidly.
- Ensure early product introduction into the market.

Knowledge:

- I know what the steps in the commercialization process are and will follow these steps.
- I identified product roll-out issues and constraints
- I have built several kill/go decision points into the commercialization process.

Legal protection:

- Did you let everyone in contact with your invention sign a disclosure form?
- Did you disclose your invention before you spoke about it to anyone?
- Did you obtain protection for your invention?
- Did you obtain the help of a qualified professional?
- I ensured that all the relevant detail and the function of the invention is accurately protected.

Market research:

- I completed detailed market research.
- I drew a reasonable sample of respondents for the research.
- I have a formal research design.
- I ensured a consistent data collection procedure.
- I developed a business plan to ensure that I have thought through the process as well as all the advantages and disadvantages of the invention and the commercialization thereof.

Product testing:

- I moved on to product development, i.e. the complete development of the product.
- Initially, I tested the product in the lab or under controlled conditions rather than with customers.
- I ran a trail production to determine whether the current facilities and skill set of employees are sufficient to produce the intended product.
- I determined roll-out equipment needs and manufactured the product in quantities large enough to identify problems.
- I commenced with the full-scale or commercial production of the product.

Resource aspects:

- I secured sufficient resources for the commercialization. This entails not only financial resources, but any resources that are needed to successfully commercialize an invention.
- I conducted a business and financial analysis.
- I ensured the invention can be commercialized from within the existing business, if one exists.
- Do you know how long it will take to receive payback on your invention?
- Do you know what the margin between costs and sales price is?
- Do you have sufficient capital to commercialize the invention on your own?
- After the prototype was produced I sold the product to a limited or test set of customers.
- I secured skilled employees during the commercialization of the invention, if needed.

Marketing:

- I promoted the invention in order for the technology to be adopted.
- I devoted adequate resources to marketing activities.
- I implemented high quality marketing actions
- I started the market launch, in other words the launch of the product, on a full-scale and/or commercial basis.
- I constantly compare the performance planned to achieve with the actual performance.
- I have identified ways and means to ensure that the performance of the invention will remain at the current level.

It can be seen that the steps of the commercialization process that were omitted by the respondents of this study are crucial aspects that need to be in place before any invention can be commercialized successfully.

The steps that the majority of the respondents (55 or more of the 60 respondents) did follow include:

Market research:

- I created a new, unique and valuable idea (55)
- I know there is a gap in the market for the invention (59)
- I confirmed that the invention has benefits perceived as useful and the benefits are highly visible (60)
- I ensured that the invention works better than the available alternatives (56)
- I have decided how commercial advantages can be secured if the inventions were used to establish a new business (59)
- I ensured that there is an attractive environment for SMEs. In other words, the political-legal, economic, technological etc. environments must be positive to commercialize the specific invention (59)
- I ensured that there are people who will buy my product (59)
- I defined the product (the target market, concept, benefits and positioning, and its requirements and features) before development began (59)
- Consumers will find that my invention fits in with their needs and lifestyle (59)
- I know that my invention will be useful for a long time (60)
- The invention I want to sell will stand out in the marketplace (59)
- I know who the intended users are and ensure that the invention will meet their needs (59)
- I determined whether the invention is subject to any laws that limit, restrict, control, regulate or ban such things as production, ownership, distribution, or operation of the product (59)
- I determined that the market will not be too small to warrant company creation (50)
- I ensured a superior (better/unique) product by accessing, gathering and exploiting the market and the customer information (59)
- I have determined whether there is a serious competitive threat in the market already (60)
- I anticipate that new competitors will appear once the invention is commercialized (56)

Technical feasibility:

- I confirmed the practical application of the invention (55)
- I did an initial, preliminary appraisal of the technical merits and difficulties of the invention (55)
- I ensured that the customers can easily understand the correct use of the product (59)

Financial aspects:

- I continuously monitor the money that I spend (58)
- I ensured the invention can be produced at a reasonable and beneficial cost (55)
- My invention is affordable to the relevant market (58)
- I guaranteed that the invention provides good value-for-money for customers (60)
- Can you efficiently manage the financial affairs? (59)

The abovementioned steps are the ones that the majority of the respondents followed in the commercialization process. Through this, the first of the secondary objectives (To investigate the steps the entrepreneur followed in the commercialization process) of this research study was answered.

The phases during which the respondents did not perform well, i.e. very few of the respondents completed the stated steps were the legal phase, the evaluation phase, the phase of technical development, the funding phase and the pre-commercialization phase. From the research consulted (see figures 4.1 and 4.2, page 80 - 81) these phases form the bulk of the commercialization process. It is therefore not surprising that so few of the respondents managed to commercialize their inventions successfully, given that the majority of the steps in the commercialization process were omitted.

What is important to note is that the respondents indicated that they did take certain steps, for example:

- I know there is a gap in the market for the invention;
- My invention is affordable to the relevant market as well as
- I ensured that there are people who will buy my product.

However, the majority of the respondents stated that they did not complete detailed market research. Therefore it can be argued that even though the respondents thought they completed certain steps, they actually did not.

This is a very important issue to address as innovators can move through the commercialization process convinced that they are completing all the mentioned steps in the commercialization process, but still fail to commercialize their invention - all the while not adequately completing each step or misunderstanding what each step entails.

To summarize, certain crucial steps in the commercialization process are omitted by the majority of the respondents of this research study. These include that they do not act quickly on market opportunities and failed to introduce their inventions to the market in a timely manner. This is a costly mistake as the need the invention was suppose to fulfill could have already changed or someone else might have also identified the opportunity and acted on it.

Furthermore, very few of the respondents acquired legal advice or protection. The high costs associated with legal protection is a great deterrent, but it was also interesting to note that

many of the respondents viewed legal protection as irrelevant, because they wanted to get into the market, make money and then exit.

The respondents also failed to conduct proper market research or draw up a business plan. These two factors are vitally important to innovators as it firstly answers whether there truly is a need in the market that the specific invention can satisfy, and secondly whether the innovator has the financial capability and skills to make a success of their business venture.

Fourthly, the majority of the respondents indicated that they do not have the resources to progress through the commercialization process. Therefore they could not do the needed market research, protect the innovation, do marketing or run a trial production of the invention.

Lastly, the respondents indicated that they have limited knowledge of the commercialization process, which implies that they did not take certain steps out of a lack of knowledge/experience.

The perception that the respondents have of themselves as innovators are that they:

- have the know-how and skills capacity and, if needed, will acquire technical knowledge from outside sources (59 of the respondents);
- are prepared to/will form collaboration and partnerships when it is in their best interest (56 of the respondents);
- ensured that they have the relevant experience and/or education (55 of the respondents);
- learn from and reduce mistakes and misunderstandings (60 of the respondents);
- constantly redesign the innovation process around best practices in order to improve the process continuously (54 of the respondents);
- take some chances, cut corners, collapse activities or omit certain steps in order to get to market as quickly as possible (37 of the respondents indicated that they seldom or never do this);
- ensured the quality of execution of the commercialization process (56 of the respondents);
- evaluate and react to risk well (57 of the respondents).

What should be noted from the abovementioned is that although the vast majority of the respondents indicated that they have the needed skills, experience and education, many of the respondents listed “a lack of knowledge” as the reason for omitting certain steps, such as market research.

Furthermore these respondents claim to redesign the process constantly in order to improve the process continuously and that they ensure the quality execution of the commercialization process. However, the respondents cannot ensure the quality execution of the commercialization process, as they do not know what the steps in the commercialization process are and therefore they omit a variety of the steps of the commercialization process.

6.3 Conclusions from further statistical analysis

After the descriptive statistics were analyzed, the respondents of this study were divided into two groups. The ***finished*** group, in other words, the 12 respondents who successfully commercialized their innovations and the ***busy/stagnant*** group of 48 respondents who have either have not commercialized their innovations yet or made no progress since 2007. This was done to enable the researcher to apply more sophisticated statistical analysis in the form of Anova's and T-tests.

It was the aim of the researcher to identify the main differences between the ***finished*** group and the ***busy/stagnant*** group of respondents. This was necessary to identify the problems or barriers that innovators encounter in the process of commercialization and that differentiate the respondents who successfully commercialized from those who have not yet succeeded in commercializing the innovations.

From statistical analysis done in chapter 5 (see page 124 – 125) it followed that the phases in the commercialization process that indicated major differences between the two groups of respondents, namely the ***finished*** and ***busy and stagnant*** groups, were:

- Idea generation phase;
- Resources;
- Pre-commercialization; and
- Commercialization.

Since these four phases were the only phases where a significant difference between the group of respondents who commercialized their inventions successfully and those who have not yet commercialized their inventions were observed, the focus of the conclusions and recommendations will fall on these four phases.

6.3.1 Idea generation phase

The main barrier that was identified in this phase of the commercialization process is the speed of diffusion of an invention (see page 127 – 128). The ***finished*** group of respondents managed to react quickly to market opportunities and introduce their inventions to the market in a timely manner. The ***busy and stagnant*** group of respondents noted that a lack of resources and support were the main reasons for their failure to ensure early product introduction to the market. From this it can be deduced that either the ***busy and stagnant*** group of respondents do not know where to obtain the needed help, or that the current support institutions available are either unknown to the innovators or the help they offer is not what is needed; innovators do not approach financial institutions for loans or were unsuccessful in their applications; or perhaps even that their inventions are of a poor quality and that is the reason for their inability to obtain resources and support.

It was interesting to note that 5 of the respondents did not confirm the practical application of the product during the idea generation phase before they continued on the commercialization process (see page 129). One of the reasons given for this is a lack of resources. However, these respondents run the risk of investing large amounts of money through the commercialization process only to realize later that the invention is not viable in terms of the technology needed or the level of performance. Therefore, it is better to ensure the invention

is viable early on in the process to minimize costly mistakes later on in the commercialization process.

The next phase in the commercialization process that indicated a significant difference between the ***finished*** and ***busy and stagnant*** groups of respondents was the resources phase.

6.3.2 Resources phase

During the resources phase (see pages 132 – 143) it was seen that many of the ***busy and stagnant*** group have very little information available on the amount of money that will be needed throughout the commercialization process. The respondents were unsure of the time to profit, the margin between the costs and sales price as well as the start-up expenses.

These respondents already progressed through the preliminary research, planning, legal protection, prototype and the market research phase (see page 125) in order to reach the resources phase. Therefore, it is argued that these individuals must have already estimated what this invention will cost to produce and what the selling price should be to secure a profit.

Furthermore, 70% of the respondents did not have sufficient resources for the commercialization of their invention. These respondents indicated that they lack the personal resources to commercialize their invention and were experiencing a lack of support.

When asked where the respondents will go for financial assistance (as can be seen on page 105), the following responses were obtained:

- Half of the respondents (30) indicated that they will prefer to involve a partner in the commercialization process in order to obtain the needed capital;
- 36.7% indicated that they will approach a government institution; and
- only 10% considered banks as an option to obtain financial help.

The respondents might lack the needed financial knowledge to understand the importance of determining the price and profit potential of an invention early on in the commercialization process in order to ensure that the invention makes financial sense. Furthermore, it seems as if though the respondents have no trust in the different banks to provide the financial support that is needed and very little of the respondents viewed government institutions as an option to obtain the support needed.

6.3.3 Pre-commercialization phase

The significant differences identified (see pages 134 – 138) between the ***finished*** and ***busy and stagnant*** groups were whether or not they succeeded in:

- promoting the invention in order for the technology to be adopted;
- formalizing the development process;
- initiating a trial production;
- identifying roll-out equipment needs and manufactured the product in large enough quantities to identify problems.

The respondents from the ***finished*** group managed to complete most the abovementioned steps. Merely 3 of the 12 respondents did not run a trial production as they viewed this as unnecessary. A possible explanation for this is that these respondents might feel confident that the manufacturing processes identified will be sufficient and no testing, and therefore incurring additional costs, is needed. It should be warned that if an error occurs when the respondents move onto the production for the commercialization phase it will be even more costly. Perhaps this can even be the divider between a successfully launched invention and one that came close.

While certain respondents indicated a lack of resources as a barrier to completing the abovementioned steps, the reason most often cited for not completing these steps are that the respondents simply are not at this phase of the commercialization process yet.

As can be seen from figure 5.10 on page 138, there is a significant difference between the group of respondents who ***finished*** the commercialization process and those who are in the ***busy and stagnant*** group in terms of the idea generation phase, however, the paramount dividing phase occur at the resources phase. During the pre-commercialization phase the importance of adequate resources is once again highlighted and confirmed, as so many of the respondents had indicated that they are not at this part of the process yet. It seems that the respondents from the ***busy and stagnant*** group can keep up with the respondents in the ***finished*** group only up till the resources phase and then they cannot move forward as they have insufficient resources available.

In all the previous phases in the commercialization process, resources were needed; however, during the pre-commercialization phase vast amounts of resources must be in place to promote the invention, to formalize the development process and to start the production of the invention. The respondents who managed to obtain the needed resources moved on to commercialize their inventions successfully, i.e. ***finished*** group and the respondents who did not manage to secure the needed resources get stuck in the ***busy and stagnant*** group.

6.3.4 Commercialization phase

During the commercialization phase, the vast majority of the ***busy and stagnant*** group of respondents did not move on to full-scale or commercial production of their inventions (see page 138) and the reason cited by most of the respondents were the fact they were not at this part of the process yet. The result of insufficient resources for commercial production is that these inventions cannot be launched on a full-scale or commercial basis.

Once again the importance of adequate resources and support is highlighted. Many of the truly unique and valuable inventions never move on to commercial production because of limited or no resources.

Hence, the factors that influence the commercialization process negatively (when the steps the respondents followed who managed to commercialize their inventions successfully are compared to those who could not yet commercialize their inventions) are a lack of resources as well as a lack of support and knowledge.

Chapter 7

Recommendations

7.1 Recommendations for the commercialization of innovation

The low success rate of commercialization, as seen in this study, indicates that there is a desperate need for help for innovators. The recommendations that follow aim to address the barriers to commercialization as identified in the research study and therefore improve the rate of successful commercialization.

I. There exists a wide variety of government institutions that provide support for innovators. However, these institutions have a very clear set of criteria in terms of the race, gender and age of the innovators that they support financially. The following is recommended in terms of government institutions:
   - In the first place it is recommended that these government institutions derive invention-related criteria by which to judge prospective inventions, rather than focus on the demographics of the innovator. Many inventions with significant potential are not commercialized as the innovators lack the needed resources and cannot obtain the needed support because of their profile.
   - Criteria that can be implemented by government institutions to evaluate the prospective inventions are provided in table 7.1. All of the criteria mentioned in table 7.1 will not necessarily be applicable to all the different types of inventions, but the responsible person(s) in the institution can tailor these criteria to best suit the specific invention. Given the very low success rate of all the government institutions who provide innovators with financial help, it is clear that their criteria for selecting inventions to support is insufficient and should be re-evaluated and adapted (for the purpose of this study there was not focussed on the details of these criteria). The criteria listed in table 7.1 can help these institutions to improve their success rate in terms of the amount of inventions who are successfully commercialized and become income-generating business ventures. By achieving a higher success rate, the government institutions will also be able to get payback on the investment that they made in the innovators.

Table 7.1: Criteria for the evaluation of inventions

Factor	Description/remark
Legality	Will there be legal problems commercializing your invention?
Safety	Are there safety issues that may scare away licensing companies?
Environmental impact	Will your invention have a positive or negative effect on the environment, and how will this affect the commercial potential?
Social impact	Will your invention have a positive or negative effect on society and how will this affect the commercial

	potential?
Potential market	Who will buy your invention?
Product life cycle	Does your invention's usefulness diminish over time?
Usage learning	How long does it take to learn how to use your invention?
Product visibility	Will your product have a distinctiveness so as to stand out in the marketplace?
Service	Will you product provide a valuable service?
Durability	How sturdy is your invention? Will it require frequent maintenance?
New competition	What is the likelihood of new competitors appearing once invention is commercialized?
Functional feasibility	How workable is the functional aspects of your invention?
Production feasibility	How practicable is it to produce your invention for sale?
Stability of demand	Will demand for your invention die off over time?
Consumer/user compatibility	Will consumers find that you invention is compatible with their needs of lifestyle?
Market research	What does market research indicate?
Distribution	How can you invention reach consumers? What types of distribution are available?
Perceived function	What do you perceive as the invention's primary function? Will consumers perceive this as its function as well?
Existing competition	What competition exists now?
Potential sales	Have you any way of estimating potential sales?
Development status	In what stage of development is your invention?
Investment costs	What type of start-up expenses do you anticipate in order to manufacture the device?
Trend of demand	What do consumer trends indicate for the demand for your invention?
Product line potential	Is there a potential to expand your invention into a line of products?
Need	Is there a need for your invention?
Promotion	What type of promotion is needed to sell you invention?
Appearance	Does you invention's appearance add to its commercial appeal?
Price	Is your invention affordable to the relevant market?
Protection	What forms of legal protection are available for you invention?
Payback period	How long will it take to receive a payback on your invention?
Profitability	What is the margin between the cost and the sale price?
Product	Is your invention dependent on or related to another

interdependence	device or product?
Research and development	Is further research and development necessary before you sell the invention

II. It is generally known that government institutions cannot provide help to all the innovators who approach these institutions for financial aid; however, they can provide the needed knowledge, at a tariff, to all the innovators. Therefore, the second recommendation is that these government institutions divide into two different operational units. One of these units will be responsible for providing financial support to a selected few of the innovators who can prove the potential of their inventions, keeping the abovementioned criteria in mind. This unit can further divide into a section that is open to all innovators, regardless of their demographic profile and a section that focuses only on the previously disadvantaged innovators. The other unit must be accessible to all the potential innovators and provide support to the innovators throughout the whole commercialization process. The support that is needed can be in terms of providing the innovators with information on:
    - what the next step in the commercialization process will be, given the current position of the innovator in the process;
    - what is needed in order to complete each step in the commercialization process successfully; and
    - where the innovators can obtain help in terms of professionals who can provide legal advice, do market research and help with the marketing of inventions, to name a few.

III. The third recommendation also pertains to government support institutions. It is recommended that these institutions must be responsible for kill/go decisions throughout the commercialization process. This implies that even if the government institution agreed to help an innovator at the beginning of the commercialization process (regardless of whether it is in terms of financial help or support only), these institutions must evaluate the invention continuously. Inventions of which the potential faded must be discarded, regardless of the phase of commercialization in which the invention is. Through this the government institution can curb the financial losses that will be incurred by either or both the institution and the innovator.

IV. The fourth recommendation might seem contradictory to the abovementioned recommendations, as it entails the creation of a completely new institution to support the innovators. However, the recommended institution must serve as a complimentary unit to the already established government institutions. As there already are a lot of pressure on the government institutions, an all together new institution can be created to support and help innovators from the idea generation phase through to the commercialization of the invention. This institution must be part of an academic institution, as all the knowledge regarding entrepreneurship and business management are already present in the academic environment. This institution can connect the innovator with the needed specialist at the appropriate time and create mentorship throughout the commercialization process.

V. Inventions with insufficient potential must be identified very early in the commercialization process to enable innovators to improve on the existing concept or abandon the concept completely and generate a new invention with sufficient potential. The fifth recommendation, therefore, is that prototype institutions are empowered to judge the potential of an invention when the innovators approach these institutions. It should be noted, however, that the prototype institutions are profit-orientated and therefore it is unlikely (and in the current set-up, not their responsibility) to convince the innovator to abandon the invention. In order to address this problem, it is recommended that the government provide some sort of financial support to these institutions to explore the sustainability and market potential. The support can be in terms of:

   i. providing the institutions with grants to relieve the pressure on the institutions to develop all the prototypes in order to generate sufficient profit to survive, or
   ii. government providing the institution with a financial reward for each invention that moved through their institution and became a commercial success. Through these recommendations, the prototype institutions will have an incentive to pursue only the inventions with commercial potential.

VI. When considering the high failure rates of inventions and new ventures it is a huge risk for financial institutions to lend money to innovators. These individuals have no surety to offer as they have only ideas and are still a long way from owning an income-generating business. To further accentuate the problem of obtaining a loan from a bank, the new Credit Law (which came into effect on 1 June 2007) of South Africa has made it extremely difficult for all individuals to borrow money and so much more for innovators without any surety. The sixth recommendation is that financial institutions offer financial support to innovators who have confirmed the commercial potential of their inventions; for example, by developing a business plan more readily and providing them with better payment options. Here it is crucial that the financial institutions appoint someone with the needed experience and skills to evaluate the business proposals of the innovators effectively and to award loans only to the inventions with the most potential, regardless of their demographic profile.

VII. I furthermore recommend that the Government Support Institutions, Universities or Universities of Technology, or the newly established units inside academic institutions as mentioned above, develop courses that prospective innovators can attend in order to improve their level of skills and understanding of the commercialization process. Important skills that must be addressed in these courses include idea screening techniques, market research skills, legal hints and financial management, to name only a few. By completing these courses, the innovators can gain a better understanding of what each of the steps in the commercialization process entails as well as whether their invention truly have the potential to be a success. To encourage innovators to attend these courses, the financial institutions can agree to give preference to the innovators who have a viable business idea and completed these courses.

VIII. In addition, it is recommended that the institutions, whether it is the government or academic institutions, follow the combined innovation and commercialization process (as is proposed on page 79 – 80). This process is an encompassing process that

covers all the activities that innovators must complete in order to improve their odds of successfully commercializing their inventions.

IX. In the ninth place it is recommended that a culture of entrepreneurship be established as early as school level. The importance of entrepreneurship, especially in the current economic conditions in South Africa where employment opportunities are very scarce, must be emphasized. Learners must have the opportunity to obtain, and build on, the skills needed to start their own businesses through the commercialization of an innovation.

X. Lastly, it is recommended that established businesses of any size are encouraged to become mentors throughout the commercialization process to the innovators who are starting the process. Government can provide the needed encouragement to established businesses to share some of their time and expertise with innovators through the BBBEE Scorecard that is used to rate businesses is terms of their BBBEE status. Currently, according to the codes of good practice, the weight of socio-economic development on the BBBEE Scorecard is 5 points. Should government increase this weight, the established businesses will be encouraged to mentor the innovators as this will improve their BBBEE score and enable them to obtain government tenders, etc.

It is acknowledged that the abovementioned recommendations would put a lot of pressure on the government to change current practices or initiate new ones. However, through this, the number of innovators who manages to commercialize their invention successfully could increase dramatically. This will translate into job creation as successful new ventures must appoint employees, providers and distributors. This, in turn, will increase the spending power of the individuals, who can now afford luxuries (on which they pay tax), cars that need fuel and homes that must pay municipality fees. Furthermore, once these newly established business ventures move on to become established businesses, the owners will have to start paying tax. Therefore, although there will be an initial monetary implication for government, it truly is in their best interest to invest strongly in entrepreneurship and create a country full of economic wealth.

The last two chapters of this thesis presented a critical evaluation of this study showing the achievement of the primary and secondary objectives and recommendations were also proposed.

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APPENDIX A

RESEARCH QUESTIONNAIRE

Please answer the following questions as honestly as you can. The questionnaire will be regarded as anonymous. Please answer all the questions.

Section A: Demographics of the entrepreneur

The following questions concern you as an individual.

1. Gender:	MALE	FEMALE

2. Age:	

3. Race:	WHITE	BLACK	COLOURED	INDIAN	OTHER

4. Please indicate the highest level of education you have.	
a) Grade 1 – 7 (Primary school)	
b) Grade 8 – 11 (High school)	
c) Grade 12	
d) Tradesman	
e) Diploma	
f) Degree	
g) Post graduate degree	
h) If other, please specify	

5. What job do you currently do?	

PLEASE NOTE: **When completing the remainder of the questionnaire, please keep the following in mind:**

If this is the **first invention** you aim to commercialize, please indicate what you are **currently doing**.
If you have already succeeded or failed in commercializing **several inventions**, please indicate what you **generally do**.

6. Do you have an already established business as a result of an invention?	YES	NO

7. If yes, how many years have your business been operational and in what sector does your business fall?	

8. If no, do you plan to establish a business with your invention?	YES	NO

9. If you do not intend to establish a business with your invention, what is your aim with the invention? Please mark the relevant choice with a X.	
a) Sell the patent outright	
b) Sell the patent and obtain royalties	
c) Licensing	
d) Produce the invention, but let someone else market it	
e) Commercialize the invention yourself	

10. Please indicate in which industry/sector your invention falls:	
a) Agriculture, forestry and fishing	
b) Mining and quarrying	
c) Manufacturing	
d) Electricity, gas and water	
e) Construction	
f) Wholesale and retail trade; hotels and restaurants	
g) Transport, storage and communication	
h) Finance, real estate and business services	
i) General government services	
j) Personal services	

11. Please indicate which type of invention you think you have.		
	Incremental innovation i.e. advances made to existing products, processes and services	**Radical innovation i.e. considerably new technologies in comparison to existing technologies**
a) Product innovation i.e. changes in products or services offered		
b) Technological innovation i.e. changes in the equipment/ methods used to transform raw materials into products or services		
c) If other, please specify		

12. Please indicate which of the following statements are applicable to you. Please note that you <u>can mark more than one option</u>.		
		Number of inventions
a) This is the first invention I aim to commercialize		
b) I have already successfully commercialized several inventions		
c) I have already failed at commercializing inventions		
d) If other, please specify		

<u>Section B:</u> <u>Innovation/ Idea generation</u>

13. Please indicate the month and the year in which you went through the following steps.			
The steps in the commercialization process	**The month and year**	**I did not do the step**	**I am not at this part of the process yet**
a) Idea generation			
b) Legally protect invention			
c) Prototype development			
d) Market research			
e) Identify potential funding opportunities			
f) Commercialize			

14. Please indicate where you got the idea for the invention. Please mark the appropriate source with an X. You can mark more than one source.		
Discussion		**Source of idea**
a) Work and work related factors		
For example:	1) From repeatedly doing the same job you find a better way of doing it or because you are truly skilful in your job you identify a more efficient way than what is used currently. 2) A current process is not efficient enough and you can improve the process.	
b) Individual related aspects		
For example:	1) Unexpected success or failure. 2) A discrepancy between reality as it is and reality as it ought to be. 3) Different people are confronted with the same frustration of an insufficient or slow process or a problem in their everyday lives. 4) Rare moments of great ideas.	
c) Technology and related aspects		
For example:	1) Every new material that is discovered enables us to do new and better things 2) The improvement in technology enabled a new innovation. 3) The group of people who provide you with input materials for your business. 4) Intellectual property gained from Universities or other institutions	
d) Research		
For example:	1) Doing research on a specific topic. 2) Sharing knowledge with people who are interested in the same industry as you are. 3) Not related to a specific industry, but any new knowledge that is gained.	
e) The market		
For example:	1) When you see your competitors doing something new and know you can improve on it 2) Identifying the needs or dreams of different people can lead you to identify an opportunity 3) The way an innovation moves through the product life cycle can present you with an innovation. 4) Changes in the economic, international, technological, etc environments. 5) New competitors, products or technologies that are introduced enables a different innovation 6) A change in a related industry creates a need in the industry you operate or opens the opportunity for an innovation. 7) The composition of the population and when it changes is a source of innovation. 8) Changes in preferences or needs. 9) Changes in laws, taxation law, etc.	

15. Please indicate whether you did the following during the idea generation phase of the commercialization process. Please mark the relevant listings with an X.						
	Did you do the listed option?		**IF NO, please indicate the reason for NOT doing it**			**N/A**
	Yes, I have done it	**No, I have not done it**	**I do not think it is important**	**I did not know about it**	**Any other reason**	
a) Exploit new market opportunities rapidly.						
b) Ensure early product introduction into the market.						
c) Create a plan of action (i.e. follow a strategy).						
d) I know what the steps in the commercialization process are and will follow these steps.						
e) Explore the market problems and needs.						
f) I generated several ideas to solve the problem in the market.						
g) Through initial screening I eliminated ideas that are not useful and focused on those with the most potential.						
h) I created a new, unique and valuable idea.						
i) I know there is a gap in the market for the invention.						
j) I ensured that the innovation is not too complicated.						
k) I confirmed that the invention has benefits perceived as useful and the benefits are highly visible.						
l) I acquired good market information and did adequate homework on the invention						
m) I confirmed the practical application of the invention						
n) I ensured that the invention works better than the available alternatives						
o) I identified product roll-out issues and constraints						
p) I made sure that the invention will require less routine service than the competitors.						
q) Ensure higher relative product quality						

Section C: Disclosure

16. Please indicate whether you did the following during the disclosure phase of the commercialization process. Please mark the relevant listings with an X.						
	Did you do the listed option?		**IF NO, please indicate the reason for NOT doing it**			**N/A**
	Yes, I have done it	**No, I have not done it**	**I do not think it is important**	**I did not know about it**	**Any other reason**	
a) **Disclosure:** The initial formal record of a discovery, which must be completed as thoroughly as possible.						
- Did you obtain a non-disclosure agreement?						
- Did you complete the form correctly?						
- Did you let everyone in contact with your invention sign a disclosure form?						
- Did you disclose your invention before you spoke about it to anyone?						
b) **Protection**: Once an invention with significant commercial potential is identified, it is essential to prohibit others from making or selling your invention by protecting your intellectual property						
- Did you obtain protection for your invention?						
- Did you ensure that your invention can be protected?						
- Did you obtain the help of a qualified professional?						
- I ensured that all the relevant detail and the function of the invention is accurately protected.						
- Are you aware of the different forms of protection that are available?						
Indicate the different options that you made use of to protect your idea.						
- Patent						
- Trademark						
- Trade secret						
- Copyright						
- Industrial design						
- Integrated circuit topographies						
- Non-disclosure agreements						

Section D: Evaluation of the innovation

17. Please indicate whether you did the following during the evaluation phase of the commercialization process. Please mark the relevant listings with an X.						
	Did you do the listed option?		**IF NO, please indicate the reason for NOT doing it**			**N/A**
	Yes, I have done it	**No, I have not done it**	**I do not think it is important**	**I did not know about it**	**Any other reason**	
a) I established new product project guidelines, i.e. expectations of how the invention will perform in the market.						
b) I conducted a preliminary, non-scientific market assessment; offering a first and quick look at the market.						
c) I did an initial, preliminary appraisal of the technical merits and difficulties of the invention.						
d) I completed detailed market research.						
e) I drew a reasonable sample of respondents for the research.						
f) I have a formal research design.						
g) I ensured a consistent data collection procedure.						
h) I developed a business plan to ensure that I have thought trough the process as well as all the advantages and disadvantages of the invention and the commercialization thereof.						
i) I started the invention small to not require too much capital, time or people.						
j) I know what resources and how much will be needed at the different phases of the development process of the invention.						
k) I have decided how commercial advantages can be secured if the inventions were used to establish a new business.						

Section E: Technology development

18. Please indicate whether you did the following during the technology development phase of the commercialization process. Please mark the relevant listings with an X.						
	Did you do the listed option?		IF NO, please indicate the reason for NOT doing it			N/A
	Yes, I have done it	No, I have not done it	I do not think it is important	I did not know about it	Any other reason	
a) I made prototypes to generate technical and market proof of the invention.						
b) I studied the availability and content of the support and development services provided by the local institutions						
c) I decided whether the invention will be manufactured in-house, or if the whole product, or parts of it, must be bought from suppliers.						
d) I moved on to product development, i.e. the complete development of the product						
e) I ensured that the invention can be effectively manufactured and sold on a part-time basis in order to focus attention on marketing activities and to still earn an income from another job.						
f) Initially, I tested the product in the lab or under controlled conditions rather than with customers.						
g) I considered whether the inventions have more potential and greater returns in the form of royalties or assignment fees than from selling it myself.						

Section F: Funding Sources

19. Please indicate whether you did the following during the funding phase of the commercialization process. Please mark the relevant listings with an X.						
	Did you do the listed option?		IF NO, please indicate the reason for NOT doing it			N/A
	Yes, I have done it	No, I have not done it	I do not think it is important	I did not know about it	Any other reason	
a) I secured sufficient resources for the commercialization. This entails not only financial resources, but any resources that are needed to successfully commercialize an invention.						
b) I continuously monitor the money that I spend						
c) I conducted a business and financial analysis						
d) I ensured the invention can be commercialized from within the existing business, if one exists.						
e) I ensured the invention can be produced at a reasonable and beneficial cost.						
f) I ensured that there is a price advantage over existing competition or substitutes.						
g) My invention is affordable to the relevant market						
h) I guaranteed that the invention provides good value-for-money for customers						
i) My invention is more expensive, but it is a better product.						

20. Financial aspect

a) Do you know how long it will take to receive payback on your invention?	YES	NO	UNCERTAIN
b) Do you know what the margin between costs and sales price is?	YES	NO	UNCERTAIN
c) Did you anticipate what the start-up expenses will be?	YES	NO	UNCERTAIN
d) Can you anticipate what resources will be needed through the process?	YES	NO	UNCERTAIN
e) Can you efficiently manage the financial affairs?	YES	NO	UNCERTAIN
f) Do you have sufficient capital to commercialize the invention on your own?	YES	NO	UNCERTAIN

21. If you do not have sufficient capital to commercialize you invention, where did you/ will you obtain financial help?	
a) Bank	
b) Partner	
c) Government institutions such as FDC/ SEDA for example	
d) Licensing	
e) If other, please specify:	

Section G: Pre-commercialization

22. Please indicate whether you did the following during the pre-commercialization phase of the commercialization process. Please mark the relevant listings with an X.						
	Did you do the listed option?		IF NO, please indicate the reason for NOT doing it			N/A
	Yes, I have done it	No, I have not done it	I do not think it is important	I did not know about it	Any other reason	
a) After the prototype was produced I sold the product to a limited or test set of customers.						
b) I secured skilled employees during the commercialization of the invention, if needed.						
c) I promoted the invention in order for the technology to be adopted.						
d) I formalized the development process in terms of deciding what methods, machinery and/ or technology is needed to efficiently develop the invention						
e) I ran a trail production to determine whether the current facilities and skill set of employees are sufficient to produce the intended product.						
f) I determined roll-out equipment needs and manufactured the product in quantities large enough to identify problems						
g) I analyzed marketing opportunities in terms of the needs and wants of the potential markets and segmented the markets in order to identify the target markets.						
h) I ensured that there is an attractive environment for SMEs. In other words, the political-legal, economic, technological etc. environments must be positive to commercialize the specific invention.						
i) I commenced with the full scale or commercial production of the product.						
j) I started the market launch, in other words the launch of the product, on a full-scale and/or commercial basis.						

Section H: Commercialization

23. Please indicate whether you did the following during the commercialization phase of the commercialization process. Please mark the relevant listings with an X.						
	Did you do the listed option?		IF NO, please indicate the reason for NOT doing it			N/A
	Yes, I have done it	No, I have not done it	I do not think it is important	I did not know about it	Any other reason	
a) I know what I want to achieve during each phase of the commercialization process.						
b) I constantly compare the performance planned to achieve with the actual performance.						
c) I have identified ways and means to ensure that the performance of the invention will remain on the current level.						
d) I aim at market leadership in the given market.						

Section I: Market research

24. Please indicate whether you did the following during the market research phase of the commercialization process. Please mark the relevant listings with an X.						
	Did you do the listed option?		IF NO, please indicate the reason for NOT doing it			N/A
	Yes, I have done it	No, I have not done it	I do not think it is important	I did not know about it	Any other reason	
a) I devoted adequate resources to marketing activities.						
b) I ensured that there are people who will buy my product.						
c) I defined the product (the target market, concept, benefits and positioning, and its requirements and features) before development began.						
d) Consumers will find that my invention fits in with their needs and lifestyle.						
e) I know that my invention will be useful for a long time.						
f) The invention I want to sell will stand out in the marketplace						
g) I have built several kill/go decision points into the commercialization process.						

Please indicate whether you did the following during the market research phase of the commercialization process. Please mark the relevant listings with an X.						
	Did you do the listed option?		IF NO, please indicate the reason for NOT doing it			N/A
	Yes, I have done it	No, I have not done it	I do not think it is important	I did not know about it	Any other reason	
h) I implemented high quality marketing actions						
i) I know who the intended users are and ensure that the invention will meet their needs.						
j) I determined whether the invention is subject to any laws that limit, restrict, control, regulate or ban such things as production, ownership, distribution, or operation of the product.						
k) I determined that the market will not be too small to warrant company creation						
l) I ensured a superior (better/ unique) product by accessing, gathering and exploiting the market and the customer information.						
m) I have determined whether there is a serious competitive threat in the market already.						
n) I anticipate that new competitors will appear once the invention is commercialized.						
o) I ensured that the customers can easily understand the correct use of the product.						

25. If you did not do market research, why didn't you? Please note that you can mark more than one.	
a) I am afraid someone will steal my idea	
b) Market research is too expensive	
c) I do not know how to do market research	
d) I rely on and trust my gut feel	
e) Market research does not give a true reflection of the market needs and wants	
f) If other, please specify:	

26. If you did do market research, please answer the following question:	N/A
a) How did you do market research?	

The innovator:

27. Please indicate if you feel the following statement is applicable to you to a great extent, to a reasonable extent, not so much or not at all.					
	To a great extent	To a reasonable extent	It is neither applicable nor inapplicable	Not so much	Not at all
a) I have the know-how and skills capacity and, if needed, I will acquire technical knowledge from outside sources.					
b) I have sufficient access to external networks of resource providers to ensure successful commercialization.					
c) I am prepared to/ will form collaboration and partnerships when it is in my best interest.					
d) I ensured that I have the relevant experience and/ or education.					
e) I learn from and reduce mistakes and misunderstandings.					
f) I constantly redesign the innovation process around best practices in order to continuously improve the process.					
g) I take some chances, cut corners, collapse activities or omit certain steps in order to get to market as quickly as possible.					
h) I ensured the quality of execution of the commercialization process.					
i) I evaluate and react to risk well.					

End of the questionnaire, thank you for your time!