The Role of Johannesburg Universities in the Emergence of an Information and Communication Technology (ICT) Cluster in Johannesburg

Submitted by: Rumbidzai Chisenga

Supervisor: Dr Jose Barreira

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ABSTRACT

The Information and Communication Technology sector in Gauteng contributes significantly towards the gross domestic product (GDP) of the South African economy. Studies identified the emergence of a technology cluster in Johannesburg in the late 1990s but highlighted that this cluster was notably weak in terms of research and development (Voyer 1997; Hodge, 1998). This study seeks to describe the role of Johannesburg universities in the emergence of an information and communication technology (ICT) cluster in Johannesburg. The mixed methodology was followed in the study. Data was collected by using questionnaires and conducting interviews to obtain quantitative and qualitative data. Respondents included school/department/centre heads and lecturers at the two Johannesburg universities: the University of Witwatersrand and the University of Johannesburg. The key findings of this study are:

- There is disparate activity in supporting Johannesburg-based ICT ventures through collaborative and contract research with Johannesburg ICT companies; amongst the schools, departments or centres that participated in the survey.

- There are isolated activities related to the incubation and commercialisation of spin off ICT ventures, in the university units represented by the respondents.

- There is some research-related collaboration and no commercialisation-related collaboration with the other Johannesburg university amongst the university units represented by the respondents.

This study contributes to the body of knowledge on the evaluation of university-industry linkages; and the relevance of academic entrepreneurship to cluster development.

DECLARATION

I, Rumbidzai Chisenga, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Rumbidzai Chisenga

Signed at ……Johannesburg……

On the ……28th…….. day of ……March…… 2013

ACKNOWLEDGEMENTS

I would like to acknowledge the help, love, support and encouragement of my family and friends who journeyed with me from the beginning of this adventure to the end. Thank you all for the prayers, hot meals, snacks, favours, check-ups and mostly for forgiving me for missing many important events over the year.

I would also like to thank Dr. Jose Barreira for his supervision and guidance. My gratitude also goes to the respondents who participated in my surveys.

To Jesus, I am looking forward to more adventures with You.

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CHAPTER 1: INTRODUCTION

1.1 Purpose of the study

The purpose of this study is to describe the role of Johannesburg universities in the emergence of an information and communication technology (ICT) cluster in Johannesburg.

1.2 Context of the study

1.2.1 South Africa's ICT sector

The South African economy is classified as an upper middle income economy by the World Bank (The World Bank Group, 2013). It is ranked as the world's 26th largest economy by Gross Domestic Product (GDP) and the 35th largest by labour force size (IST-Africa Consortium, 2013). The country's GDP constitutes 25% of the GDP of Africa as a whole which has resulted in South Africa being described as "the economic powerhouse of the African continent" (IST-Africa Consortium, 2013; p.1).

The South African Information and Communication Technology (ICT) sector is the largest on the African continent and is ranked 20th in the world (IST-Africa Consortium, 2013). Some of the ways in which the South Africa's ICT sector has been described include the following statements by IST-Africa Consortium (2013, p.1):

- "The Internet economy contributes 2% to South Africa's GDP. This contribution is…planned to reach 2.5% by 2016.
- South Africa spends close to 10% of GDP on ICT goods and services, most of which are imported.
- Between 2006 - 2010, South Africa produced 20 - 25 PhDs on average in ICT related fields of study.

- Government, Universities and Science Councils have a keen interest in ICT R&D, but funding and current spending on ICT R&D is limited compared to other fields."

1.2.2 The ICT Industry in Johannesburg

Johannesburg is a city in the Gauteng province of South Africa. With more than a fifth of the South African population living in Gauteng, the province contributes about a third of the country's GDP and about 9% of the continent's GDP (Official website of the City of Johannesburg, 2012). About two-thirds of South Africa's ICT companies are located in this province (Global Africa Network (Pty) Ltd, 2007). "International giants like Microsoft, Hewlett-Packard, IBM, ICL, Cisco and Unisys all have a strong presence in Gauteng, as do South Africa's own ICT businesses" (Global Africa Network (Pty) Ltd, 2007; p. 1).

1.2.3 The Emergence of an ICT Cluster in Johannesburg

Research on the development of technology clusters in South Africa identified the emergence of ICT clusters in the Western Cape and Gauteng Provinces (Moodley, 2003). Previous research had identified the Midrand area, in particular, as an emerging technology cluster in Johannesburg (Hodge, 1998; Voyer 1997).

The emerging Midrand cluster was described as "rapidly growing… with a large contingent of high-tech multinationals and blue chip local firms" (Hodge, 1998; p. 851). The cluster's success was partially attributed to the Midrand area being centrally located (Hodge, 1998). In addition to the location advantage, the success of the Midrand technology cluster was attributed to "high visibility, a positive high-tech image, good quality of life, a visionary town council, good investment returns, low operating costs and lack of local competition" (Hodge, 1998; p. 851).

However, Hodge (1998) noted that one weakness of this emerging ICT cluster was that it was not based on research and development but on supply chain efficiency. Hodge (1998, p. 851) went on to state that the Midrand ICT cluster was "not built on a solid foundation of high technology infrastructure and

dynamism which weakens the cluster's location advantage". In an earlier study, Voyer (1997) had pointed out the Midrand area's limited educational and public research infrastructure, and noted the absence of a university or research institute in the municipality. Recent studies (within the five years preceding this study) on the development of the Midrand technology cluster could not be found.

1.2.4 The Role of the University Within a Cluster

Highlighting the need to understand the role of specific role players in a cluster, Boja (2011, p. 41) stated that:

> Clusters do not magically appear in random areas or in regions that theoretically provide the best conditions; clusters are initiated in regions where there have been previous (clusters), where a number of companies grouped and have developed economic links for collaboration or competition; also the cluster initiative belongs to a market player.

According to Boja (2011), this market player can support or attract other market players into the cluster. One such market player is "a research university" as discussed by Taylor (2008, p. 24) in a study on the emergence of a cluster in Atlanta. A research university was listed as the first of seven required characteristics for clusters and it was described as institution that must have "the resources and the willingness to embrace corporate partnerships as well as the institutional ability to play a leading role in local economic development" (Taylor, 2008; p. 24). A study by the European University Association (2010) described universities' research roles as vital for knowledge generation and innovation to meet local and global social and economic needs. Kotecha, Walwyn, and Pinto's (2011) study proposed that universities play a crucial role in laying "the foundations for a healthy innovation-based economy" and one of the ways in which universities contribute is by conducting research and development (Kotecha et al., 2011; p. 6).

These conclusions about the role of universities in cluster formation are consistent with Hodge's (1998) findings on the strength of the Midrand cluster. While this cluster was considered strong in displaying some required

characteristics such as network linkages and city characteristics, a noted weakness of the emerging cluster was the absence of research and development (Hodge, 1998). This finding serves to highlight the need to understand the role of research institutions in Johannesburg in cluster formation.

A knowledge gap exists in understanding how Johannesburg universities have contributed towards the emergence of a technology cluster in Johannesburg. This study aims to describe the support, if any, Johannesburg universities have provided to both start up and established ICT firms in Johannesburg.

1.3 Problem Statement

1.3.1 Main problem

This study seeks to describe the activities that Johannesburg universities engage in to initiate or support both start-up and established ICT ventures in Johannesburg. Below are the sub-problems outlining the specific aspects of this main problem that are addressed in this study.

1.3.2 Sub-problems

The first sub-problem of this study is to describe the activities through which Johannesburg universities partner with or support start-up and established ICT ventures in Johannesburg in research and development.

The second sub-problem is to describe the role Johannesburg universities play in the commercialisation of ICT spin-offs from these universities.

The third sub-problem is to describe the nature of collaboration between the Johannesburg universities in their support of ICT ventures in Johannesburg.

1.4 Significance of the Study

It is envisaged that the study will provide insight into the nature of activities in which Johannesburg universities are engaged, in an effort to support the emergence of the Johannesburg ICT cluster. The findings of this study intend to contribute towards filling knowledge gaps or spur further research in the following areas:

- The nature of support offered by universities in research-driven clusters compared to universities in supply chain-driven clusters.
- The contribution of universities in emerging countries to the development of ICT clusters.
- The contribution of metropolitan universities in the development of an ICT cluster in a metropolitan area.

This study aims to contribute to the body of knowledge that could provide guidance to universities in emerging economies and in Johannesburg in particular, on the activities they can prioritise, improve on or maintain in order to support the emergence of an ICT cluster effectively. It could also guide policy makers on how to support universities in Johannesburg in order to harness Johannesburg's location advantages for the development of a technology cluster.

1.5 Delimitations of the Study

There are various ways in which the activities of a university can contribute towards the emergence of an ICT cluster; however, this study focuses only on research activities, the commercialisation process and the degree of university collaboration. Also, the focus of the study was limited to ICT ventures and ICT spin-offs, not any other form of spin off or venture.

A further delimitation is that the study focuses only on Johannesburg universities, and does not extend to other tertiary education institutions in Johannesburg. Basant and Chandra (2007, p. 1049) suggested that universities

are different from other tertiary institutions in that they are “high end research oriented academic institutions”. Therefore Johannesburg based technikons, Further Education and Training (FET) colleges and other tertiary institutions that offer education or training in technology and/or entrepreneurship were excluded from the study. It was envisaged that this would not significantly impact the results of the study as the focus of the study was the role of Johannesburg universities in technology cluster formation.

1.6 Definition of terms

Term	Definition
Cluster	The term refers to a group of stakeholders including companies and knowledge/research institutions working together to ensure "the critical mass of knowledge, technologies, sources and funds needed for enhancing the competitiveness of individual companies and the group as a whole" (Prodan, 2007; p. 30).
Clusterpreneur	A key role player in cluster formation and development (Stoerring and Christensen, 2008).
Incubation	"A business support process that accelerates the successful development of start-up and fledgling companies by providing entrepreneurs with an array of target resources and services" (Prodan, 2007; p. 29).
Incubator	An organisation that incubates new ventures.
Information Communication Technology (ICT)	"ICT products (or services) must primarily be intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display" (Organisation for Economic Co-operation and Development, 2008; p. 11).
Spin-off	"A new company that arises from a parent organisation", such as a new venture that is started by university students and/or academic staff (Prodan, 2007; p. 29).
Technological	"The innovative application of scientific and technical

entrepreneurship	knowledge by one or several persons who start and operate a business and assume financial risks to achieve their vision and goals" (The Canadian Academy of Engineering, 1998 in Prodan (2007, p. 27).
Technological entrepreneur	Individuals with the ability to recognise and anticipate high-technology opportunities and turn these into value creating enterprises (Prodan, 2007).
Technology venture/ Technology-based firm	A new firm that "exploits breakthrough advances in science and engineering to develop better products and services for customers" (Prodan, 2007, p. 26).

1.7 Assumptions

It was assumed that respondents to this study's surveys had sufficient knowledge about their organisations' involvement in technology oriented academic or entrepreneurial activities to be able to clearly articulate answers to the presented questions.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

This chapter provides findings on the review of literature related to how clusters and entrepreneurship are related, as well as the role of universities in cluster development.

In the first section, section 2.2, findings on the review of literature examining the relationship between clusters and entrepreneurship are presented. The second section, section 2.3, presents literature review findings on the university's role in the development of a cluster in general, and specifically a technology cluster. From this literature review, the identified three roles of the university which formed the basis of this study's three research propositions are listed.

In the following three sections, sections 2.4, 2.5 and 2.6, findings related to literature exploring the following roles of the university in a cluster are presented:

- The role of universities in partnering with or supporting technology ventures through research and development.
- The role played by universities in the commercialisation of technology spin offs.
- The degree of collaboration between universities in initiating or supporting technology ventures.

The final section of this chapter, section 2.7, concludes this chapter by summarising the key findings of the literature review and re-stating the three research propositions.

2.2. The Relationship Between Regional Clusters and Entrepreneurship

Porter (1998, p. 78) offered two definitions of clusters as follows: 1) “critical masses - in one place - of unusual competitive success in particular fields”, and 2) “geographic concentrations of interconnected companies and institutions in a particular field”. Porter (1998) went on to state that clusters are highly typical but local factors such as knowledge, relationships and motivation are the source of each cluster’s competitive advantage, as these cannot be matched by competitors outside of the cluster; describing this as the “paradox of location” (p. 78). In explaining this paradox, Porter (1998, p. 78) stated that "what happens inside companies is important, but clusters reveal that the immediate business environment outside companies plays a vital role as well."

Porter (1998) identified three ways in which clusters affect competition, and in the course of this identification, made a link between clusters and entrepreneurship. According to Porter (1998, p. 80), firstly, clusters increase the productivity of companies within the cluster and secondly, they drive “the direction and pace of innovation, which underpins future productivity growth”. Relevant to entrepreneurship, Porter (1998, p. 80) suggested that the third way in which clusters affect competition is “by stimulating the formation of new businesses, which expands and strengthens the cluster itself”.

In their definition of a regional cluster, Bresnahan and Gambardella (2004) also linked entrepreneurship to the definition of a cluster. They defined a regional cluster as “a spatial and sectoral concentration of firms; and we measure (its) success by the ability of the cluster as a whole to grow, typically through the expansion of entrepreneurial start-ups" (Bresnahan & Gambardella, 2004; p. 2). Referring to the importance of technology clusters in particular, Bresnahan and Gambardella (2004) noted that regional clusters could have pervasive effects on the national economy as follows:

> National economic growth can be fueled by (the) development of such clusters (high-technology clusters). In the United States the long boom of the 1980s and 1990s was largely driven by growth in the information

> technology industries in a few regional clusters" (Bresnahan & Gambardella, 2004; p. 1).

These assertions on the impact of clusters were supported by Bezold's (2004, p. 1) observations of the St Louis technology clusters below:

> St. Louis's technology based clusters affect the region's broader economy in two powerful ways: by paying above average salaries that support retail spending and drive other multiplier effects across the economy…and the export (of) goods and services around the nation and the U.S.

Prodan (2007) also found that a cluster has positive effects on innovation and competition, information and the attainment of experience, and the long-term development and growth of business within the cluster. According to Prodan (2007, p. 30), a cluster is a group of stakeholders, including companies and knowledge or research institutions, working together to ensure "the critical mass of knowledge, technologies, sources and funds needed for enhancing the competitiveness of individual companies and the group as a whole". Like Porter (1998), Prodan (2007; p. 30) noted that "a cluster promotes the development of unique knowledge which is extremely difficult for the competition to match".

A more recent study on the role of regional clusters in regional entrepreneurship also found that clusters have a positive impact on entrepreneurship within the region (Delgado, Porter and Stern, 2010). Delgado et al., (2010) found that strong clusters positively impact regional entrepreneurship in that they contribute towards the survival of start-up firms and the expansion of existing firms. They also stated that "industries located in regions with strong clusters experience higher growth in new business formation and start-up employment" (Delgado et al., 2010; p. 1).

The literature reviewed above indicates that, firstly, there exists a relationship between cluster development and entrepreneurship, and secondly, that cluster development impacts entrepreneurship positively.

2.3. Locating the University's Role Within a Technology Cluster

"A cluster's boundaries are defined by the linkages and complementarities across industries and institutions that are most important to competition" (Porter, 1998; p. 79). Boja (2011) conducted an analysis of five models of cluster determinants, which identified universities or research institutions as examples of institutions that are important for the development of a cluster. These models are depicted and discussed below.

The red blocks have been added to highlight a component of each model that is associated with universities or research institutions.

Model 1: The Diamond of National Advantage

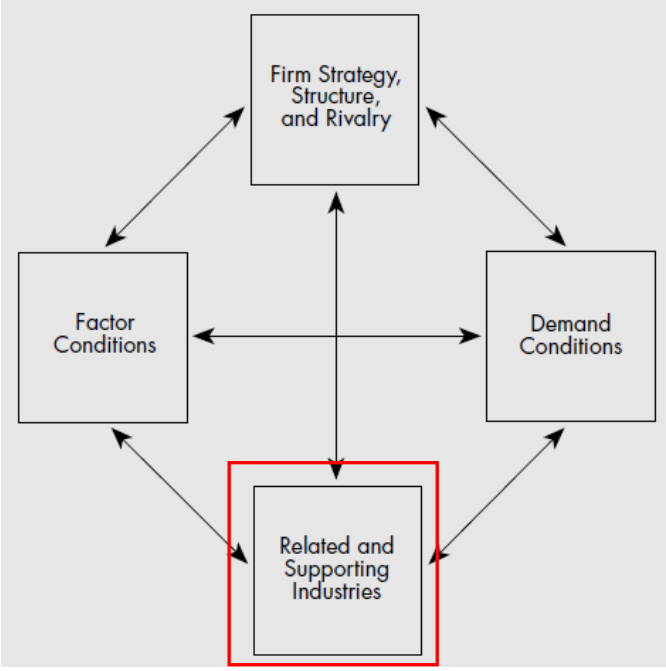

Figure 1: The Diamond of National Advantage (Porter, 1990; p. 78)

Porter (1990) identified factor conditions; demand conditions; related and supporting industries; and firm strategy, structure and rivalry as the four attributes that individually and collectively, are a source of competetive advantage for a nation. Commenting on the model, Boja (2011) suggests that "related and supporting industries describe the factors that allow cluster firms to

evolve and maintain their competitive advantages" and that "in terms of innovation, important factors are university and research centres that may provide new technology needed in production processes" (Boja, 2011; p. 38).

Model 2: The Triple Helix Model

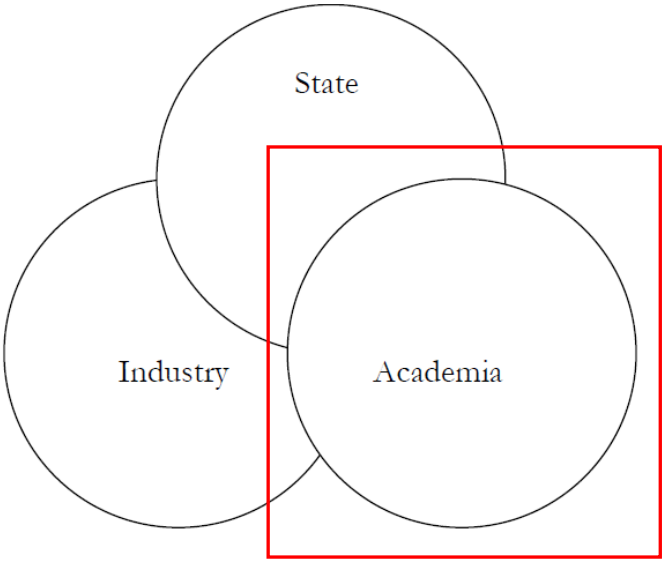

Figure 2: The Triple Helix Model (Etzkowitz, 2002; p. 4)

The Triple Helix Model is an innovation model that identified three institutions that interact in the innovation process. What is significant about this model is that the three "institutional spheres overlap and collaborate and cooperate with each other" (Etzkowitz, 2002; p. 4). "The Triple-Helix model is based on close cooperation between these three factors:

- Universities and research centres are involved in projects, financed by the private sector, to deliver technology, knowledge and to innovate; new business can be created using spin-off technology and financial support from private companies;
- a business environment that involves higher education in research projects and supports private entrepreneurship; and
- government financed research" (Boja, 2011; p. 39)

Model 3: The Cluster Initiative Performance Model (CIPM)

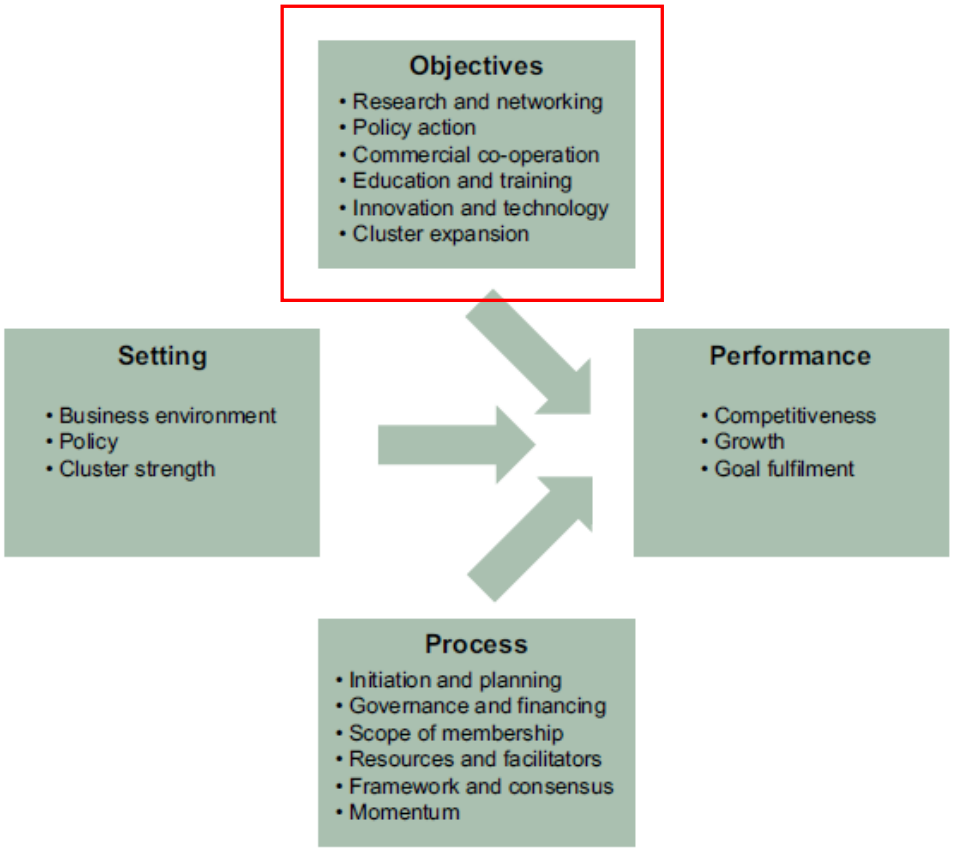

Figure 3: The Cluster Initiative Performance Model (CIPM) (Sölvell, Lindqvist and Ketels, 2003, p. 25)

The CIPM is a cluster initiative model with four components: 1) the social, political and economic setting; 2) the cluster initiative objectives; 3) the development process of the cluster initiative; and 4) the cluster initiative's performance. The first three components lead to the performance of the cluster initiative in a causal manner (Sölvell et al., 2003). There are six categories under the cluster initiative objectives as shown in Figure 3 above. Boja (2011; p. 39) describes these categories as "research and development of research networks, private lobby and communication with the political sector, commercial cooperation, development of educational infrastructure, innovation and development of new technologies, development and extension of an existing cluster."

Model 4: Actors on the Cluster Stage

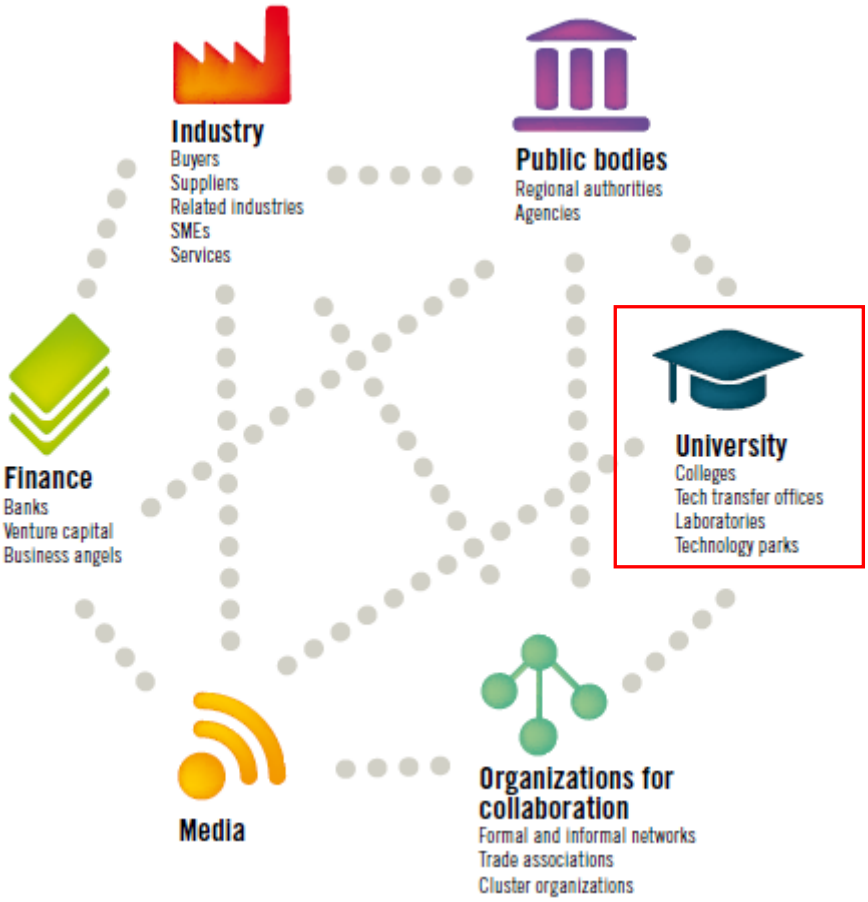

Figure 4: Actors on the Cluster Stage (Sölvell, 2009; p. 16)

This model identified six categories of stakeholders in a cluster and referred to them as “actors” (Sölvell, 2009; p. 16). Universities were identified as one of the six categories, representing “academic actors including universities and colleges, research institutes, technology transfer offices and science parks” (Sölvell, 2009; p. 17). In a different study, Stoerring and Christensen (2008; p. 2) had used the term “clusterpreneurs” to categorise the important role players in cluster formation. The four clusterpreneurs they identified were; 1) universities and other research institutions; 2) policy makers; 3) private firms and industry associations; and 4) business services and venture capital organisations (Stoerring and Christensen, 2008).

Model 5: The Funnel Model – The General Business Environment in a Nation

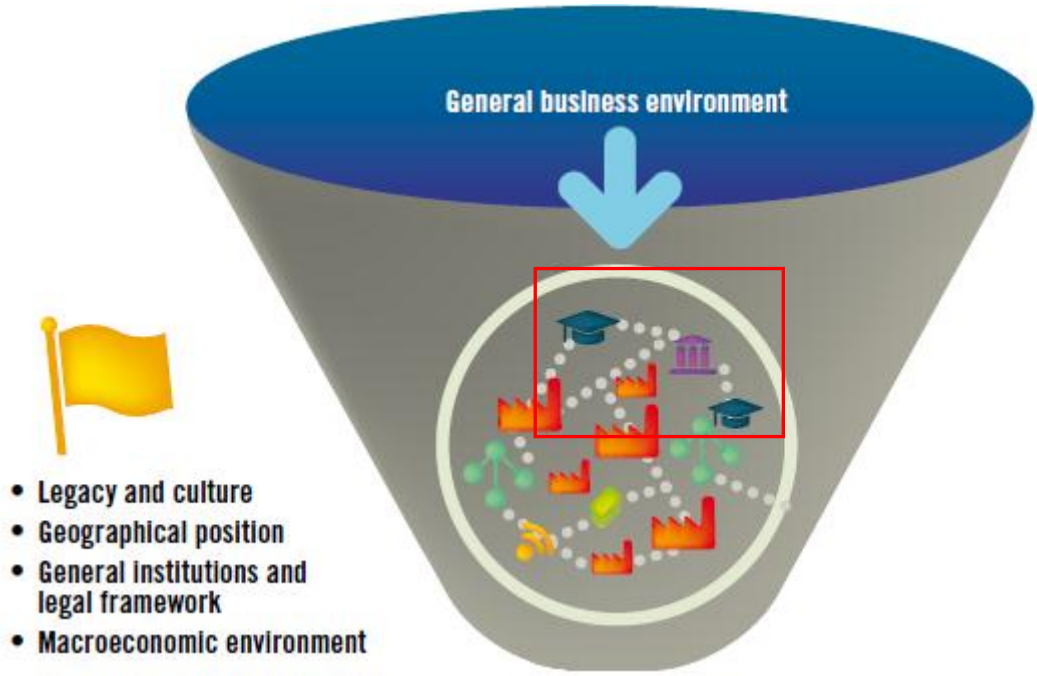

Figure 5: The Funnel Model – The General Business Environment in a Nation (Sölvell, 2009; p. 25)

The Funnel Model shows that clusters are shaped by the overall history and culture of a region, the geographical circumstances, general institutions and legal framework, and the overall macroeconomic environment (Sölvell, 2009). Universities and academic or research institutions fall under the general institutions and legal framework factors that impact clusters.

The five models of cluster determinants discussed above establish that academic or research institutions, particularly universities, are important role-players in cluster development. In the Model of Technological Entrepreneurship, Prodan (2007) established a firm link between technology clusters, universities and entrepreneurship, and it was identified that universities were one of the seven key elements of specifically technological entrepreneurship. Prodan (2007) noted that in relation to new technology-based firms, universities play the following three key roles:

- An educational role.

- A role in establishing new high-technology companies with university-based research and development, university spinoffs and university incubators.

- A role in co-operating with high-tech companies, clusters, technology parks etc.

Below is the Model of Technological Entrepreneurship as proposed by Prodan (2007). It illustrates how the various clusterpreneurs interact with one another during the process of technological entrepreneurship.

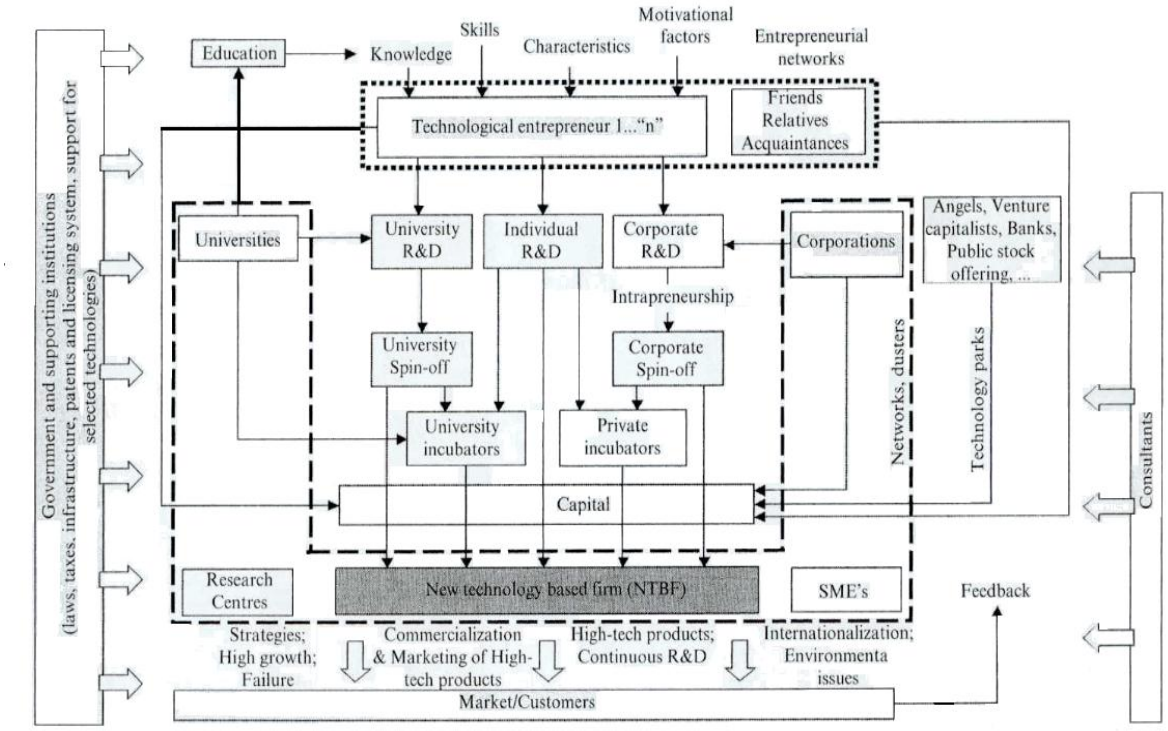

Figure 2.1 Model of technological entrepreneurship

Figure 6: Model of Technological Entrepreneurship (Prodan, 2007; p. 28)

According to this model, the three main functions of a university in a cluster are: 1) providing academic research, 2) commercialising spin offs, and 3) collaborating with other clusterpreneurs, including other research institutions. These functions summarise the three roles universities play in a cluster as identified by Prodan (2007). The sections below focus on the review of literature

related to each of these roles as they relate to the respective sub-problems of this study.

2.4. The Role of Universities in Partnering With or Supporting Start Up and Established Technology Ventures Within a Cluster, Through Research and Development

Prodan (2007; p. 29) noted that universities, being "the modern seedbeds for scientific breakthroughs and technological innovation," are an "important source of scientific knowledge and scientific discovery". The studies reviewed in the previous section showed that, theoretically, there is a sound basis for arguing that the university is a key clusterpreneur. The models of cluster determinants reviewed also converged towards the assertion that one of the university's main contributions as a clusterpreneur is through research and development activities as suggested by Prodan (2007). This section provides a characterisation of activities undertaken by these research universities and considers how practical studies have tested claims regarding the role of the university as a clustepreneur.

A study undertaken by Johnston (2004), which examined the ways in which universities and the private sector interact in Ontario, Canada, identifies that the universities' contributions to the needs of the private sector include supplying skilled, effective knowledge workers; producing research discoveries that can be commercialized; and continuously creating programmes in response to the needs of the private sector. Johnston (2004; p. 1) noted that "the most common bases of university-industry interface are in the education of talented critically thinking people, and in research, development (R&D) and innovation".

Bresnahan and Garmbadella's (2004) study pointed out that in the Silicon Valley cluster, it is universities like Stanford and Berkeley, with strong technical research capabilities, that are more closely linked to commercial activities.

Ramachandran and Ray's (2005; p. 23) study which analysed the formation of an information technology cluster in Bangalore, India, claimed that the Bangalore IT cluster owed its recognition as a leading Indian IT cluster, partly to the " historical development of the city's educational, research and industrial infrastructure." A different study on Indian clusters highlighted that the Institute of Science (IISc) in Bangalore, India offers to the industry, the know-how generated within the institute through in-house research and industry-sponsored projects (Basant and Chandra, 2007). In a framework that placed academic institutions in a city cluster, Basant and Chandra (2007) identified the following four linkages through which academic institutions can interact with a city cluster:

1. Labour market linkages, which refer to universities supplying the skills required by the market. Johnston (2004) also discussed the university's role in supplying skilled knowledge workers.

2. Linkages for demand and supply of goods and services. A university, like any other organisation, requires input resources to produce its output and interacts with the market through the demand of such inputs and the supply of its output.

3. Linkages for the creation, acquisition and dissemination of knowledge. This is the academic role of the university to teach and train.

4. Linkages to create new enterprises and commercialise them through the participation of students and staff. This linkage and linkage 3 above are support the university's role of producing research discoveries that can be commercialized; and continuously creating programmes in response to the needs of the private sector as identified by Johnston (2004).

Some studies have arrived at different conclusions regarding the role of the university in cluster emergence. An analysis of the role of Korean universities in cluster emergence concluded that the way in which Korean universities contributed more meaningfully to cluster development was through the production of highly qualified graduates and not the production of research that can be commercialised (Sohn and Kenney, 2007). Sohn and Kenney (2007) argued that the focus on producing highly skilled graduates, though a relatively

less direct way of contributing towards cluster emergence, has been a successful one for Korean universities. Stoerring (2007) did not argue against the importance of a strong research institution in cluster development but stated that a strong knowledge base does not have to result in a cluster.

Perkmann and Walsh (2007; p. 262) discussed the activities involved in university-industry linkages. These activities are summarised in the table below.

Research partnerships	Inter-organizational arrangements for pursuing collaborative R&D
Research services	Activities commissioned by industrial clients including contract research and consulting
Academic entrepreneurship	Development and commercial exploitation of technologies pursued by academic inventors through a company they (partly) own
Human resource transfer	Multi-context learning mechanisms such as training of industry employees, postgraduate training in industry, graduate trainees and secondments to industry, adjunct faculty
Informal interaction	Formation of social relationships and networks at conferences, etc.
Commercialization of property rights	Transfer of university-generated IP (such as patents) to firms, e.g. via licensing
Scientific publications	Use of codified scientific knowledge within industry

Table 1: University-Industry Links (Perkmann and Walsh, 2007; p. 262)

This study acknowledged that, in a cluster, it is important that there are university-industry research linkages and went on to examine the nature of activities universities should undertake in order to contribute towards cluster development. Perkmann and Walsh (2007) stated that university-industry linkages should be characterised by activities such as research partnerships, described as collaborative research and development; contract research; and related publications. Activities such as academic consulting; the conversion of research projects into commercially viable ventures; human capital exchange and networking also form part of university-industry linkages.

It is proposed, therefore, that universities in Johannesburg support Johannesburg-based ICT ventures by participating in collaborative and contract research with Johannesburg ICT companies.

2.5. The Role of Universities in the Commercialisation Process of Technology Spin-Offs

Producing spin offs and incubating new ventures are two of the key entrepreneurial activities universities engage in as part of their educational role in technology entrepreneurship (Prodan, 2007). Stoerring (2005) argued that the commercialisation of research is the main way in which universities affect industry, that is the impact of the universities is maximised when research is converted into marketable commodities. This conversion may result in spin off ventures. A spin-off is a new company that arises from the parent organization and the degree of support a spin-off receives from its parent organisation is an important factor in its ongoing success (Prodan, 2007).

Incubation is defined as a "business support process that accelerates successful development of start-up and virgin companies by providing entrepreneurs with an array of target resources and services-expertise, networks and tools" (Prodan, 2007; p. 29). University incubators promote venture creation by providing the technology entrepreneur with expertise, networks and tools to ensure that the venture is successful (Prodan, 2007). The main goals of incubators, as identified by Prodan (2007) include:

- producing viable and freestanding firms;
- commercialising new technologies;
- potential to create jobs;
- revitalising neighbourhoods; and
- strengthening local and national economies.

As discussed in the previous section, Basant and Chandra (2007), Prodan (2007) and Perkmann and Walsh (2007) identified the creation of new enterprises or the commercialisation of new technologies as important activities of universities. Initiating, incubating and commercialising spin-offs based on the work of university students and/or academic staff is therefore an important

output of universities within a technology cluster. Part of the commercialisation process may include licensing or patenting new inventions and new technologies. Basant and Chandra (2007; p. 1039) noted that linkages to create new enterprises between universities and the industry can take a variety of forms including “technology licensing”.

One study noted that in New Zealand, the university’s role is particularly important for economic development as “two-thirds of New Zealand’s intellectual property and scientific publications come from universities and research institutes” (Ahn, Gray and Collier, 2010; p. 1).

However, as noted by Mohan, Ejnavarzala and Lakshmi (2012, p. 3) in emerging economies such as India, commercialisation and the production of spin offs are not prevalent activities at universities due to “lack of seed funding, inappropriateness of research for commercialization, and absence of institutional regulations and a conducive policy to set up firms.” This evaluation was made in reference to specifically the IT sector (Mohan et al., 2012). Despite this evaluation, literature reviewed in sections above shows that the commercialisation of research projects is an important role for universities in clusters.

It is proposed, therefore, that Johannesburg universities support technology entrepreneurship by incubating and commercialising university spin-off ICT ventures.

2.6. Collaboration Between Universities in Initiating or Supporting Technology Ventures Within a Cluster

“The collaboration between universities, research centres, corporations, small and medium enterprises and new technology-based firms, as well as the interrelationship between them, is a fundamental tenet of success of new technology-based firms in the global market” (Prodan, 2007; p. 28).

The role of universities in national systems of innovation in developing countries has been recognised in both regional and national policy documents (Kotecha

et al., 2011). These policies have called for a strengthening of these institutions through inter- and intra-regional collaboration between higher education institutions (Kotecha et al., 2011). There has been growing interest expressed by higher education bodies such as the Association of African Universities, the Inter-University Council of East Africa (IUCEA) and the Southern African Regional University Association (SARUA) in strengthening intra-African higher education cooperation (European University Association, 2010).

Greater university collaboration is expected to strengthen the research output and human capital development within a region or cluster, which in turn positively impacts cluster development (Kotecha et al., 2011).

For the purposes of this study, collaboration between universities is defined as:

- Referring research projects between universities according to strength in research area or topic.
- Partnering in research projects (of academic staff and students) for the transference of skills and expertise.
- Co-publishing and co-patenting by academic staff and students of the University of Johannesburg (UJ) and the University of the Witwatersrand (Wits).

It is proposed, therefore, that universities in Johannesburg collaborate with one another in supporting Johannesburg-based ICT ventures through research and development; and the commercialisation thereof.

2.7. Conclusion of Literature Review

The literature review reflects that universities play a significant role in technology entrepreneurship and cluster formation by providing research-based expertise; starting, commercialising and supporting university spin-offs; and collaborating with other universities or institutions in these processes. Based on this, below are the propositions to be tested by this study:

2.7.1 Proposition 1: Johannesburg universities support Johannesburg-based ICT ventures by participating in collaborative and contract research with these companies.

2.7.2 Proposition 2: Johannesburg universities support technology entrepreneurship by incubating and commercialising university spin-off ICT ventures.

2.7.3 Proposition 3: Johannesburg universities collaborate in supporting Johannesburg-based ICT ventures through research and development; and the commercialisation thereof.

CHAPTER 3: RESEARCH METHODOLOGY

This section is divided into eight sections. The first two sections, sections 3.1 and 3.2, discuss the research methodology and design that was followed in the study. Sections 3.3 to 3.6 address the population and sample, the research instrument, the procedure for data collection, and data analysis and interpretation. In the remaining two sections, sections 3.7 and 3.8, the limitations of the study, and the validity and reliability of the study are explained.

3.1 Research Methodology or Paradigm

The purpose of this study is to describe the role of Johannesburg universities in the emergence of an information and communication technology (ICT) cluster in Johannesburg. The methodology that was employed to test the propositions of the study is the mixed methodology, which incorporates both quantitative and qualitative approaches. Creswell (2009) observed that the use of mixed method research gained momentum through the publishing of books, journals encouraging this strategy and numerous studies in diverse fields in which this strategy was applied. Each of the two approaches is discussed to highlight the advantages and disadvantages of each methodology and to offer justification for the decision taken to combine the two approaches for this study.

The quantitative research methodology was utilised in the research because the aim of quantitative research is to describe, test the hypotheses or make predictions (Merriam, 1998). Since this study seeks to describe, it is in line with the objective of quantitative research as stated by Merriam (1998). Quantitative research follows a predetermined, structured design and yields precise, hard, reliable data which enables generalisations to be made from findings of the research (Merriam, 1998). This methodology was pursued for this study in order to obtain such hard, reliable data that would enable the researcher to make generalisations about the role of Johannesburg universities in the emergence of a Johannesburg technology cluster. Quantitative research methodologies answer questions related to how much, how often, how many, when and who

(Cooper & Schindler, 2011). These are the types of questions used in the proposed study's research instruments.

On the other hand, the goal of qualitative research is to "achieve an in-depth understanding of a situation" (Cooper & Schindler, 2011; p. 160). It is sometimes referred to as interpretive research because such research is focused on developing an understanding by making use of detailed description (Cooper & Schindler, 2011). For this study, the qualitative approach was used to gain an understanding of the opinions of the sample described in the following two sections, with the aim of providing a description of the role Johannesburg universities play in the emergence of a technology cluster in Johannesburg.

Creswell (2009, p. 203) stated that "there is more insight to be gained from the combination of both qualitative and quantitative research than either form by itself. Their combined use provides an expanded understanding of research problems." Applying the mixed methodology in a study allows the researcher to access the benefits of both quantitative and qualitative approaches (Creswell, 2009). Cooper and Schindler (2011, p. 183) listed four mixed research strategies as follows:

1. "Qualitative and quantitative studies can be conducted simultaneously.
2. A qualitative study can be ongoing while multiple waves of quantitative studies are done, measuring changes in behaviour and attitudes over time.
3. A qualitative study can precede a quantitative study, and a second qualitative study then might follow the quantitative study, seeking more clarification.
4. A quantitative study can precede a qualitative study."

This study followed the fourth strategy. Quantitative data was gathered through the use of questionnaires, which was followed by the collection of qualitative data through individual interviews.

Following a mixed methods approach for this study enabled:

- Analysis at multiple levels of the sample given the time constraints. More detail on sampling is provided in the following two sections.

- The leverage of the breadth that a quantitative approach provides as well as the depth that qualitative research offers. Basic descriptive statistics on the role Johannesburg universities play in the emergence of a technology cluster in Johannesburg were obtained and reported on, and commentary that provided insight into the opinions of the respondents was also obtained and reported on.

However, the use, and effectiveness, of mixed method research has been questioned by critics who consider quantitative and qualitative approaches conflicting or divergent due to seemingly different epistemological and ontological assumptions in the two approaches (Mouton, 1996). Mouton's (1996) conclusion on this matter was that "the so-called conflict between quantitative and qualitative paradigms…is not necessarily a real conflict…(as) most researchers accept that quantitative and qualitative tools are compatible and that the choice for their inclusion in a particular project is determined by the specific research problem" (Mouton, 1996; p. 40).

For the purposes of this study, and specifically the research problem, using the mixed methodology model did not result in any conflict in data collection and analysis.

3.2 Research Design

Questionnaires and interviews were the two survey research techniques used to collect data for this study. Neuman (2006, p. 42) noted that "in survey research, they (researchers) use a written questionnaire or formal interview to gather information on the backgrounds, behaviors, beliefs, or attitudes of a large number of people". Survey research is not the only methodology available for quantitative research but it is the dominant method (Cooper & Schindler, 2011).

Statistical studies are designed to capture a sample's characteristics from which generalisations about the population can be made (Cooper & Schindler, 2011), and the quantitative component of this study was conducted as a statistical study. The statistical study was employed so that basic descriptive statistics could be obtained in order for the researcher to make generalisations about the role of Johannesburg universities in the emergence of a technology cluster in Johannesburg, based on the research propositions. Questionnaires were used, therefore, to obtain data for the quantitative, statistical component of this study.

Quantitative data was gathered by the use of two self-administered, online questionnaires that were distributed to the samples discussed in section 3.3 below. The questionnaires are attached in Appendix A and B. A questionnaire was favoured above other data collection techniques because it provides a relatively quicker way of obtaining responses and is relatively less time consuming than other data collection techniques (Biggam, 2008). The points below outline further advantages of conducting a survey using questionnaires, identified by Cooper and Schindler (2011), which serve to further confirm this data gathering technique as suitable for this study:

- It facilitates contact with otherwise inaccessible participants, in this case heads of schools, departments or centres at Johannesburg universities.
- An online survey is a low cost option for obtaining feedback from various respondents, which was true for this study.
- It enables the gathering of data from dispersed locations relatively faster. Instead of travelling to the different universities faculties, and departments; and ICT companies, online questionnaires were distributed via email to the respondents at different locations.
- It requires minimal human resource support. The researcher did not have to employ assistants to collect data.
- It is an efficient way of collecting and analysing data because the data was collected electronically. This eliminated the need to re-capture the data.

Cooper and Schindler (2011) also identified the following disadvantages of using a self-administered survey:

- There is no interaction between the interviewer and respondents that allows for probing or explanation. This was mitigated by conducting the interviews that are discussed below.

- There is a low response rate in some modes due to the lack of personal engagement with the potential responses. In this study, even though this risk was mitigated by re-sending the questionnaires every week, the response rates associated with both samples were very low.

- Accurate mailing lists are required in order to maximise the chance of reaching the potential respondents that meet the sampling criteria. An effort was made to obtain accurate mailing lists for one group of respondents, that is, the heads of schools, departments or centres, and greater detail on the data collection procedure is provided under section 3.5 below.

Qualitative data was obtained by conducting individual interviews. Cooper and Schindler (2011) noted that the interview is the primary data collection technique in qualitative research. For this study a structured interview was conducted with each of the interviewees. The use of the structured interview, whereby a detailed interview guide is used to ask specific questions in a particular order, is beneficial (Cooper & Schindler, 2011). Some of the benefits Cooper and Schindler (2011) identified and their relevance to this study are:

- Structured interviews allow for direct comparability of responses. For this study, this enabled rapid analysis of qualitative data collected.

- They eliminate question variability which legitimises answer variability. Again, this enabled the quick analysis of qualitative data collected.

- The interviewer's neutrality is maintained. Focusing on the specific questions enabled the interviewer to remain purposeful and neutral during the research interviews.

- Face-to-face interviewing enables the observation of non-verbal behaviour. This helped the interviewer to pose questions or probe differently in this research.

- Telephonic interviews are less costly than face-to-face interviews as they eliminate travel expenses. This medium helped the interviewer to conduct more interviews over a short period of time.

The interview technique has its own disadvantages. One of these is that an interviewer can have incomplete recollection of the interview. However, this element was mitigated by recording the interviews conducted for this study. Another disadvantage is that the responses of the interviewees could be biased and an interviewee could say what he or she believes the interviewer wants to hear rather than his or her own opinion. For this study, this was mitigated by withholding the interviewer's opinions and the results of the quantitative study from the interviewees. This was done to enable the interviewees to give unbiased opinions. Lastly, the interviewer could be biased in his or her reporting of the data gathered from the interviews. For this study, this was mitigated by presenting both the themes extracted and some direct quotes obtained from the interview. This data is presented in Chapter 4.

3.3 Population and Sample

3.3.1 Population

Data for this study was collected from two sets of target audiences: 1) Academic staff at Johannesburg universities; and 2) Owners or managers of Johannesburg-based ICT companies.

There are two universities in Johannesburg, the University of the Witwatersrand (Wits) and the University of Johannesburg (UJ). The population for the survey research was academic staff from the faculties listed below. This list of faculties was obtained from information found on the websites of the two universities.

- Wits: Commerce, Law and Management

- Wits: Engineering and the Built Environment
- Wits: Health Sciences
- Wits: Humanities
- Wits: Science
- UJ: Art, Design and Architecture
- UJ: Economic and Financial Sciences
- UJ: Education
- UJ: Engineering and the Built Environment
- UJ: Health Sciences
- UJ: Humanities
- UJ: Law
- UJ: Management
- UJ: Science

In addition to university representatives, representatives of ICT ventures located in Johannesburg were invited to respond to the survey. The population for this questionnaire was owners or managers of Johannesburg-based ICT companies that were listed on an online directory website, YellowPages.com, in February 2013.

3.3.2 Sample and Sampling Method

Different sampling methods were used to select the samples for the quantitative and qualitative approaches, and again, there were two target populations that were sampled per approach.

For the quantitative component the sample was as follows:

- **Heads of schools, departments and centres per faculty at Wits and UJ**. The instrument was distributed to 95 Heads in total, whose direct email addresses were listed on the respective university website. Purposive sampling, a form of non-probability sampling whereby a sample matches certain criteria, was used to select this sample (Cooper & Schindler, 2011). To be part of the sample, respondents had to be a Head or Deputy or Acting Head (Deputy or

Acting Heads were included in the sample where the Head's email address was not obtained) of a school, department or centre at the universities' faculties:

- Wits: Commerce, Law and Management
- Wits: Engineering and the Built Environment
- Wits: Health Sciences
- Wits: Humanities
- Wits: Science
- UJ: Art, Design and Architecture
- UJ: Economic and Financial Sciences
- UJ: Education
- UJ: Engineering and the Built Environment
- UJ: Health Sciences
- UJ: Humanities
- UJ: Law
- UJ: Management
- UJ: Science

Because Heads of schools, departments or centres are accountable for the activities of academic staff and students, it was assumed that they had the most up-to-date, centralised information required to complete the survey. A total of 21 respondents completed the questionnaire.

- **Owners or managers of Johannesburg-based ICT companies** that were listed on an online directory website, YellowPages.com, in February 2013. Purposive sampling was used to select this sample. This second questionnaire was distributed to 254 email addresses whose details were tagged to the following meta-tags or search variables: internet services, internet security, internet web development, information services, information technology, telecommunication equipment, telephone equipment and telecommunication consultant. If a company's details appeared under the results of more than one of the different meta tags, it was included only once in the mailing list. This number also excludes private company domain duplications of the email addresses, for

example, if four email addresses were listed for one private company domain such as @company.com, these emails were counted as one in an effort to accurately correlate the number of email addresses with the actual number of companies emailed. A total of nine respondents completed the questionnaire.

For the qualitative component of the study, sampling was done by means of a combination of judgement, convenience and snowball sampling. Judgement sampling, a form of purposive sampling, "occurs when a researcher selects sample members to conform to some criterion" (Cooper & Schindler, 2011; p. 385). Respondents that participated in the interviews had to be lecturers who are not Heads, Deputy Heads or Acting Heads of schools, departments or centres at Wits and UJ. It was important to set this criterion as the intent of the qualitative sample was to obtain data from different levels of academic staff.

Cooper and Schindler (2011) define snowball sampling as the location of respondents through referral using other respondents' networks. It was a useful way of obtaining interview respondents within a short timeframe.

For the qualitative component of the study, the samples from the two target populations consisted of:

- **Senior and junior lecturers from Wits or UJ**. Initial respondents were randomly selected from the universities' websites and those who agreed to participate were then asked to nominate colleagues who could be requested to participate. The goal of including this sample in the research was to enable academic staff employed at multiple levels to participate in the study. This sample was not intended to be representative. A total of five senior and junior lecturers participated in the interviews. Three of these were from Wits and the remaining two from UJ.

- **Owners or managers of Johannesburg-based ICT companies**. For this sample, respondents who had participated in the questionnaire survey were invited to also participate in the interviews. Convenience sampling was used to select this sample. Convenience sampling refers

to the selection of accessible and readily available potential respondents (Cooper & Schindler, 2011). It was an appropriate sampling method for as it was expected that the respondents who had been exposed to the study, and had already engaged with the questionnaire would more be more willing to participate in the interview. Only one of these respondents was willing and able to participate within the established timeframe.

Table 2: Profile of Respondents Summary

Quantitative technique sample (Online questionnaires)	**Questionnaire attached**	**Number of distributed questionnaires**	**Number of respondents**
Heads of schools, departments and centres at Wits and UJ	Appendix A	95	21
Owners or managers of Johannesburg-based ICT companies	Appendix B	254	9
Qualitative technique sample (Structured interviews)	**Interview guide attached**	**Number of distributed questionnaires**	**Number of respondents**
Senior and junior lecturers from Wits and UJ	Appendix C	Not applicable	5
Owners or managers of Johannesburg based ICT companies	Appendix C	Not applicable	1

3.4 The Research Instrument

Two questionnaires were used to collect data for this study. These research instruments are attached as Appendices A and B of this document. Close-ended questions were used in both questionnaires. Answer options from which respondents could choose in a multiple choice selection format were provided. A Likert-type scale was used for these options wherever it was appropriate. A consistency matrix, which shows how each question on the questionnaire and

the interview sheet is related to each of the three propositions of this study, is attached as Appendix D. The two questionnaires were submitted to a statistician for validity, reliability and consistency checks prior to distribution.

The interview sheet that was used for the structured interviews has been attached as Appendix C of this document. Open-ended questions were used to elicit the respondents' opinions on questions that were related to this study's propositions.

3.5 Procedure for Data Collection

The steps outlined below were followed to collect data from Heads of schools, departments and centres at Wits and UJ, through the use of questionnaires:

- A questionnaire was developed and submitted to a statistician for consistency checking.
- The survey questionnaire was uploaded onto www.surveymonkey.com to be distributed electronically.
- Contact details for the Heads, Deputy or Acting Heads of schools, departments or centres at Wits and UJ were obtained from the respective websites. Deputy and Acting Heads were included where the email address of the Head could not be sourced.
- The online questionnaire was distributed to respondents as a link via email.
- The survey link was re-sent at least once a week for five weeks to potential respondents who had not responded.
- Data was collected for analysis.

The following are the steps that were followed by the researcher to collect data from owners or managers of Johannesburg-based ICT companies, through the use of questionnaires:

- A questionnaire was developed and submitted to a statistician for consistency checking.
- The survey questionnaire was uploaded onto www.surveymonkey.com to be distributed electronically.
- Email addresses for companies were obtained by searching for Johannesburg based companies that were listed under the following tags on www.yellowpages.com: internet services, internet security, internet web development, information services, information technology, telecommunication equipment, telephone equipment and telecommunication consultant.
- The online questionnaire was distributed to respondents as a link via email.
- The survey link was re-sent at least once a week for five weeks to potential respondents who had not responded.
- Data was collected for analysis.

To collect qualitative data:

- An interview guideline was designed.
- Respondents were first invited to participate in the interview by email and telephonic follow ups were conducted by the researcher. Once an interview appointment had been secured, the respondent was asked to nominate another party that could be invited to participate in the interview.
- Interviews were conducted and data was gathered for analysis.

3.6 Data Analysis and Interpretation

Descriptive statistics were used to analyse the quantitative data, for this study. Descriptive statistics are useful preliminary tools for data description (Cooper &

Schindler, 2011). For this study, graphs and frequency tables were used to describe findings of the data collection procedure and these findings are presented and discussed in Chapters 4 and 5 respectively. The themes gathered from interviews are also presented and discussed in Chapters 4 and 5 respectively.

3.7 Limitations of the Study

The results of the study are limited in their applicability because they cannot be generalised due to the fact that for both samples, the response rate for questionnaires was very low. This issue is discussed further in Chapter 5. The study may also be limited in that there may be unrecorded entrepreneurial activities taking place at individual student or staff member level that the sampled audience may not have been aware of while responding to the questionnaire.

3.8 Validity and Reliability of Research

Validity and reliability are criteria for evaluating a measurement tool (Cooper & Schindler, 2011). Validity, the first of these criteria, is the extent to which a test measures the actual object or subject of measurement (Cooper & Schindler, 2011) and there are two forms of validity: internal validity and external validity. Internal validity is “the ability of a research instrument to measure what it is purported to measure” (Cooper & Schindler, 2011; p. 280). External validity is “the data’s ability to be generalized across persons, settings and times” (Cooper & Schindler, 2011; p. 280).

The second criterion for evaluating a measurement tool is reliability, which indicates the accuracy and precision of a measurement procedure (Cooper & Schindler, 2011). Reliability is “concerned with estimates of the degree to which a measurement is free of random or unstable error” (Cooper & Schindler, 2011; p. 283). The reliability of an instrument is measured by its stability, equivalence and internal consistency. An instrument is said to be stable when consistent results can be obtained from repeated measurements of the same person.

Equivalence looks at variations at one point in time among observers and samples of items. Internal consistency assesses homogeneity among items of the research instrument (Cooper & Schindler, 2011).

In order to ensure that this research is valid and reliable:

- The questions on the instrument were based on the literature reviewed as part of the study in order to draw out relevant questions and measurements related to constructs for the proposed study.

- A Likert-type scale was used for some of the questions in the research instruments wherever it was appropriate to do so.

- The research instruments were submitted to a statistician and subjected to stability, equivalence and internal consistency tests prior to being sent out to the respondents.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

In this chapter, the data gathered for this study is presented. First, the demographic profile of the respondents for both questionnaires and the interviewees is presented in section 4.2. In the following three sections, sections 4.3, 4.4 and 4.5, the results related to each of the three propositions for this study are shared. During the data collection process, data related to other university-industry linkages that were not part of this study's propositions was gathered. These results are presented in section 4.6. The final section, section 4.7 summarises the results obtained from the study.

4.2 Demographic Profile of Respondents

The propositions of this study were tested by gathering data from the following sample sets:

- Heads of departments, schools or centres per Faculty at Wits and UJ, via an online questionnaire.
- Owners or managers of Johannesburg-based ICT companies, via an online questionnaire and interviews.
- Senior and junior lecturers from Wits or UJ, via interviews.

4.2.1 Demographic Profile of University Heads

The first questionnaire was distributed to 95 Heads of a school, department or centre at Wits and UJ. As depicted in Figure 7 below, 11 Heads from UJ and 10 Heads from Wits responded to the survey.

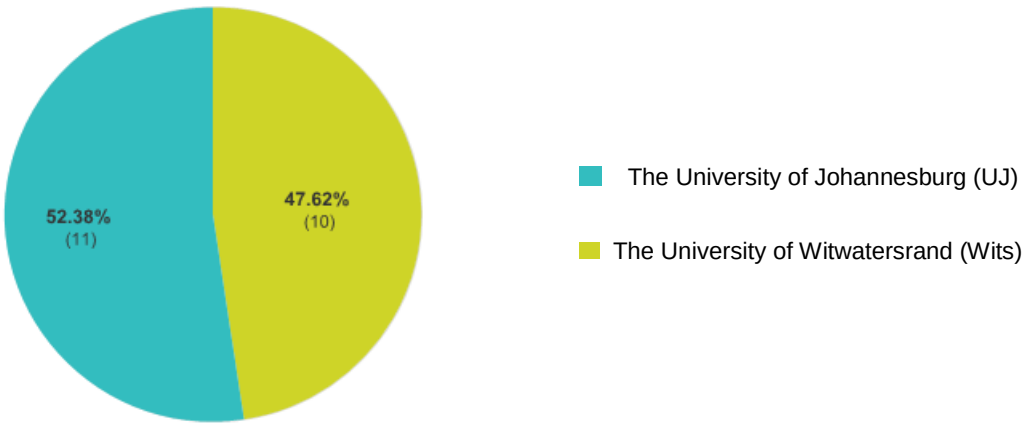

Figure 7: Respondents to Questionnaire for Heads of Schools, Departments or Centres at Johannesburg Universities

Table 3 below shows the number and percentage of respondents per faculty from each of the two universities.

Table 3: Percentage and Number of Respondents per Faculty

Wits and UJ faculties	% and no. of respondents	
Wits: Commerce, Law and Management	4.76%	1
Wits: Engineering and the Built Environment	9.52%	2
Wits: Health Sciences	9.52%	2
Wits: Humanities	9.52%	2
Wits: Science	14.29%	3
Wits: Not under a faculty	0%	0
UJ: Art, Design and Architecture	19.05%	4
UJ: Economic and Financial Sciences	9.52%	2
UJ: Education	0%	0
UJ: Engineering and the Built Environment	4.76%	1
UJ: Health Sciences	4.76%	1
UJ: Humanities	0%	0
UJ: Law	0%	0
UJ: Management	0%	0
UJ: Science	14.29%	3
UJ: Not under a faculty	0%	0
Total		21

Table 3 shows that at least one Head from each of Wits' five faculties completed the survey, and this was the case with six of UJ's faculties. However, there was no participation from three faculties from UJ.

4.2.2 Demographic Profile of ICT Company Representatives

The questionnaire for ICT companies was distributed to 254 email addresses, and the survey was completed by nine company representatives. The background of the nine companies is as follows: one was initiated through the conversion of a Johannesburg university's academic research project into a commercially viable venture; three have been operating for between three and five years; two have been operational for between six and 10 years; and four

have been operating in the ICT industry for more than 10 years. Table 3 below shows the number and percentage of respondent companies categorised by the core or main activities of the company.

Table 4: Percentage and Number of Respondent Companies by Core Activities

Core/main activities of respondent ICT companies	% and no. of respondents	
Information technology software development and/or retail	11.11%	1
Computer hardware/ Electronic equipment manufacturing and/or retail	11.11%	1
Telecommunications	11.11%	1
IT consulting services (including custom development, implementation and ICT education)	33.33%	3
Internet services (including internet access, personal computer/internet security and web development)	11.11%	1
Other	22.22%	2
Total		9

Table 4 shows that three of the respondents to the ICT companies' questionnaire were from companies whose main activities fall under the IT consulting services category. Two respondents were from companies whose main activities were unspecified. The rest of the four respondents represented companies whose core activities fall under each of the remaining four categories: Software Development, Computer Hardware, Telecommunications and Internet Services.

4.2.3 Demographic Profile of Interview Participants

Individual interviews were conducted to gather qualitative data for the testing of the study's propositions. Six respondents partcipated in the interviews - five lecturers and one company representative. Of the five lecturers:

- Three were from Wits and two from UJ.
- Two of the lecturers were senior lecturers while two were junior lecturers.

- None had completed the questionnaire survey.

The company representative interviewed is from a Johannesburg-based ICT company whose core activities fall under IT consulting services. The respondent had completed the ICT companies questionnaire.

4.3 Results Pertaining to Proposition 1

The first proposition of this study is that Johannesburg universities support Johannesburg-based ICT ventures by participating in collaborative and contract research with Johannesburg-based ICT companies.

4.3.1 Results from the Survey of Heads of Schools, Departments or Centres at UJ and Wits

This proposition was first tested by examining the Heads' opinions on the respective university's policies governing university-industry research partnerships. Heads of schools, departments or centres at Wits and UJ were asked if they agreed with the statement that the respective university policy governing research partnerships between academic staff or departments and private companies encourages academic staff to enter into research partnerships with private companies. Of the respondents, 38% were neutral, 34% agreed and 28% disagreed with this statement.

Respondents were then asked to select an option that gave the best indication of the number of standing research partnership agreements their respective units have with Johannesburg-based ICT companies. The graph below depicts the number of standing research partnership agreements the schools, departments or centres represented by the 21 respondents from Wits and UJ, have with Johannesburg-based ICT companies.

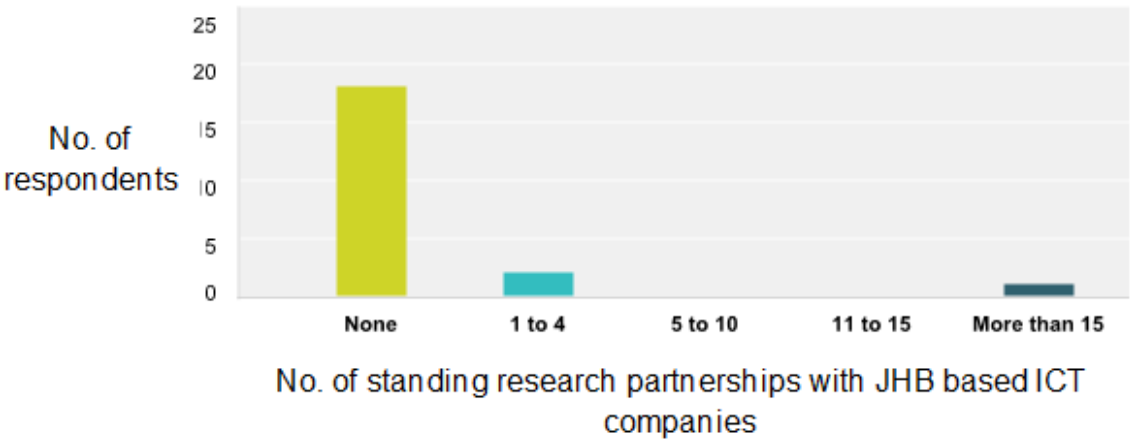

Figure: 8 Number of Standing Research Agreements with JHB ICT Companies

As shown by the graph, 18 of the respondents indicated that their unit does not have any research agreements with Johannesburg-based ICT companies. Two heads indicated that their schools, departments or centres have up to four standing research agreements with Johannesburg-based ICT companies. One respondent's school, department or centre has more than 15 research agreements with Johannesburg-based ICT companies.

The questionnaire probed about the nature of research activities in which the respondent's units have engaged, in partnership with Johannesburg-based ICT companies, in the last three years. Table 5 below, shows that two respondents indicated that their respective units had participated in training activities and one respondent noted that his or her unit had participated in staff exchanges.

Table 5: Research Activities Conducted in Partnership with ICT Companies

Research activities conducted for or with Johannesburg based ICT companies in the past three years	% and no. of respondents	
Prototyping, testing and reporting	0%	0
Temporary personnel exchanges of academic staff or students with Johannesburg based ICT companies	4.76%	1
Training of firm staff by faculty staff or vice versa	9.52%	2
Writing up case studies based on Johannesburg based ICT companies	0%	0
None	85.71%	18

4.3.2 Results from the ICT Companies' Survey

Results pertaining to proposition 1 from the survey of ICT companies are shown in table 6 below.

Table 6: JHB ICT Companies and JHB Universities' Research Collaborations

Universities	No. of ICT company respondents whose company has partnered or collaborated with the indicated academic institution in conducting research and development (R&D)	No. of ICT company respondents whose company staff have co-authored research publications with the indicated academic institution
The University of Witwatersrand (Wits)	1	0
The University of Johannesburg (UJ)	0	0
Another tertiary institution in Johannesburg (e.g. a Technikon, College etc.)	0	0
Another university (other than UJ and Wits) in South Africa	1	2
An international institution	2	2
None of the above	6	5
Total	**9**	**9**

Table 6 shows that of the nine ICT company respondents, only one company has partnered with a Johannesburg-based university in conducting research and none of the companies' employees has co-authored publications with a Johannesburg-based university in the last three years.

4.3.3 Themes on University-Private Company Research Partnerships Emerging from Interviews

In the interviews, senior and junior lecturers were asked to give their opinions on the ways in which their respective institutions encourage research partnerships between academic staff or departments and private companies, such as ICT companies. The themes that emerged from this discussion were:

- The extent to which a particular school, department or centre is involved in industry partnerships is varied across the different academic units, even if they belong to the same faculty or institution.

- University-industry research partnerships are usually initiated by private companies and not by universities.

- Universities encourage research in general, however, the nature and scope of that research is up to the researcher.

The table below summarises these themes and uses text from the interviews to support these themes.

Table 7: Themes on University-Private Company Research Partnerships Emerging from Interviews

	Theme 1 **Involvement in partnerships is varied**	**Theme 2** **Private companies initiate**	**Theme 3** **Research in general is encouraged, it's up to the academics**
Respondent 1	It (university–industry research partnerships) would depend on the different schools or departments to what extent you can get involved in partnerships but they are definitely encouraged. Some schools have it to a greater extent than others.	(Companies) will bring in their research problems which they would have taken from their businesses or other context and they'll ask us to help with the research or parts of it.	
Respondent 2	It depends on which department you are from.	Our department does get approached by different organisations to assist with research.	The topic of research is up to the researcher. They (the university) don't really care as long as it is something that can be published in an accredited journal.
Respondent 3	I see that there is a lot of engagement with other organisations in my department but I'm not sure about other departments.	It's the companies that approach the school for collaborations. I don't know how much the school approaches the companies.	I wouldn't say that the university explicitly encourages it but they do allow it. They allow the funds to go towards the research and they allow the interactions with other organisations.
Respondent 4			Most of the research that's done is done in collaboration with people outside the academic field. It depends on the scope of the research being done.
Respondent 5	Specifically in our school, our final year students are required to do investigational and design projects which meet the needs of industry. Therefore we are continually looking for private partners who would sponsor projects and co-mentor the students. It depends on the academics in that school.	In the teaching arena, we encourage a lot of our industry partners to come in and add value to our teaching through case studies, seminars and practicals.	The research office is continually looking for opportunities for academics to participate beyond the confines of the university environment. The information is sent out via the communication that goes out at least twice a week.

ICT company representatives were asked during the interview to suggest what Johannesburg-based universities can do to encourage research partnerships between universities and ICT companies in Johannesburg. It was suggested that Johannesburg universities should proactively communicate with ICT companies to raise awareness on opportunities for research collaborations.

	Communicate and raise awareness
Respondent 6	They could communicate with businesses if something like that is an option especially for small businesses. I've never heard of it. It wouldn't even occur to me to approach a university.

The results above neither support or disprove the proposition that universities in Johannesburg support Johannesburg-based ICT ventures by participating in collaborative and contract research with Johannesburg ICT companies. They do, however, reflect that there is disparate activity amongst the schools, departments or centres that participated in the survey in supporting Johannesburg-based ICT ventures through collaborative and contract research with said companies.

4.4 Results Pertaining to Proposition 2

The second proposition of the study is that Johannesburg universities support technology entrepreneurship by incubating and commercialising university spin-off ICT ventures.

4.4.1 Results from the Survey of Heads of Schools, Departments or Centres at UJ and Wits

This proposition was first tested by asking the Heads of schools, departments or centres to indicate their opinion on whether the university policy governing the conversion of university research projects into commercially viable ventures encourages academic staff to convert research projects into commercially viable businesses. Of the 21 respondents, 13 chose the neutral option, five agreed, one strongly agreed, two disagreed and one strongly disagreed.

Subsequent questions sought to establish whether there are departments that have been involved in incubation and commercialisation activities related particularly to ICT ventures. This was done by seeking information on the number of ICT ventures incubated, the number of ICT spin-offs produced and the number of ICT-related patents registered per school, department or centre within the three years preceding the study. Data gathered on these questions is summarised in Table 8 below.

Table 8: Summary of incubation and commercialisation activities at universities

Heads of schools/departments/centres on the number of Johannesburg based ICT start-up ventures their unit has incubated in the last three years			Heads of schools/departments/centres on the number of research projects that have been converted into commercially viable Johannesburg based ICT ventures in the last three years			Heads of schools/departments/centres on the number of ICT related patent applications originating from their unit in the last three years		
	No. of respondents	% respondents		No. of respondents	% respondents		No. of respondents	% respondents
None	17	80.95	None	16	76.19	None	19	90.48
We do not track/record this	4	19.05	1 to 5	1	4.76	1 to 10	2	9.52
			We do not track/record this	4	19.05			

Table 8 shows that 17 academic units have not incubated ICT start-ups while four do not record such activity. It also shows that one academic unit has been involved in the conversion of up to five research projects into commercially viable ventures in the three years preceding the study. 16 schools, departments or centres have not been involved in the commercialisation of research projects and four units did not record such activity in the preceding three years. Also shown in table 7 is that two academic units have submitted at least one patent application in the last three years, while 19 units have not applied for any ICT-related patents in the last three years.

Respondents were also asked to select, based on opinion, the main reason why staff and students from their school, department or centre do not commercialise research projects. This selection was made from a list of reasons that were provided. The responses are presented in Table 9 below.

Table 9: Reasons Academics Do Not Commercialise Research Projects

Reasons academics do not commercialise research projects	No. of respondents	% respondents
In-appropriateness of research for commercialisation	6	28.57
A pure academic focus on the part of academic staff	7	33.33
Institutional (university) bureaucracy which makes the commercialisation process onerous	3	14.29
Other	4	19.05
Lack of seed funding	1	4.76

As shown above, 7 of the respondents indicated that the primary reason for non-commercialisation of research projects is a pure academic focus on the part of academic staff. The inappropriateness of research for commercialisation was selected as the main reason by six respondents. Cumulatively, these two reasons were selected by 13 respondents, who represent 61% of the total number of respondents.

4.4.2 Themes on the Commercialisation of Research Projects Emerging from Interviews

The respondents who participated in the interviews were asked to suggest reasons why staff and students from their respective institutions do not commercialise research projects. ICT company representatives were also asked to give their opinions on why Johannesburg universities do not commercialise research projects. Interviewees were not given a set of reasons to choose from, however, four themes emerged from the interviews as potential reasons why staff and students from Johannesburg universities do not commercialise their research projects. These themes are:

- The research conducted is inappropriate for commercialisation.
- Academic staff and students are often focused on the achievement of academic goals, not commercialisation.
- Academic staff and students lack the personal drive required to commercialise research projects.
- University rules and regulations associated with the commercialisation of research projects are perceived to be burdensome.

Table 10 below summarises these themes and the related comments made by interviewees.

Table 10: Themes on the Commercialisation of Research Projects Emerging from Interviews

	Theme 1 **Inappropriateness of research for commercialisation**	**Theme 2** **The goal is often purely academic**	**Theme 3** **Lack of personal drive to commercialise**	**Theme 4** **Rules and regulations are burdensome**
Respondent 1	It's because they are researching something that is not necessarily a practical thing that is needed in business. If they take a problem that people are working on, you can immediately practically apply and in that case it would be easier to commercialise.			
Respondent 2	The research that's done is not commercially viable. PhD students use it (the research) in their field of work. The research that's done is mainly for operations purposes rather than for commercial purposes.	The student is trying to pass and get a qualification rather than make money.	If someone asks for it (the research) and it can get used commercially, I don't think they (the researcher) would refuse.	
Respondent 3				There are many rules and regulations to do with intellectual property. And the intellectual property is seen to belong to the university.

	Theme 1 Inappropriateness of research for commercialisation	Theme 2 The goal is often purely academic	Theme 3 Lack of personal drive to commercialise	Theme 4 Rules and regulations are burdensome
Respondent 4	The research collaborations are usually rather small. Research is often conducted by a student with the help of a Supervisor. The scope of the research tends to be small whereas if research was done as a team, we could do big projects which could be commercialised.			Some people don't even have enough funding to get data for their research. What are the chances that they will commercialise? It is a process to get funding for the research, how about funding for commercialisation?
Respondent 5	If you're looking at undergraduate students, the kind of projects they are doing are usually not up to the standard of what industry would require.	For postgraduate students, academic enterprise does not involve commercialising. It's just not part of the academic project.		I developed software which I had hoped to patent but when I saw the kind of admin, in terms of filling in forms and the resources that are required in order to patent, I just dropped it. A lot of us are not interested in the processes that are required in order to commercialise projects. I think Wits Enterprise comes in as a middleman. Previously it didn't exist so a lot of us didn't bother.

	Theme 1 Inappropriateness of research for commercialisation	Theme 2 The goal is often purely academic	Theme 3 Lack of personal drive to commercialise	Theme 4 Rules and regulations are burdensome
Respondent 6			Doing it is not linked to their own personal career performance or job performance. They do not have a vested interest in commercialising.	

In relation to the proposition that Johannesburg universities support technology entrepreneurship by incubating and commercialising university spin-off ICT ventures, the results presented above show that there are isolated activities related to the incubation and commercialisation of spin-off ICT ventures, in the units represented by the respondents.

4.5 Results Pertaining to Proposition 3

The third proposition for this study is that Johannesburg universities collaborate in supporting Johannesburg-based ICT ventures through research and development; and the commercialisation thereof.

4.5.1 Results from the Survey of Heads of Schools, Departments or Centres at UJ and Wits

In order to test for this proposition, Heads of schools, departments or centres surveyed were asked to provide appoximations of the percentage of standing research partnerships that included the other Johannesburg university, the number of co-authored publications with the other Johannesburg university, as well as the number of co-registered patents in respect of the unit they represent

during the three years preceding the study. These results are summarised in Table 11 below.

Table 11: Summary of Wits and UJ Collaborations In ICT-Related Research and Commercialisation

Heads of schools/departments/centres on the percentage of their unit's standing research partnerships with Johannesburg based ICT companies include the other Johannesburg university			Heads of schools/departments/centres on the average number of research publications co-authored by their unit's academic staff and/or students together with academic staff and/or students from the other Johannesburg university, per year			Heads of schools/departments/centres on the approximate number of ICT related patents were co-registered by their unit's academic staff and/or students and the other Johannesburg university in the last three years		
	No. of respondents	% respondents		No. of respondents	% respondents		No. of respondents	% respondents
None	18	85.71	None	10	47.62	None	21	100
Greater than zero but less than 1%	2	9.52	1 to 10	8	38.1			
Between 6% and 10%	1	4.76	11 to 20	1	4.76			
			More than 30	2	9.52			

The results presented in table 10 show that 18 units have not partcipated in research partnerships, in a formalised manner with the other university. Two respondents noted that fewer than 1% of their research partnerships include the other Johannesburg university. In one unit, between 6% and 10% of research partnerships include the other Johannesburg university.

When Heads of Schools, departments or centres were asked if they are of the opinion that there is a high degree of collaboration between their unit's staff and students and staff and students of the other Johannesburg university in the conversion of research projects into commercially viable ventures, they responded as follows:

Table 12: Summary of Responses on the Degree of Collaboration between Johannesburg Universities in the Commercialisation of Research Projects

	No. of respondents	% respondents
Strongly disagree	11	52.38
Disagree	5	23.81
Neutral	5	23.81

Table 12 shows that 52% of the respondents strongly agree with the statement that that there is a high degree of collaboration between their unit's staff and students and those of the other Johannesburg university in the conversion of research projects into commercially viable ventures.

4.5.2 Themes on the Collaboration of Johannesburg Universities

Senior and junior lecturers who participated in the interviews were asked to suggest reasons why staff and students from their institution do not collaborate with staff and students from the other institution for research projects and in the commercialisation thereof. ICT company representatives were not asked to comment on the collaboration proposition in the interviews. The three themes that emerged from the interviews pertaining to the third proposition are that:

- Collaboration happens at an individual level and is dependent on personal relationships.
- There is a lack of guidance on collaboration at an institutional level.
- Pride is one of reasons academic staff and students do not collaborate with the other Johannesburg university.

Table 13 summarises these themes and the related comments the interviewees made.

Table 13: Themes Emerging from Interviews on the Collaboration of Johannesburg Universities

	Theme 1 **Collaboration happens at an individual level**	**Theme 2** **Lack of guiding structures/ frameworks**	**Theme 3** **Pride**
Respondent 1	When collaboration happens it's because someone knows someone form the other university. There must be a link there already. Individuals are the ones who do it, not as a collective.	Collaboration is something you have to go out and be proactive about doing. If there isn't a structure, it becomes even more difficult.	

	Theme 1 **Collaboration happens at an individual level**	**Theme 2** **Lack of guiding structures/ frameworks**	**Theme 3** **Pride**
Respondent 2	There is not enough communication between the different institutions especially among the postgraduate students.	When you do research, you get a government grant. If you collaborate with another university then the grant will partly go to the other university. But how does performance get measured?	You don't sleep with the enemy.
Respondent 3	It just takes the staff or students initiating it. People meet at for example conferences. Sometimes they meet in their capacity as people who know what they do.		
Respondent 4			You get input form people from other universities but you still conduct your own research. People don't mind input but still prefer to do it on their own. They still want the credit.
Respondent 5	I have collaborated with 2 members from the other university for at least 8 years. We have a very good working relationship. I think it's personality driven. It's driven by who you know on the other side who shares the same interests as you. Where there isn't a relationship or a mutual interest, then collaboration doesn't happen.		

The third proposition of this study was that Johannesburg universities collaborate in supporting Johannesburg-based ICT ventures through research and development; and the commercialisation thereof. The results presented above show that there is a degree of research-related collaboration and no commercialisation-related collaboration with the other Johannesburg university amongst the units represented by the respondents.

4.6 Other University-Industry Linkages

During the data collection process, data that is not directly related to this study's propositions but other university-industry linkages was gathered. Table 14 below summarises the findings related to other university-industry linkages from the survey taken by university heads.

Table 14: Other Johannesburg University-Industry Linkages from the Survey Taken by University Heads

Heads of schools/departments/centres on the percentage of their unit's full time academic staff that provides advisory/consulting services to Johannesburg based ICT companies			Heads of schools/departments/centres on the number of courses or programs their unit has introduced in the last three years in response to the emerging skills needs of the South African ICT industry			Heads of schools/departments/centres on the percentage of their unit's alumni that initiates an ICT start-up company within three years of graduating			Heads of schools/departments/centres on the approximate percentage of their unit's graduates that are employed by Johannesburg based ICT companies within a year of graduating		
	No. of respondents	% respondents		No. of respondents	% respondents		No. of respondents	% respondents		No. of respondents	% respondents
None	12	57.14	None	13	61.9	None	7	33.33	None	7	33.33
Between 1% and 10%	8	38.1	1 to 5	7	33.33	Between 1% and 10%	4	19.05	We do not track/record this	10	47.62
Between 10 and 49%	1	4.76	More than 15	1	4.76	We do not track/record this	10	47.62	Between 1 and 10%	1	4.76
									Between 31% and 40%	1	4.76
									More than 40%	2	9.52

In the table above it is shown that nine university schools, departments or centres provide advisory or consulting services to Johannesburg-based ICT companies with one unit having between 10% and 49% of its staff involved in this linkage. Also, eight units have introduced courses or programmes in response to the emerging skills needs of the South African ICT industry, with one of those having introduced more than 15 such courses in the three years preceding the study.

Table 14 also shows that on average, between 1% to 10% of the graduates in four schools, departments or centres initiated an ICT start up within three years of graduating. Lastly the table shows that at 5 schools, departments or centres, a percentage of their graduates are employed by Johannesburg ICT companies within a year of graduating. In two of these units, more than 40% of

their graduates join Johannesburg-based ICT companies within a year of graduating.

Table 15 below, summarises findings related to other university-industry linkages from the survey taken by ICT company representatives.

Table 15: Other Johannesburg University-Industry Linkages from the Survey Taken by University Heads

ICT company representatives on whether their company has supplied Wits and UJ with services or products in the last three years			ICT company representatives on the institution from which they have employed the majority number of graduates in the last three years			ICT company representatives on activities funded at Wits and UJ in the last three years		
	No. of respondents	% respondents		No. of respondents	% respondents		No. of respondents	% respondents
No	6	66	The University of Witwatersrand (Wits)	0	0	We do not fund activities at this institution	9	100
Yes, mostly on an adhoc basis	2	22	The University of Johannesburg (UJ)	0	0			
Yes, mostly as a contracted supplier	1	11	Another tertiary institution in Johannesburg (e.g. a Technikon, College etc.)	33.33	3			
			Another university (other than UJ and Wits) in South Africa	66.67	6			
			An international institution	0	0			
			None of the above	11.11	1			

The table above shows that of the nine companies that participated in the survey, three have a market relationship with Wits and UJ as a supplier. It also shows that none of the companies have employed a majority of their graduates from Johannesburg universities in the last three years. None of the companies have funded activities at both Wits and UJ in the last three years.

The results presented above show that other industry linkages that exist between the units represented in the surveys and Johannesburg ICT companies are through the provision of consulting services by academic staff, the introduction of ICT industry-relevant programmes or courses and the employment of university graduates by Johannesburg-based ICT companies.

4.7 Summary of the Results

In the current chapter, results on data gathered for this study was presented. Statistical data was presented mainly through the use of frequency tables, while qualitative data was presented by grouping the data collected into themes. Results gathered on other industry linkages, other than the ones that formed the basis of this study's propositions; between Johannesburg universities and Johannesburg-based ICT companies were also presented.

Relative to this study's propositions, the following conclusions were made following the presentation of the data:

- There is disparate activity in supporting Johannesburg-based ICT ventures through collaborative and contract research with Johannesburg ICT companies, amongst the schools, departments or centres that participated in the survey.

- There are isolated activities related to the incubation and commercialisation of spin-off ICT ventures, in the units represented by the respondent heads.

- There is some research-related collaboration and no commercialisation-related collaboration with the other Johannesburg university amongst the units represented by the respondents.

CHAPTER 5: DISCUSSION OF THE RESULTS

5.1 Introduction

The results of this study are discussed and explained in this chapter with reference to the related literature. In the first section, section 5.2, results related to the demographic profile of respondents are discussed. In sections 5.3, 5.4 and 5.5, results pertaining to the three propositions of this study are discussed with reference to literature reviewed. Section 5.6 of this chapter offers a summary and conclusion.

5.2 Demographic Profile of Respondents

The number of respondents for the different samples was very low. As the purpose of this study was to draw conclusions about the role of Johannesburg universities, it had been expected that a representative sample would be obtained in order to enable generalisations to be made. This was not achieved.

The sample of Heads of schools, departments and centres per faculty at Wits and UJ, whose email addresses were accessible was 95. Questionnaires were distributed to these 95 potential respondents and 21 completed the survey representing 22% of the accessible sample. As shown in Table 2, there was representation from each faculty of Wits as evidenced by the participation of at least one respondent per faculty. This was not achieved at UJ as three faculties were not represented in the study.

The second sample group of the study was owners or managers of Johannesburg-based ICT companies. The related questionnaire was distributed to 254 email addresses sourced from an online directory. Even though there was participation of respondents across each of the main categories of core activities listed, the response rate was again too low to allow for generalisations from this sample. Nine respondents, representing 5.5% of the identified sample completed the survey.

There was no intention of obtaining a representative sample for the qualitative component of the study. Interviews were conducted with five lecturers from both Wits and UJ and one ICT company representative.

5.3 Discussion Pertaining to Proposition 1

The first proposition of this study is that Johannesburg universities support Johannesburg-based ICT ventures by participating in collaborative and contract research with Johannesburg ICT companies. The results presented in relation to this proposition showed that 34% of the respondents were of the opinon that university policy governing research partnerships between academic staff or departments and private companies encourages academic staff to enter into research partnerships with private companies. 28% of the respondents disagreed with this statement while 38% took a netutral stance.

Probing on the number of standing research agreements with ICT companies showed that only three of the 18 university schools, departments or centres represented had standing research agreements with ICT companies in Johannesburg. Results on the nature of research activites university units take part in with ICT companies indicate that two units had participated in training activities, while one unit had participated in staff exchanges. However, none of the units represented by the respondents had participated in prototyping, testing and reporting; and writing up cases studies based on Johannesburg ICT companies.

On the other hand, only one of the respondents from the ICT companies had partnered or collaborated with a Johannesburg university in conducting research and development. Also, none of these companies' employees had co-authored publications with staff or students at either of the two Johannesburg universities.

Three themes emerged from interviews conducted with senior and junior lecturers at Johannesburg universities and one ICT company representative.

These are:

- The extent to which a particular school, department or centre is involved in industry partnerships is varied across the different academic units, even if they belong to the same faculty or institution.

- University-industry research partnerships are usually initiated by private companies and not by universities.

- Universities encourage research in general, however the nature and scope of that research is up to the researcher.

There is evidence of research activities involving Johannesburg-based ICT companies in according to the results presented. However, the results, and discussion above neither support nor disprove the proposition that universities in Johannesburg support Johannesburg-based ICT ventures by participating in collaborative and contract research with Johannesburg ICT companies. They also do not support or challenge the proposals made about the university's research function within a cluster put forward by Johnston (2004), Basant and Chandra (2007), Prodan (2007) and Perkmann and Walsh (2007). This is because generalisations cannot be made about the universities due to the fact that representative samples were not achieved.

However, the results reflect that there is disparate activity in supporting Johannesburg-based ICT ventures through collaborative and contract research with Johannesburg ICT companies, amongst the schools, departments or centres that participated in the survey.

5.4 Discussion Pertaining to Proposition 2

The second proposition of the study is that Johannesburg universities support technology entrepreneurship by incubating and commercialising university spin-off ICT ventures.

Results relating to whether university policy governing the conversion of university research projects into commercially viable ventures encourages academic staff to convert research projects into commercially viable businesses were first presented. These results showed that one respondent strongly agreed

with this statement, five agreed, two disagreed, one strongly disagreed and 13 chose the neutral option. The ratio of respondents who agree with the statement in relation to those who do not is (excluding the neutral respondents) is 2: 1 which indicates that more of the respondents are of the opinion that university policy governing the conversion of university research projects into commercially viable ventures encourages academic staff to convert research projects into commercially viable businesses. These findings challenge Mohan et al.'s (2012) assertion that univerities in emerging economies lack a conducive policy to set up firms.

The summary of incubation and commercialisation activities at universities provided in Table 8 shows that 17 academic units have not incubated ICT start-ups while four do not record such activity. It also shows that only one of the 21 academic units represented has been involved in the conversion of research projects into commercially viable ventures in the three years preceding this study. This table shows that 16 schools, departments or centres have not been involved in the commercialisation of research projects and four units did not record such activity in the previous three years. Results on patent applications show that two academic units have submitted at least one patent application, while 19 units have not applied for ICT-related patents in the preceding three years. These results indicate that there is hardly any commericlaistaion activities taking place at Johannesburg universities.

When it comes to reasons for non-commercialisation, 61% of the respondents indicated that the two main reasons for non-commercialisation of research projects are: 1) a pure academic focus on the part of academic staff; and 2) the inappropriateness of research for commercialisation. The following four themes on reasons why university staff and students do not commercialise research projects emerged from the interviews, corroborated the results of the questionnaire survey:

- The research conducted is inappropriate for commercialisation.
- Academic staff and students are often focused on the achievement of academic goals, not commercialisation.

- Academic staff and students lack the personal drive required to commercialise research projects.

- University rules and regulations associated with the commercialisation of research projects are perceived to be burdensome.

These findings are consistent with the observation of Mohan et al., (2012) that incubation and commercialisation are not prevalent at universities in emerging economies due to lack of funding and inappropriateness of research for commercialisation.

Results presented in Table 14 show that Johannesburg universities and ICT companies in Johannesburg interact in the provision of consulting services, the introduction of industry relevant programmes and the supply of skilled graduates. This evidence of other industry linkages may support Sohn and Kenney's (2007) finding that universities may still meaningfully contribute in cluster development through other avenues that exclude research partnerships and the commercialisation of research.

In relation to the proposition that Johannesburg universities support technology entrepreneurship by incubating and commercialising university spin-off ICT ventures, the results and discussion above shows that there are isolated, minimal activities related to the incubation and commercialisation of spin-off ICT ventures, in the units represented by the respondent heads.

5.4 Discussion Pertaining to Proposition 3

The third proposition for this study is that Johannesburg universities collaborate in supporting Johannesburg-based ICT ventures through research and development; and the commercialisation thereof.

The results presented in Table 10 show that 18 units have not partcipated in research partnerships in a formalised manner with the other university. Two respondents noted that fewer than 1% of their research partnerships include the other Johannesburg university. In one unit, between 6% and 10% of research partnerships include the other Johannesburg university.

Table 11 shows that 52% of the respondent university heads strongly agree with the statement that that there is a high degree of collaboration between their unit's staff and students and those of the other Johannesburg university in the conversion of research projects into commercially viable ventures.

The three themes that emerged from the interviews pertaining to the third proposition are that:

- Collaboration happens at an individual level and is dependent on personal relationships.
- There is a lack of guidance on collaboration at an institutional level.
- Pride is one of reasons academic staff and students do not collaborate with the other Johannesburg university.

While a majority of the questionnaire respondents agreed with the statement that that there is a high degree of collaboration between their unit's staff and students and those of the other Johannesburg university in the conversion of research projects into commercially viable ventures, the results on collaboration show that the degree of collaboration is not as high as it is preceived to be. The themes emerging from the interviews, suggest that this finding is attributed to lack of guidance on collaboration at an institutional level and pride on the part of academic staff and university students. This may indicate a weakness in cluster development support by the units represented as greater university collaboration is expected to strengthen the research output and human capital development within a region or cluster, which in turn positively impacts cluster development (Kotecha et al., 2011).

The third proposition of this study was that Johannesburg universities collaborate in supporting Johannesburg-based ICT ventures through research and development; and the commercialisation thereof. The results discussed above show that there is some research-related collaboration and no commercialisation-related collaboration with the other Johannesburg university amongst the units represented by the respondents.

5.5 Conclusion

The discussion in this chapter leads to the main conclusion that the results gathered from the study cannot be used to make generalisations about the role of Johannesburg universities in the emergence of a technology cluster in Johannesburg. This is because a representative sample was not attained in all sample groups. However, the following conclusions on the activities of the represented Johannesburg university schools, departments or centres in relation to the propositions of this study can be reached:

- There is disparate activity in supporting Johannesburg-based ICT ventures through collaborative and contract research with Johannesburg ICT companies, amongst the schools, departments or centres that participated in the survey.

- There are isolated activities related to the incubation and commercialisation of spin off ICT ventures, in the units represented by the respondents.

- There is some research-related collaboration and no commercialisation-related collaboration with the other Johannesburg university amongst the units represented by the respondents.

CHAPTER 6: CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

6.1 Introduction

The conclusions of this study are stated in this chapter. Implications of the study are noted and recommendations are suggested for specific stakeholders. Also put forward in this chapter are suggestions for further research.

6.2 Conclusions of the Study

It is concluded that the results of this study cannot be used to make generalisations about the role of Johannesburg universities in the emergence of a technology cluster in Johannesburg. However, the following were the findings of the study:

- There is disparate activity in supporting Johannesburg-based ICT ventures through collaborative and contract research with Johannesburg ICT companies, amongst the schools, departments or centres that participated in the survey.

- There are isolated activities related to the incubation and commercialisation of spin off ICT ventures, in the units represented by the respondents.

- There is some research-related collaboration and no commercialisation-related collaboration with the other Johannesburg university amongst the units represented by the respondents.

Although the results of this study cannot be used to make generalisations, this study contributes to the body of knowledge on the evaluation of university-industry linkages; and the relevance of academic entrepreneurship to cluster development, in respect of Johannesburg universities.

6.3 Implications and Recommendations

It was envisaged that this study would provide insight into the entrepreneurial activities of universities in Johannesburg in an effort to support the emergence of an ICT cluster in Johannesburg. Findings of this study may not enable such insights to be drawn at the institutional level but could provide such insights to the university schools, departments or centres whose representatives participated in the study.

It is recommended that Johannesburg universities conduct further investigations on the entrepreneurial activities they can prioritise, improve on or maintain in order to support the emergence of an ICT cluster effectively. Policy makers could also investigate how the policy framework could support universities in Johannesburg in order to harness Johannesburg's location advantages towards the emergence of a technology cluster.

This study may also inform the various directions that could potentially be investigated in subsequent studies as discussed in the next section.

6.4 Suggestions for Further Research

Even though Gauteng's ICT sector has been growing rapidly, the researcher is not aware of studies that have been conducted on the evolution of the Johannesburg ICT cluster. Studies that investigate the cluster's stage of maturity might guide signifcant role players in cluster development, including universities, to understand what they should be doing to support the cluster at its identified stage of maturity. If the performance of all the clusterpreneurs in the Johannesburg technology cluster can be evaluated, the evolution of this cluster can be benchmarked, predicted and re-directed. Studies could be commisioned to predict the growth rate of this cluster based on the performance of the clusterpreneurs, and the subsequent demands this growth rate will have on each of the clusterpreneurs or vice versa.

One of the delimitations of this study is that it focused only on Johannesburg universities, and more insight might be gained by extending the study to other

universities across the Gauteng province. This will ensure that universities with unique characteristics such as the Tshwane University of Technology, a technology university and UNISA, a long-distance learning university will be included in the study. Studies could further investigate how the different universities, with their unique attributes and strengths, do or could individually and collectively contribute towards the development of the ICT cluster in the broader Gauteng region.

Results from this study, particularly the qualitative component picked up on sentiments towards academic entrepreneurship. A study on the attitudes and perceptions of academic staff and university students from Wits and UJ towards academic entrepreneurship could potentially provide these institutions with a better understanding of how academic entrepreneurship is perceived by staff and students.

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APPENDIX A

Research Instrument – Heads of schools/departments/centres at Wits and UJ

1. The institution you represent is:

- The University of Witwatersrand (Wits)
- The University of Johannesburg (UJ)

2. You represent a school/department/ centre that falls under the Faculty of:

- Wits: Commerce, Law and Management
- Wits: Engineering and the Built Environment
- Wits: Health Sciences
- Wits: Humanities
- Wits: Science
- Wits: Not under a faculty
- UJ: Art, Design and Architecture
- UJ: Economic and Financial Sciences
- UJ: Education
- UJ: Engineering and the Built Environment
- UJ: Health Sciences
- UJ: Humanities
- UJ: Law
- UJ: Management
- UJ: Science
- UJ: Not under a faculty

3. In your school/department/centre, what is the approximate ratio of full time PhD qualified staff members to students?

- None of our full time staff members have PhDs
- 1 full time PhD qualified staff member to 10 students
- 1 full time PhD qualified staff member to 50 students
- 1 full time PhD qualified staff member to 100 students
- 1 full time PhD qualified staff member to 200 students

- 1 full time PhD qualified staff member to more than 200 students

4. In your opinion, the university policy governing the conversion of university research projects into commercially viable ventures encourages academic staff to convert research projects into commercially viable businesses.

- Strongly agree
- Agree
- Neutral
- Strongly disagree
- Disagree

5. In your opinion, the university policy governing academic staff consulting to private companies encourages academic staff to consult to private companies.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

6. In your opinion, the university policy governing research partnerships between academic staff or departments and private companies, encourages academic staff to enter into research partnerships with private companies.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

7. Approximately, how many standing research partnership agreements with Johannesburg based ICT companies does your school/department/centre have?

For the purposes of this research, an organisation is considered an Information and Communication Technology (ICT) company if the core/main activities of the company involve the production, maintenance or retail of one or more of the

following broad categories as listed by the Organisation for Economic Co-operation and Development (2009):

- *Computers and peripheral equipment*
- *Communication equipment*
- *Consumer electronic equipment*
- *Miscellaneous ICT components and goods*
- *Manufacturing services for ICT equipment*
- *Business and productivity software and licensing services*
- *Information technology consultancy and services*
- *Telecommunications services*
- *Leasing or rental services for ICT equipment*

- None
- 1 to 4
- 5 to 10
- 11 to 15
- More than 15

8. What percentage of your school/department/centre's standing research partnerships with Johannesburg based ICT companies include the other Johannesburg university?

- None
- Greater than zero but less than 1%
- Between 1% and 5%
- Between 6% and 10%
- More than 10%

9. On average, how many journal publications does your school/department/centre (staff and students) produce per year?

- None
- 1 to 20
- 21 to 40
- 41 to 60
- More than 60

10. On average, how many research publications are co-authored by your school/department/centre's academic staff and/or students together with

other academic staff and/or students from the other Johannesburg university, per year?

- None
- 1 to 10
- 21 to 30
- 11 to 20
- More than 30

11. Approximately how many courses or programs has your school/department/centre introduced in the last three years in response to the emerging skills needs of the South African ICT industry?

- None
- 1 to 5
- 6 to 10
- 11 to 15
- More than 15

12. Which of the following research activities has your school/department/centre's staff and students conducted for or with Johannesburg based ICT companies in the past three years? You may select more than one option.

- None
- Prototyping, testing and reporting
- Temporary personnel exchanges of academic staff or students with Johannesburg based ICT companies
- Writing up case studies based on Johannesburg based ICT companies
- Training of firm staff by faculty staff or vice versa

13. Approximately, what percentage of your school/department/centre's full time academic staff provides advisory/consulting services to Johannesburg based ICT companies?

- None
- Between 1% and 10%
- Between 10 and 49%
- Between 50% and 69%
- 70% and above

14. In the last three years, approximately how many Johannesburg based ICT start-up ventures has your school/department/centre incubated? *For the purposes of this research, incubation is defined as business support that accelerates the successful development of start-up companies by providing entrepreneurs with target resources and services, that may include expertise, networks and tools (Prodan, 2007).*

- We do not track/record this
- None
- 1 to 5
- 6 to 10
- 11 to 20
- More than 20

15. In the last three years, approximately how many of your school/department/centre's research projects have been converted into commercially viable Johannesburg based ICT ventures?

- We do not track/record this
- None
- 1 to 5
- 6 to 10
- 11 to 20
- More than 20

16. There is a high degree of collaboration between your school/department/centre's staff and students and those of the other Johannesburg university in the conversion of research projects into commercially viable ventures.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

17. Approximately what percentage of your school/department/centre's alumni initiates an ICT start-up company within three years of graduating?

- We do not track/record this
- None

- Between 1% and 10%
- Between 11% and 20%
- Between 21% and 30%
- Between 31% and 40%
- More than 40%

18. On average, approximately what percentage of your school/department/centre's graduates are employed by Johannesburg based ICT companies within a year of graduating?

- We do not track/record this
- None
- Between 1% and 10%
- Between 11% and 20%
- Between 21% and 30%
- Between 31% and 40%
- More than 40%

19. In the last three years, approximately how many ICT related patent applications originating from your school/department/centre were submitted for registration?

- None
- 1 to 10
- 11 to 20
- 21 to 30
- More than 30

20. In the last three years, approximately how many ICT related patents were co-registered by your school/department/centre's academic staff and students and the other Johannesburg university?

- None
- 1 to 10
- 11 to 20
- 21 to 30
- More than 30

21. In your opinion, the MAIN reason why staff and students from your school/department/centre do not commercialize research projects is:

- Lack of seed funding

- In-appropriateness of research for commercialization
- Absence of institutional (university) regulations to set-up firms
- A pure academic focus on the part of academic staff
- Institutional (university) bureaucracy which makes the commercialization process onerous
- Other

APPENDIX B

Research Instrument – ICT Companies

1. Your company is:

- Formally registered to trade in South Africa
- An informal operation

2. Does your company have operations in Johannesburg?

- Yes
- No

3. Does your company operate under the Information and Communication Technology (ICT) sector?

- Yes
- No

4. You would classify the main activities of your company as:

- Information technology software development and/or retail
- IT consulting services (including custom development, implementation and ICT education)
- Telecommunications
- Computer hardware/ Electronic equipment manufacturing and/or retail
- Internet services (including internet access, personal computer/internet security and web development)

5. Was your company initiated through the conversion of a Johannesburg university's academic research project into a commercially viable venture?

The two Johannesburg based universities are The University of Witwatersrand (Wits University) and The University of Johannesburg (UJ).

- Yes
- No

6. Your company has been trading in the South African ICT industry for how many years?

- Less than a year
- More than a year but less than 3 years
- Between 3 and 5 years
- Between 6 and 10years
- More than 10 years

7. How many full time staff members does your company employ?

- Less than 10
- 11 to 50
- 51 to 300
- 301 to 500
- 501 to1000
- More than 1000

8. Does your company have a dedicated Research and Development (R&D) department/team?

- No, we do not conduct R&D
- No, R&D is driven through projects that employees participate in over and above their work
- No, we use academic interaction to complement our limited in-house R&D capabilities
- Yes, our R&D constitutes a significant part of the company budget
- Yes, our R&D spend is a relatively small component of the company budget

9. In the last three years which institution/s has your company partnered or collaborated with in conducting research and development (R&D)? You may select more than one option.

- The University of Witwatersrand (Wits)
- The University of Johannesburg (UJ)
- Another tertiary institution in Johannesburg (e.g. a Technikon, College etc.)
- Another university (other than UJ and Wits) in South Africa
- An international institution
- None of the above

10. In the last three years, your staff have co-authored publications on research related to the ICT industry or an aspect thereof, with academics from which institution/s? You may select more than one option.

- The University of Witwatersrand (Wits)
- The University of Johannesburg (UJ)
- Another tertiary institution in Johannesburg (e.g. a Technikon, College etc.)
- Another university (other than UJ and Wits) in South Africa
- An international institution
- None of the above

11. In the last three years, did your company supply The University of Witwatersrand (Wits) with services or products?

- No
- Yes, mostly as a contracted supplier
- Yes, mostly on an adhoc basis

12. In the last three years, did your company supply University of Johannesburg (UJ) with services or products?

- No
- Yes, mostly as a contracted supplier
- Yes, mostly on an adhoc basis

13. In the last three years, the majority number of graduates your company employed were from which institution?

- The University of Witwatersrand (Wits)
- The University of Johannesburg (UJ)
- Another tertiary institution in Johannesburg (e.g. a Technikon, College etc.)
- Another university (other than UJ and Wits) in South Africa
- An international institution
- None of the above

14. In the last three years, the biggest share of funding from your company to activities at The University of Witwatersrand (Wits) went towards:

- We do not fund activities at this institution

- Bursaries
- Research grants and/or sponsored publications
- Other
- Sports
- Conferences

15. In the last three years, the biggest share of funding from your company to activities at University of Johannesburg (UJ) went towards:

- We do not fund activities at this institution
- Bursaries
- Research grants and/or sponsored publications
- Other
- Sports
- Conferences

APPENDIX C

Interview Guide

Questions for senior and junior lecturers

Ice-breaker: In your opinion are JHB universities effectively supporting the emergence of a JHB technology cluster? Why do you say so?

1. In your opinion, does your institution encourage research partnerships between academic staff or departments and private companies e.g. ICT companies? In what way/s?

2. In your opinion, what are some of the reasons why staff and students from your institution do not commercialise research projects?

3. In your opinion, what are some of the reasons why staff/ students from your institution do not collaborate with staff/students from the other institution in research and development and in commercializing research projects?

Questions for ICT company owners or managers

Ice-breaker: In your opinion are JHB universities effectively supporting the emergence of a JHB technology cluster? Why do you say so?

4. In your opinion, what can Johannesburg universities do to encourage research partnerships between universities and ICT companies in Johannesburg?

5. In your opinion, what are some of the reasons why Johannesburg universities do not commercialise research projects?

APPENDIX D

Consistency matrix

Research problem: Describe the activities that Johannesburg universities engage in to initiate or support both start-up and established ICT ventures in Johannesburg in order to support the emergence of a technology cluster in Johannesburg					
Sub-problem	**Literature Review**	**Hypotheses or Propositions or Research questions**	**Source of data**	**Type of data**	**Analysis**
Describe the activities through which Johannesburg universities partner with/ support start-up and established ICT ventures in Johannesburg in research and development.	Basant and Chandra (2007) Prodan (2007) Perkmann and Walsh (2007) Bresnahan and Garmbadella, (2004) Johnston (2004)	It is proposed that universities in Johannesburg support Johannesburg-based ICT ventures by participating in collaborative and contract research with Johannesburg ICT companies.	**University Heads' questionnaire:** Questions number 5, 6, 7, 12 and 19 **ICT representatives' questionnaire:** Question number 8, 9, and 10 **Interview**: Questions number 1 and 4	Ordinal, Interval and Nominal	Descriptive statistics and qualitative data analysis

Research problem: Describe the activities that Johannesburg universities engage in to initiate or support both start-up and established ICT ventures in Johannesburg in order to support the emergence of a technology cluster in Johannesburg					
Sub-problem	**Literature Review**	**Hypotheses or Propositions or Research questions**	**Source of data**	**Type of data**	**Analysis**
Describe the role Johannesburg universities play in the commercialisation of ICT spin-offs from these universities.	Basant and Chandra (2007) Prodan (2007)	It is proposed that Johannesburg universities support technology entrepreneurship by incubating and commercialising university spin off ICT ventures.	**University Heads' questionnaire:** Questions number 4, 13, 14, 15, 17 and 21 **ICT representatives' questionnaire:** Question number 5 **Interview**: Questions number 2 and 5	Ordinal, Interval and Nominal	Descriptive statistics and qualitative data analysis

Research problem: Describe the activities that Johannesburg universities engage in to initiate or support both start-up and established ICT ventures in Johannesburg in order to support the emergence of a technology cluster in Johannesburg					
Sub-problem	**Literature Review**	**Hypotheses or Propositions or Research questions**	**Source of data**	**Type of data**	**Analysis**
Describe the nature of collaboration between Johannesburg universities in supporting ICT ventures in Johannesburg.	Prodan (2007) Kotecha et al (2011)	It is proposed that universities in Johannesburg collaborate in supporting Johannesburg-based ICT ventures through research and development; and the commercialisation thereof.	**University Heads' questionnaire:** Questions number 8, 16, and 20	Ordinal, Interval and Nominal	Descriptive statistics and qualitative data analysis