Antecedents of Social Networks and their Influence on the Propensity of Academic Entrepreneurs to Develop Successful Spin-Off Ventures

A focus on academic entrepreneurship in the South African universities context

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ABSTRACT

There is an ongoing discussion about potentially commercialisable academic research not resulting in effective commercialisation in South Africa. This research adds to the body of knowledge by considering the role that an individual academic entrepreneur's social network plays in the spin-off process. The purpose of research is to improve our understanding of the social networks used by academic researchers that enable them to identify and commercialise their innovative research and commercialise it within the university context through the formation of an entrepreneurial spin-off.

The study followed a quantitative methodological approach to establish the role of these networks in spin-off development and was actualised using a cross-sectional survey. Respondents were self-identified academic entrepreneurs, drawn from South African academic institutions. The research considered assumptions that research mobilisation, collaboration, unconventionality, university support, bureaucracy and the aspirations of the academic entrepreneur impact spin-off success.

The study results provided a conceptual framework that integrates and enhances spin-off success using the academic entrepreneur's social network while enhancing entrepreneurial spin-off theory. The research showed that the existence of a triple helix is insufficient on its own to create a successful spin-off by providing insight on the networks needed for success. Further, the study clarified the importance of individual-level characteristics that are important for academic entrepreneurship to succeed. The outcomes highlighted that research mobilisation, collaboration, risk taking activities, bureaucracy and academic aspirations have significant implications for successful academic entrepreneurship. These findings are noteworthy as the research has been conducted across disciplines and universities with vastly different resource availabilities.

KEY WORDS

Triple Helix; Innovation; Academic Entrepreneurship; South Africa; Social Networks;

DECLARATION

I, Derek Crompton Seely, 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 PhD at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Signature: DerekSeely

Signed at …Ottawa, Canada……

On the …12th… day of June…… 2023.

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CHAPTER 1: INTRODUCTION

1.1 Purpose of the study

This study aims to deepen our understanding of the role of social networks in the creation of university spin-offs by focusing on academic entrepreneurship in the South African context.

1.2 Context of the study

For more than a decade, the developing world has considered ways to improve its rate of development and economic growth. Globally, high degrees of innovation and entrepreneurship within domestic economies have been noted as an effective method of enhancing economic development (O'Shea, Chugh, & Allen, 2008). For this reason, attention has turned to universities where product development and new industry creation have been introduced through new knowledge production. Following the introduction of legislation to support the commercialisation of academic research in Europe and the United States of America, there was an increase in the number of academic led spin-offs from universities in these regions (Clarysse, Tartari, & Salter, 2011; Klooster, 2022).

In South Africa, universities face increasing demands from the youth for knowledge and skills that will enable them to participate in the economy (Alessandrini, Klose, & Pepper, 2013). Universities are expected to find ways of meeting these demands. It is expected that rents received by the university from academic innovation commercialisation could be used to overcome existing financial burdens as well as offering a financial return to government for their financial support as well as engineering future economic growth (Lester, 2005; Peng, Campbell, & Lee, 2014). In addition, there is research to suggest that new economic growth is moving from low-cost labour-intensive economies to

developed knowledge-based economies, making the promotion and exploitation of academic innovation important in maintaining emerging market competitiveness (Farrell, Mapanga, Chitha, Ashton & Joffe (2022).

The concept of academic entrepreneurship is defined in different ways by various authors (Davey, Rossano, & Sijde, 2015; Jacob, Lundqvist, & Hellsmark, 2003; Steffensen, Rogers, & Speakman, 1999). It has been suggested by some authors that it is the product of the commercialisation of intellectual property that has originated from university sources (Etzkowitz, Asplund, & Nordman, 2001). While other authors suggest that academic entrepreneurship should be explained as the entrepreneurial activities undertaken by academics as an addition to their normal university duties (Shore & Mclauchlan, 2012). The thesis will use the understanding that academic entrepreneurship is "the commercialisation of university-generated knowledge through new ventures" (Davey et al., 2015,. pg. 3). This definition will allow for the heterogeneity of academic entrepreneurship to emerge while allowing for the context-specific social network drivers and inhibitors to be identified.

However, academic entrepreneurs who develop academic innovation into businesses must navigate and transcend multiple social networks during start-up, making the process particularly complex and difficult. Despite the increasing importance of the commercialisation of academic innovation in emerging markets, academic research on the influence of social networks and their propensity to encourage spin-off firm development is limited, fragmented and it lacks rigorous development (Rasmussen & Wright, 2015; Sousa-Ginel, Franco-Leal, & Camelo-Ordaz, 2017; Terjesen & Elam, 2009). The rise in the importance of the social network over the past decade has increased the need for detailed analysis in various fields. In the developing economies, the lack of effective formal institutions results in a reliance on social networks to create and enforce relationships and sustain cooperation between members of a community (Chandrasekhar & Kinnan, 2014).

To date, most of the research on academic spin-offs has focused on two processes, both of which have been established in the developed economies. The first process is a national innovation system approach, which originated in Europe. This systems approach argues that the success of these firms is a result of the macro-level interaction of three principal agents in the economy (Brannback, Carsrud, Krueger Jr., & Elfving, 2008; Cai, 2013). This approach was developed in the literature as the 'triple helix theory'. It was suggested that for a knowledge economy to succeed in the process of academic spin-off creation, the engagement of government, universities and industry must be effective (Leydesdorff & Etzkowitz, 1996). This theory assumes that entrepreneurs who commercialise academic innovation will be supported by government and will drive future economic growth. The second process was developed through the introduction of legislation in the United States that supported a transformation of the university to promote the commercialisation of knowledge within the university. This was achieved by granting ownership of intellectual property arising from academic research output (D'Este & Perkmann, 2011).

Since universities produce educated people and new ideas, they are the main source of the assets needed to develop and grow a sustainable knowledge-based economy (Algieri, Aquino, & Succurro, 2013). To ensure a robust process of spin-off firm creation from academic knowledge, the South African legislature has implemented a series of measures based on those found in the developed markets to strengthen the linkages between universities, industries and government. In a report by Alessandrini et al. (2013), it is suggested that innovation developed by South African public universities is not being effectively commercialised. This finding implies a failure of the developed market models in South Africa. As a result, it would be expected that South Africa would have limited commercialisation of academic research. At the same time, according to the Global Competitiveness Index 2022, South Africa ranks relatively well at 27th out of 138 countries for collaboration in research and development (R&D) between university and industry.

In research conducted by Kruss and Visser, (2017), it is suggested that financial drivers, degree of knowledge creation and the roles that drive academics to engage with industry, as well as the types of benefits that they require from their intellectual property, are likely to differ significantly between universities in South Africa. This will result in significant differences in the observed quantity and quality of spin-off development. Thus, while the developed market research in this field is clear on the importance of the engagement of the role players, the heterogeneous and complex social networks found in the developing market may explain why some South African universities may be able to foster academic spin-off development, whereas others cannot.

1.3 Research Problem

New ventures do not develop in a vacuum, but are shaped by the social and institutional environment in which they exist (Urban & Gamata, 2020; Rasmussen, Mosey, & Wright, 2014). Yet, proponents of the triple helix and entrepreneurial university theories within developing knowledge economies have attempted to develop identical rigid structures and mimic organisations that facilitate the establishment of an innovation system within the developed economies. South Africa has followed suit and by legislating the relationship between the state and the university, government has attempted to ensure spin-off creation (Comacchio, Bonesso, & Pizzi, 2012; Ranga & Etzkowitz, 2013; Todeva, 2013) in a similar way to that of the Bayh-Dole Act (1980) in the United States. Further, through the National Intellectual Property Management Office (NIPMO), the requirement for the existence of a boundary spanning entity within the university was created. The intention was that academic innovation will be transferred to industry in a similar way to that envisaged by the triple helix model. However, research suggests that the business environment is made up of interconnected parts or a network, where new knowledge and support are found (Vahlne & Johanson, 2009).

Recently, proponents of strategy research have argued that new business development is heterogeneous (Gartner, Stam, Thompson, & Verduyn, 2016) and is guided by complex networks of relationships (Vahlne & Johanson, 2009). While the norms and procedures used for business development (Lester, 2005; Meyer, 2003) are well defined in the literature, there is an emerging body of research that suggests that new firms succeed or fail through influences created within and outside these networks (Kruss & Visser, 2017; Whittington, 2006).

In an attempt to understand and improve the process of the establishment of academic spin-offs, researchers have undertaken a number of investigations, which include the effectiveness of technology transfer from university to industry (Shane, 2004; Shinn, 2002; Zhang, 2009), economic value creation through academic innovation (Algieri et al., 2013; Grimpe & Hussinger, 2008; Rorwana & Tengeh, 2015) and entrepreneurial intentions of researchers (Chantson & Urban, 2018). Researchers also highlight the importance of collaborative and dynamic interactions between universities, government and industry (Ankrah, Burgess, Grimshaw, & Shaw, 2013; Carlsson & Fridh, 2002; Markman, Gianiodis, Phan, & Balkin, 2005; Siegel, Veugelers, & Wright, 2007). The majority of these investigations have been conducted in the developed economies and all rely on the rigid models described by the triple helix and entrepreneurial university. However, it is important that practitioners do not simply use these extant models in a 'one-size-fits-all' approach without paying attention to the institutional structures and existing capabilities that emerge from the specific characteristics in the local context in which they are grounded (Bramwell, Wolfe, & Hepburn, 2012).

With this understanding in mind, it is clear that there is a need for more studies that consider academic entrepreneurship in the creation of spin-offs in their unique social context (Kruss & Visser, 2017) as the existing theories have not been able to accurately explain why there are dichotomous outcomes in the creation of spin-off firms from different South African public universities. While (Kruss & Visser, 2017) have been explicit

in their call, there are also implicit calls from studies as well. Recent research has called for a more in-depth reviews of additional organisational-level factors that impact academic entrepreneurship (Urban & Gamata 2020; Chantson & Urban, 2018). It is also suggested that research is currently focused on singular universities or faculties and should rather considers multiple universities, faculties and departments when investigating factors that support the commercialisation of research. It is argued that this will offer a more thorough understanding of the process and drivers of academic innovation (Ismail et al., 2015). It was also noted in a paper by Kahsay, (2017) that while the importance of innovative research is widely understood, it is subject to a number of factors that are both internal and external to the university. Studies that are able to contextually highlight these factors will enhance innovation in future research in those regions.

Developing countries, such as South Africa, have a young innovation system, high levels of income and social inequality, absent linkages between key institutions and sporadic and uneven technological development (Bernardes & Albuquerque, 2003). In this context, South African public universities face the additional challenge of contributing to global science and knowledge while addressing domestic social and economic problems (Suzigan & Albuquerque, 2011). The social context that universities in South Africa find themselves in has been influenced by the legacy of colonisation, apartheid and a high Gini coefficient combined with high levels of poverty and inequality (Kruss & Visser, 2017).

This research finds that academic entrepreneurship leading to spin-off creation at public universities in South Africa has been shaped and continues to be shaped by the individual social context evident in the development of and engagement with their social networks. Thus, as networks operate as a linking and facilitating alliance that allows for resources to be acquired and utilised, this research improves academic entrepreneurial effectiveness by adding to our understanding of the social network factors that impact the effectiveness of spin-off creation through the consideration of the effectiveness of spin-

off creation at universities that operate in different historical social contexts and have access to different social networks thereby isolating the factors that drive academic spin-off creation in South Africa.

There is an immediate need for developing countries, such as South Africa, to improve their understanding of the current process of how academic innovation is converted into a spin-off company through the networks that facilitate access to, and utilization of, academic innovation (Alessandrini et al., 2013; Brannback et al., 2008; Carlsson, 2006; Kruss & Visser, 2017). This research contributes to knowledge through its investigation of the role of the social networks in the creation of academic led spin-offs at South African public universities. Its explicit contribution is through the identification and analysis of the specific social networking practices that engage to ensure the development of the academic spin-off firm in South Africa.

1.4 Contribution to Knowledge

This study contributes to the entrepreneurial social network and academic entrepreneurial literature.

Many studies have been conducted to explain how academic entrepreneurs develop spin-off ventures and most of these studies have created models to predict and facilitate the process of spin-off creation (Chia & Holt, 2008; Etzkowitz, 2003a; O'Shea et al., 2008; Rorwana & Tengeh, 2015). Further studies have been carried out to investigate the benefits of these ventures to the entrepreneur, university, and broader society. Most studies have been done in the developed markets of Europe and the United States (Carlsson & Fridh, 2002; Clarysse et al., 2011; Rothaermel, Agung, & Jiang, 2007). However, recently, studies have started to emerge that focus on the developing markets (Alessandrini et al., 2013; Kruss & Visser, 2017). These studies offer evidence of observations and outcomes that defy the existing knowledge base. As the existing

research relies on triple helix theory and the entrepreneurial university Theory to explain the phenomenon, the theories are not yet linking the involvement of the social network into the inter- and extra-organisational dynamics of academic firm development.

This study is carried out in South Africa, which is a developing market and focuses on the role of social networks and their influence on the propensity of academic entrepreneurs to develop spin-off ventures. This study contributes to the existing body of knowledge by first, moving away from the hegemony of the extant theories, which is supported by research that suggests that the application of general laws for entrepreneurship is not possible as the theoretical merits of the argument and the empirical findings are often context specific (Zahra & Wright, 2011).

Secondly, some academic entrepreneurs have shown success in spinning off academic innovation into standalone business while others have shown minimal achievement. There is little investigation on why there is a dichotomous outcome in the creation of spin-off companies in South Africa at different South African universities (Kruss & Visser, 2017)

Thirdly, the existing research highlights the importance of the engagement of the macro role players identified in these theories, while simultaneously indicating that their interactions should result in a homogenous outcome. This research contributes through findings that suggest that even though the importance of macro role players cannot be ignored, entrepreneurship is not simply an economic process but is guided by the social context, which in turn shapes the social networks that engage with the academic entrepreneur to support or obstruct entrepreneurial outcomes (Jack & Anderson, 2002).

If South African academic entrepreneurs use inter- and extra-organisation relationships and interpersonal relationships to solve problems and get buy-in to develop their innovation, then the existing theory is not yet incorporating the importance of the social network. Thus, performance, conduct and behaviour can be more fully understood by examining the networks of relationships in which firms are developed (Martins, 2016).

Fourthly, as South African universities are facing increasing demands on limited financial resources, this research offers practical enhancements to the effective universal use of academic innovation to improve the future income of universities.

Fifthly, South Africa needs new and innovative ways of increasing the demand for labour, which new firms would provide. As, academic innovations could originate at any university and the process and effectiveness of utilising this innovation would lead to improvements in efficiencies and competitiveness for existing and emerging industries, this research offers practical benefits that, if implemented, would result in improved profitability and lower costs of capital.

By adopting a quantitative approach, this research contributes to the entrepreneurship theory base by understanding the unique interactions within the social networks as well as the frequency of these interactions with all role players by extending the theory through model testing. The need for this contribution is supported by the argument that entrepreneurship is not merely an individual undertaking, but the product of institutional and interpersonal interactions that should be understood, within the context of social networks (Cai, 2013; Sarason, Dean, & Dillard, 2006). Research suggests that social capital is a strong and consistent predictor in successful business creation (Davidsson & Honig, 2003) and it has been established that the successful development of an entrepreneurial firm is often supported by the various networks (both individual and organisational) that directly or indirectly participate, support, regulate and encourage innovation and firm development (Urban & Gamata 2020; Anderson et al., 2010; Carlsson & Stankiewicz, 1991).

These contributions add meaningfully to the theoretical and practical extant body of knowledge. The contributions are summarised as follows:

1. This is a developing market study that focuses on South Africa.
2. The study considers a unique type of business – an academic spin-off.

3. The study uses an integrated approach to understand the effect of the social network and foster greater understanding between the university and the academic entrepreneur.
4. This study is interdisciplinary in nature.

Therefore, this study integrates the social network into the existing theory on spin-off firm development in South Africa, thus making a theoretical contribution. It also makes a practical contribution by extending the model that universities, academics and other stakeholders can use to understand academic spin-off creation by incorporating the influence that social networks have on spin-off development.

1.5 Research Objectives of the study

This thesis suggests that much of the literature on academic spin-off development uses the triple helix theory and entrepreneurial university theory as its foundation for spin-off development. Neither of these theories has been able to link the influence of the academic's social network. The objective of this research is to build on recent developments in entrepreneurial and innovation literature to understand the involvement of the social network in academic firm development with a focus on academic entrepreneurship in South Africa.

1.5.1 *Specific Objectives*

The specific objectives on which the data in this thesis was collected is detailed in this section. These objectives are designed to address the research problem

a. *To understand the experience of South African Academic Entrepreneurs within their social networks*

b. *To explore the impact of the social network as a multi-dimensional construct that influences the academics propensity to develop an academic led spin-off.*

c. *To understand what social network constructs, are important in the early stages of research mobilisation against the latter stages of spin-off success.*

d. *identify, analyse and establish the relevance of which specific social networking factors are used by academic entrepreneurs when developing a spin-off firm.*

1.6 Research Questions

To what extent do South African academic entrepreneurs use inter- and extra-organisational relationships and interpersonal relationships to commercialise their innovation through the development of spin-off ventures within the South African university context.

The research was guided by the following specific research questions:

1.) To what extent do South African Academic Entrepreneurs use research mobilisation to commercialise their innovation through the development of spin-off ventures within the South African university context
2.) To what extent do South African Academic Entrepreneurs collaborate to commercialise their innovation through the development of spin-off ventures within the South African university context
3.) To what extent does the existence of risk and unfavourable outcomes influence South African Academic Entrepreneurs in the commercialisation of their innovation through the development of spin-off ventures within the South African university context
4.) To what extent does engagement with business and government support South African Academic Entrepreneurs in the commercialisation of their innovation through the development of spin-off ventures within the South African university context
5.) To what extent do South African Academic Entrepreneurs aspiration affect their development of spin-off ventures within the South African university context.

1.7 Significance of the Proposed Study

The National Research Foundation indicates that 1.5 percent of GDP is spent annually on research by government (NRF & Qhobela, 2017). Unless direct benefits can be observed from academic research, it is unlikely that funding will continue indefinitely. Spin-off creation from academic innovation is recognised as a significant contributor to the realisation of these benefits. It is clear from the literature that for a spin-off firm to develop, there is a necessity to create the knowledge and to adapt it to practice. While a

robust understanding of this process exists through the extant theories, the resultant outcome is not as clear. An understanding of the social networks involved in the creation of an academic spin-off in South Africa will provide additional understanding in the South African context in order to improve the level of sustainable firm creation.

In support of the above significance, it is also observed that commercial success for a spin-off does not begin with the academic innovation, it develops through the entrepreneurs analysis of the universities' policies as well as the history, culture, attitudes, industry affiliation and market orientation (Carlsson & Fridh, 2002). These subjective evaluations, imply that academic entrepreneurs may make investment decisions based partially on their ability to recognise the long-term value of their innovation (Zhang, 2009), an understanding of this implication will add to our theoretical understanding of the development of a successful spin-off.

For an effective contribution to emerge, research should integrate interdisciplinary knowledge in order to move the field's thinking forward through the establishment of new connections that have been observed from traditional concepts, which will allow for an understanding to develop around their practical implications (Corley & Gioia, 2011). The thesis adds to the extant theory by considering the impact that the diverse social networks, which have been established through the unique historical economic, political and social context of South Africa's development, have on the success of academic spin-offs. It is important to establish a theoretical understanding for local practise, as extant research focuses primarily on the United States and selected European countries (Algieri et al., 2013; Hulsbeck, Lehmann, & Starnecker, 2013; Kruss & Visser, 2017; Lee, 1996).

The context-specific nature of this type of research makes it difficult to form generalised conclusions for developing countries outside of South Africa. However, direct and indirect observations from this research will enable policy makers to improve legislation and

regulatory guidance aimed at supporting academic spin-off creation and improve the return on invested capital for the state.

Further, the research assists academic entrepreneurs in understanding how they should engage with their networks and organise their available resources to improve the probability of success of new ventures and assess better the factors needed to establish these new investments.

Finally, the research aims to support universities in finding the best avenue for the management of their intellectual property and thereby improving or creating new revenue streams.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This research presents a systematic review of the literature on academic entrepreneurship and social networks, specifically performing a systematic review of social networks theory.

Spin-offs are known to enhance economic growth, create wealth and improve scientific knowledge (O'Shea et al., 2008). Extant research is clear that a new spin-off firm is based upon an academic research breakthrough that has commercialisable applications (Shane, 2000). However, despite the clarity of these findings, companies that are created in an emerging economy face challenges that affect their chances of survival. Key to the success of the creation of a spin-off is the ability of the academic entrepreneur to convert their innovation into a spin-off company (Zahra 2007). The research on triple helix theory and the entrepreneurial university lays down a framework in which the necessary role players needed to create a successful spin-off can engage (Etzkowitz, 2003a; Etzkowitz, 2003b). In the developing market context, spin-off firms are developing in a way that is not consistent with the extant theory. The reasons that have been proposed are that the academic entrepreneur may not possess the skills needed to recognise the opportunities (Shane & Venkataraman, 2000) or the skill and knowledge to exploit it (Lockett & Wright, 2005). In addition, it has been suggested that traditional universities may lack the commercial orientation needed, thus limiting support for the development of these spin-offs (Lockett & Wright, 2005; Siegel, Waldman, Atwater, & Link, 2003a).

However, within entrepreneurship studies, the heterogeneity of the entrepreneurial experience (Klyver, Hindle, & Meyer, 2008; Westhead, Ucbasaran, Wright, & Binks, 2005) and the effect of that on the social context in which the new firms emerge, have been excluded from possible explanations to enhance the theory base on spin-off development.

Social Network Theory has developed in the field of business internationalisation (Vahlne & Johanson, 2009). It seeks to understand how firms are linked to each other by networks of complex and invisible relationships. Research on social networks has made a significant contribution to understanding the human influence in the success of entrepreneurial endeavours.

As the literature review assists in providing meaningful context to the research problem by positioning it within the current body of knowledge, this literature review will provide a systematic review of the conceptual understanding of the extant theories. It will examine the core activities of the triple helix and entrepreneurial university, define the core constructs central to this research and introduce the understanding that context is heterogeneous (Zahra & Wright, 2011). The review will then analyse the social networks that are present within academic entrepreneurship through relationships and market structures to create a comprehensive picture of the consequences of the social network on entrepreneurial firm success.

A systematic review allows this research to consider an examination of data from several independent studies on the topic to determine an overall understanding of the theory (Khan, Kunz, Kleijnen, & Antes, 2003). A systematic review will be effective when there are clearly defined criteria for inclusion in the study; a systematic search that attempts to identify all relevant studies; an assessment of the validity of the findings of the study to ensure the risk of bias is limited and it is accompanied by a systematic presentation of the findings and characteristics of the relevant studies (Khan et al., 2003). It is important to undertake a systematic review of the different theories, as understanding the building blocks of the social network that results in the formation of an academic spin-off company is complex and often dialectic (Rasmussen et al., 2014). Further, this approach will allow the research to separate social network factors that may be idiosyncratic to spin-off firm creation, while allowing for patterns that are specific to the impact of social networks on entrepreneurship, in general, to emerge.

Finally, the literature review concludes with the summary of the research problems and the conceptual framework that describes the foundation of the research.

2.2 Conceptual Understanding

Theoretical understanding of the development of successful academic spin-offs has been built on two key cornerstones. It is important to clarify the practice as understood in the extant theory (Etzkowitz & Leydesdorff, 2000; Chaminade & Edquist 2010) in order to further develop the theory base. To achieve this, I provide a systematic review of the conceptual understanding of the extant theories of the triple helix and entrepreneurial university that explain the phenomenon. The purpose of the theories on academic spin-off creation is to describe, understand and explain how the process evolves from the creation of the innovation at a university to its successful commercialisation. Through these descriptions, it is argued that the degree of future successes can be improved and failures limited (Etzkowitz & Leydesdorff, 2000; O`Shea, Allen, Morse, O'Gorman, & Roche, 2007; Ranga & Etzkowitz, 2013).

2.2.1 *Triple Helix Innovation Theory*

Early innovation system studies developed a body of literature that identified three independent role players that are key to understanding the complex interactions taking place in the economy (Williams & Woodson, 2012). These role players are government, industry and knowledge producing institutions (universities) (Cai, 2013). According to Leydesdorff & Etzkowitz (1996), when these role players engage effectively, the outcome will be to encourage entrepreneurship, increase levels of innovation and spur economic growth.

Termed triple helix theory, this knowledge emerged as a blueprint for innovation development in the Nordic countries (Brannback et al., 2008) and was then adopted as

an effective innovation system development model in developed western economies (Shinn, 2002). Success in these regions gave credibility to the model and today, the geographic influence of the triple helix is broad. Development of a triple helix Innovation System has been recommended in the innovation literature that considers Latin America (Zawislak & Dalmarco, 2011), Asia and African innovation studies (Shinn, 2002; Williams & Woodson, 2012) and is also supported in South African innovation studies (Alessandrini et al., 2013).

While the normative triple helix model has assisted many researchers in understanding how the interactions between the three role players have enhanced firm creation (Shinn, 2002), this theory may only explain how rational agents make economic development decisions that lead to the establishment of a knowledge economy (Brannback et al., 2008).

As the triple helix framework was developed in post-industrial knowledge economies, as noted by Williams and Woodson (2012, p.234), it is “inadequate” in its normative form for understanding dynamic innovation systems in emerging economies. The model pays little attention to the individuals, processes and strategies employed within the system or how these processes, strategies and individuals affect their environment; therefore, does not accurately reflect reality.

Further, Etzkowitz and Leydesdorff (2000) suggest that successful innovation spin-offs will evolve when they operate within an open dynamic system that evolves from the starting point of the innovation, through its distribution and ultimately, its production. However, the application of triple helix theory within the South African context has, to date, been developed at an extra-organisational level only (Alessandrini et al., 2013). Whittington (2006) suggests that this line of analysis is common among researchers, as they have a propensity to concentrate on activities at either the intra-organisational level or focus on the aggregate effects at the extra-organisational level.

2.2.2 *Entrepreneurial University*

The impact of globalisation and the resultant transformation of economies led to a broad call for governmental policies to focus on self-help outcomes and demanding that governments should only intervene if there was a market failure (Chaminade & Edquist, 2010). Reductions in government expenditure, private sector-directed initiatives and wherever possible, the commercialisation of public services, is supported (Gibb & Hannon, 2010). An academic whose goals are to deliver a high number of quality and quantity of research papers finds it more difficult to transmit knowledge outside of academia and are noted to be ineffective in naturally stimulating the development of new enterprises (Laukkanen, 2003).

To support a reduction in governmental involvement, additional participation by the university in the development of commercialisable innovation was encouraged. The US national government enacted the Bayh-Dole Act in 1980. The Bayh-Dole Act (1980) promotes the transfer of university-developed technology to industry by assisting universities in developing the innovation created by the researcher (Carlsson & Fridh, 2002). The goal of the legislation was to involve the university as a key provider of new technologies and business ventures. These functions are sometimes referred to as the universities 'third mission' (Shore & Mclauchlan, 2012), where universities, in addition to their traditional core roles, also encourage economic and social development. Once undertaken, this process will result in the creation of an 'entrepreneurial university', which would exhibit a market-orientated paradigm.

As universities witnessed increases in revenues from patenting and licencing of technological innovation that had been developed at these 'entrepreneurial universities', support for the 'entrepreneurial university' system grew (Wood, 2011). As university influence expanded in the commercialisation of their academic innovation, universities become core within the system that underpins innovation and economic development.

Over time, positive feedback loops between academic success and technological innovation developed (D'Este & Perkmann, 2011), which has led to many countries, including South Africa, to develop regulations to enforce the management and distribution of university developed intellectual property (IP).

2.3 Definition of Key Concepts

This section defines the core constructs of entrepreneurship, innovation and the relationship between these factors. It considers the role of academic research in the creation of a spin-off and outlines the concept of academic entrepreneurship. It also introduces the understanding that context is heterogeneous, the importance of the social context in which entrepreneurship develops and the personal attributes of the academic entrepreneur.

2.3.1 *Defining Entrepreneurship*

Entrepreneurship is a unique phenomenon. While there is little consensus among scholars on the definition of entrepreneurship (Shane, 2012; Zahra & Wright, 2011), this research considers Shane & Venkataraman's (2000) description that entrepreneurship is a nucleus of opportunity; a process of evaluation, an exploitation of an opportunity and an outcome of the individuals who discover, assess and create it, to offer the most robust explanation. As the key driver of entrepreneurial activity is the value created through the exploitation of the opportunity (Barreira, 2004), value may be derived through the opening of new markets, new production methods and through new sources of supply found in changes in the external environment. This understanding suggests that entrepreneurship may be linked to the entrepreneur (person) and the entrepreneurial behaviour (what the person does to exploit the opportunity) (Hayter, Fischer & Rasmussen (2021); Shane &

Venkataraman, 2000). This suggests that entrepreneurship is not merely organisational but is created through the use of the social networks.

As there is a problem with the explanatory power of many existing theories of entrepreneurship in emerging economies (Anderson & Ronteau, 2017), understanding the process undertaken by an entrepreneur in the development of academic innovation should be developed through an in-depth investigation into what actually takes place (Golsorkhi, Rouleau, Seidl, & Vaara, 2011) within the broader social context.

As the study of entrepreneurial practice has evolved, so has the understanding of how structures and individual actions are linked to the social context influencing the development of organisations (Bourdieu, 1990). Phenomenon-driven enquiries have allowed management research to focus on solving empirical problems through a practical lens (Schwarz & Stensaker, 2016).

Imbedded within the definition of entrepreneurship is a call to focus on heterogeneity of entrepreneurship and the social context in which it develops. Spin-off creation from academic innovation in the emerging South African economy should be explored through the direct and indirect engagement of the entrepreneurs within their social network (Golsorkhi et al., 2011; Morris, Kuratko, & Covin, 2010).

The term is used to define an academic who starts a firm to gain commercial benefit from their innovative research (Jain, George, & Maltarich, 2009). It is important to clarify that when investigating an academic entrepreneur, the contemporary concept of ‘entrepreneurship’ is transformed from the individual to a social focus and that it is believed that an entrepreneurial orientation can be taught to the academic (Jacob et al., 2003; M. Wright, Lockett, Clarysse, & Binks, 2006).

2.3.2 *Defining Innovation*

Innovation can be defined as a process of discovery or transformation of the existing body of knowledge and prior learnings on an organisational or individual level that generates a new idea, product or service and results in the constructive destruction of the underlying capabilities and products available within the environment (Fagerberg, 2009; S Shane & Venkataraman, 2000). Innovation is a novelty, originality or the outcome of a new entrepreneurial endeavour but it does not just emerge in isolation (Rosenberg, 1979). It is the exploitation of existing internal and external knowledge that evolves when problem-solving skills are used to create new knowledge once an opportunity, need or failure is identified (Cohen & Levinthal, 1990).

For innovation to take place, there needs to be 'know-how' (Teece, 1977) and an interdependence between the existing knowledge available in the environment and the expected benefits derived at the technological level and within the social framework (Rosenberg, 1979). The degree of the innovation can be quantitatively determined from the extent of available knowledge and the existing market structures (Cohen & Levinthal, 1990). Consequently, innovation is a dynamic process that transforms existing knowledge while generating new underlying capabilities, designed to alter what is available within the environment. Innovation is not necessarily something completely different and will depend on the level of knowledge diffusion within an industry. However, for innovation to emerge, it is necessary for knowledge to be recognised and for there to be an ongoing desire to create new knowledge (Miller, Fern, & Cardinal, 2007).

2.3.3 *Synergy between Entrepreneurship and Innovation*

Innovation and entrepreneurship are common in today's vocabulary. They are not homogeneous concepts, yet they both refer to the transformation of knowledge into an exploitable opportunity (Fagerberg, 2009; Shane & Venkataraman, 2000). Thus, there is

a significant overlap between innovation and entrepreneurship, as innovation is a tool of entrepreneurship that is used to address a market need. Innovation and entrepreneurship interact together to ensure the success of a new firm. Theoretical and descriptive arguments suggest that both concepts need to be present at the initial phase of a new venture to ensure this success (Zhao, 2005). The literature further suggests that entrepreneurship is the carrier of innovation to the market and it is the market that is needed to test the viability of the perceived novelty (Drucker & Noel, 1986). This view built on the argument that through the process of introducing innovation into an economy, entrepreneurship will create the necessary change and competition needed within the market to enact transformation and overcome shocks (Wong, Ho, & Autio, 2005). Finally, it is noted that both innovation and entrepreneurship have been presented in the literature as being capable of being taught, learnt and practiced (Drucker & Noel, 1986).

2.3.4 *Defining Academic Research*

The nature of research is understood in two different ways by the literature. In its broad-based form, it refers to the expected philanthropic ideals held by many university researchers, while in its literal form, it refers to the focus of academic research and its applicability to commercial development.

As the nature of academic work is the contribution to knowledge in the form of new concepts, models, empirical findings and techniques, academic researchers seek rapid dissemination of these ideas (Siegel et al., 2007). Academics strive to publish in the most selective scholarly journals, present at conferences and perform research to assist in the development of new teaching and case study materials. The desired end result is peer recognition and an increase in stature within the academic profession through citations and relationships with other academic researchers (Siegel et al., 2007). Academics have limited ambitions for financial reward. However, research grants that enable academics to pay for laboratory equipment and research assistants are suggested as the primary

financial motivators (Siegel et al., 2007). This contradicts the guiding theory of business, that suggests business seeks a 'first mover advantage' and implies that firms act quickly to obtain proprietary control (Barnes, Pashby, & Gibbons, 2002; Siegel et al., 2007) over new innovation. Although, firms wish to access new knowledge, new tools, new methods and new products to improve their position in the market, they seek to protect this innovation as a key source of competitive advantage, through proprietary control over innovation.

2.3.5 *Defining Academic Entrepreneurship*

While economists, management scholars and sociologists have suggested a number of different interpretations and conceptual frameworks that explain academic entrepreneurship, the use of academic research as the foundation of developing new technologies and business ventures has been the common interpretation (Laukkanen, 2003).

Historically, academic entrepreneurship has been found in diverse forms in the literature. These include the funding of research groups; consulting by an academic to industry; industrial support for university innovation; patenting; direct commercial involvement (Laukkanen, 2003). These research reports imply that traditionally, academic entrepreneurship will succeed when there is: university leadership that can link traditional academic values with entrepreneurial orientation; strong links between university and industry; diversification of funding away from government sources; availability of top academics and a propensity to embrace an entrepreneurial culture (O'Shea, Allen, O'Gorman & Roche, 2004).

However, as the practice at universities has evolved (Table 2.3.1), there is now an emerging shift in the focus of the academic entrepreneurship literature. Understanding these shifts allows for new direction in theorising and empirical analysis. Universities now

focus on collaborative networks, entrepreneurship garages and new forms of public-private incubators (Siegel & Wright, 2015). In developing an understanding about these new processes, it is necessary to develop an understanding of the networks that enable them. To understand them we need to understand the academic entrepreneur's access to the social network. Extant research suggests that the greater the access to knowledge in the network, the greater the probability of success (Leyden, Link, & Siegel, 2014). This implies that social networks are of primary importance in expanding our understanding of academic entrepreneurship and the development of the new spin-off firm. When researchers can understand the social network, they will be positioned better to offer clarity on how heterogeneous social ties are brought together to successfully develop academic inspired innovation. Thus, the ability to access a social network will be core to the understanding of academic entrepreneurship.

Table 2.3.1:Evolution of Conceptual frameworks used to understand academic entrepreneurship

Type of activities	Existing enablement options	Resultant observed core focus	Outcome
Development of new products / processes	• University leadership • Links between university and industry • Availability of top academics • Entrepreneurial culture at the university	Collaborative networks Incubating processes	Spin-off company
Funding research groups	• University leadership • Links between university and industry • Availability of top academics	Collaborative networks Incubating processes	Spin-off company
Consulting to industry	• University leadership • Links between university and industry • Availability of top academics	Collaborative networks Incubating processes	Spin-off company
Patenting	• University leadership • Links between university and industry • Availability of top academics • Entrepreneurial culture at the university	Collaborative networks Incubating processes	Spin-off company

Direct commercial involvement	• University leadership • Links between university and industry • Availability of top academics • Entrepreneurial culture at the university	Collaborative networks Incubating processes	Spin-off company

Source: Adapted from Laukkanen (2003) & Siegel & Wright (2015)

2.3.1 *Entrepreneurial Ecosystems within Academic Entrepreneurship*

There is an evolutionary nature within entrepreneurship. It is driven by a need for economies to refresh their technological boundaries to remain competitive over time (Cho, D, Ryan, P & Buciuni, G, 2022). The authors suggest that this re-engineering of the economic system depends on the ability of the environment to engage with a heterogeneous set of core skills, which then serve as the foundation of future development. The entrepreneurial ecosystem is found to not be industry-specific but a dynamic process that allows for lifecycles of industries to take place within an economy. While it is clear from the extant literature that these systems exist, the authors argue that there is little understanding of how they facilitate the creation and evolution of economies. The extant literature argues in favour of heterogeneity within the social network (Aldrich & Zimmer (1986).

2.3.2 *Defining the Heterogeneity of the Social Network*

As the social network is a relationship or transaction between people that contains communication, exchange of content and expectations between individuals (Aldrich & Zimmer, 1986), the networks will range from strong to weak depending on the strength of the relationship. The entrepreneurship and innovation systems literature indicates that understanding firm development is a complex and interactive process, as innovation does not occur in isolation but through continuous, collaborative and dynamic exchanges with

other organisations (Chaminade & Edquist, 2010; Jack, Moult, Anderson, & Dodd, 2010). Thus, differences in the social contexts will result in differences in expected outcomes (Anderson & Obeng, 2017).

Sarason, Dillard, & Dean, (2010) propose that a duality exists between the nature of the entrepreneur (agent) and structure in which the entrepreneur operates and that this duality needs to be explored in order to understand fully the entrepreneurial process that leads to firm creation. This integrated relationship cannot be understood through the extant of theories as they operate within isolated regions (Anderson & Ronteau, 2017). Thus, it is important to differentiate between different social contexts when developing an understanding of the social network phenomenon. Research shows that emerging economies from China to Africa and Eastern Europe have differences within each country, are different from each other as well as being different from the developed economies (Anderson & Ronteau, 2017).

Studies conducted as far back as the mid 1980's have linked the success of new business in part to the structures and networks that provide opportunities for entrepreneurs and in part to the behaviour or personal attributes of an entrepreneur (Aldrich & Zimmer, 1986). These studies continue today with Hayter et al. (2021) suggesting that an individual will need to form a self-concept about their propensity to engage in entrepreneurship as the majority of academics and academic entrepreneurs are established scientists with a limited focus on entrepreneurship.

2.4 Theoretical Foundation

As this thesis develops a conceptual framework that explains the impact of social networks on the propensity of academic entrepreneurs to commercialise innovation, it will adopt an integrated approach. The study will integrate systems theory, social network theory and cognitive theory.

2.4.1 *Systems Theory*

Studies that aim to understand the impact of specific societal complexity through an understanding of outcomes that are the result of the influence of different functional systems, should consider systems theory as the main paradigm of the study (Colapinto & Porlezza, 2012). Systems theory is a cross-disciplinary and comprehensive framework that allows for the integration of different theories. Social systems theory is a sub-set of general systems theory in which the relationship between a person and their social environment is explored (Von Bertalanffy, 1972). The theory considers how human behaviour is influenced by the social system they are imbedded in and is based on the ideal that the whole system is comprised of interrelated subsystems whose influences affect the outcome. Thus, systems theory explores the complexity of social engagements within the diversity of society.

The advantage of the systems approach is that it informs the researcher to consider with care the normative understandings of the empirical observations and theoretical concepts that have been applied to complex society. In addition, it is applicable to the relationship between society and science, as social systems are not easily defined and create an identity by drawing from an environment and by using boundaries created by their environment (Colapinto & Porlezza, 2012; Gorke & Scholl, 2006).

2.4.2 *Social Network Theory*

A network is a series of relationships (Greve & Salaf, 2003; Kadushin, 2012). Social network theory originated from mathematical graph theory. Today, the theory has developed around interpersonal relationships, the creation of cliques and theories that explore the structure within communities (Liu, Sidhu, Beacom, & Valente, 2017). This theory been used extensively in International Business, Psychology and the Social Sciences to investigate social engagements at an individual level as well as at population

level. There are three key network concepts that explain this theoretical understanding. These are structural equivalence, cohesion and centrality (Liu et al., 2017). Network cohesion measures the interconnections between subgroups and cliques, structural equivalence considers the similarity of characteristics between actors in the network and centrality considers how the network engages with the flow of information between the role players in order to understand the advantageous position that results in more social ties and greater opportunities (Aldrich & Zimmer, 1986; Liu et al., 2017). Thus, social network theory is a lens through which the effect of the social context can be researched and understood (Perry-Smith & Mannucci, 2017).

Social Capital

The support found within the social network is described as social capital. As with the definition of economic capital, the base for understating social capital is simple. It is an investment in a socially constructed relationship that is expected to yield returns (Lin, 2005). In order to access returns, entrepreneurs entrench their business decision making into social structures while developing and maintaining their social contacts and networks in a similar way to how they acquire economic resources (Greve & Salaf, 2003). Burt (2017) argues that social capital is the total of actual and virtual resources that accrue to a group or individual, by accessing a series of relationships of mutual recognition and familiarity.

Interactions with other network participants influence various aspects of the creative process, including: the facilitation of the flow of information; improving access to new information; allowing for new ideas to be tested and accessing opportunities that are not easily identified (Greve & Salaf, 2003). These aspects are expected to reduce transaction costs, improve outcomes (Lin, 2005) and improve the availability of resources to sustain new business development (Greve & Salaf, 2003). At an individual level, social capital assumes that investments in the social network will provide returns or benefits directly to

the individual. At the group level, certain groups can use this capital as a collective asset to benefit the group and enhance their prospect of success (Lin, 2005).

Social capital will contribute directly to the resource base of the spin-off firm, by reducing outside stakeholder uncertainty, allowing for the firm to adapt to any environmental uncertainties, assisting in reducing costs and increasing customer benefits. It is argued that should the development of social capital allow for these outcomes then the competitive advantage of the firm will be enhanced and the prospect of success improved (Florin, Schulze, & Lubatkin, 2019).

2.4.3 *Cognitive Theory*

Cognitive psychology is the exploration of thinking, memory and individual perceptions. Cognitions are defined as the processes by which a sense is understood and applied (Mitchell, Busenitz, Morse, & Smith, 2002).

Cognitive theory is used to empirically identify the decision processes of an entrepreneur that may lead to differing levels of interest in entrepreneurial opportunities (De Carolis & Saparito, 2006). Within entrepreneurship studies, it has been suggested that possession of an innovation and the cognitive ability to exploit it are needed for the entrepreneurial process to take place (Shane & Venkataraman, 2000). Thus, entrepreneurial cognition is important when understanding ‘why’ academic entrepreneurs act as they do, and in doing so, this thesis will enhance the conceptual understanding needed to create a theoretically rigorous result (Mitchell et al., 2002).

2.5 Theoretical Conceptualisation of Social networks supporting Spin-off firm creation

There is a tradition of studying the spin-off entrepreneurial process through the triple helix (Cai, 2013; Etzkowitz & Leydesdorff, 2000; Rothaermel et al., 2007) and the entrepreneurial university (Laukkanen, 2003; Rasmussen & Wright, 2015). However, these models do not fully explain the development of the academic spin-off firm within the developing world context (Alessandrini et al., 2013).

It has been observed that entrepreneurs use people in their networks to assist with the establishment of their new businesses. Research suggests that during the early stages of new business establishment, entrepreneurs rely disproportionately more on their network of relationships to explore aspects of establishment, than at any other time in the development process (Greve & Salaf, 2003). Further, this process of network reliance is noted as similar regardless of the level of experience of the entrepreneur. Moreover, it is not just the existence of a network that encourages firm development. In research conducted by Klyver, Hindle and Meyer (2008), it was found that mono-dimensional networks were not effective, while there was strong support for multifarious networks that will differ depending on the context of the endeavour. In addition, there are a number of significant studies that suggest that the aspirations of an entrepreneur to develop novel products or make their company grow play a significant driver in the development of a new enterprise (Kolvereid and Bullvag,1996; Wiklund and Shepherd, 2003).

The extant literature argues that any study, which attempts to explain spin-off firm development through the extant models only, without taking into consideration the social network's effect on the academic entrepreneur's propensity to create this unique type of firm, lacks a key factor that is needed to make the procedure valid (Aldrich & Zimmer 1986; Alessandrini et al., 2013).

In order to answer the questions about the relationship of the social network on academic entrepreneurship, a conceptual model has been established. It is created from a systematic review of the literature and combines multiple studies that investigate the same phenomenon by combining them as if they were one study and thereby allowing for individual discrepancies to be resolved.

This research paper is built on the findings that networks allow for the improvement in the effectiveness of the entrepreneurial process through the capture of resources and learning by observing others (Anderson et al., 2010). There is strong evidence in the literature that suggests that the engagement of networks in the process of entrepreneurial firm development is supported by the patterns of relationships between actors in the network, the resources that are exchanged and utilised by the participants and the mechanisms that govern and support relationships between the participants (Hoang & Antoncic, 2003a). Further, it cannot be ignored that academic entrepreneurs have been found to have a unique set of aspirations that are not closely linked to the traditional business developmental aspirations of a business focused entrepreneur (Meyer 2003, O'Gorman et al., 2008 & Hayter 2011)

Due to the non-commercial orientation of universities, it is expected that academic entrepreneurs face additional bureaucracy when developing and/or accessing these networks (Rasmussen et al., 2014). The research argues that this challenge serves as back-stop that sets *entrepreneurs* and *academic entrepreneurs* apart in how they face their environment in the development of spin-offs.

Further, social networks and social capital are not easily disentangled within the entrepreneurship discipline (Corolleur, Carrere, & Mangematin, 2004). In extending the existing theory on entrepreneurial spin-off development, the researcher engaged social network theory, which considers the relationships between each person in the network as well as linking it to the research on the aspirations of academic entrepreneurs.

The study reviewed complex interpersonal relationships needed by participants in the network to gain access to resources possessed by others (Nicolaou & Birley, 2003). These networks assist in suppling advice and information to the entrepreneur. In return, the academic entrepreneur will use the network to engage their own aspirational motivations to assist them in gauging the prospect of success. Positive perceptions will improve the linkages between the entrepreneur and the network and encourage the exchange of resources (Hoang & Antoncic, 2003a).

This section explores the body of research that gives insight into the entrepreneurial practitioner through an understanding of how the network aids success in academic spin-off development supported by the aspirations of the academic. Whittington (2012) suggests that creators of entrepreneurial ventures are not 'simple' but rather social beings whose socio-political and cultural environment will impact how they work and what they can achieve.

The value of the individuals' personal network is an integral part in the explanation of success in the creation of a spin-off firm. Academic innovators are a product of their environment and perceive opportunities in a way that is influenced by their social background (Anderson et al., 2010) and personal aspirations. Thus, a successful outcome is more likely if created and developed through social interaction within social networks. It is suggested by Hite (2005) that the social interaction that takes place within the entrepreneur's social network is fundamental in the development of a new firm, thus making it influential in the entrepreneurial orientation of the academic entrepreneur.

In order to study the social behaviours of the academic entrepreneur, this thesis will engage the theory of entrepreneurial orientation (EO). Walker, Auer, & Ritter, (2006) found that EO is of significant benefit in studies that investigate academic entrepreneurship.

2.5.1 *Entrepreneurial Orientation of an Academic Entrepreneur*

When considering the conditions under which an entrepreneur commercialises academic innovation, the existing research suggests that while the viability of the innovation will be judged by the university, academic and entrepreneur, it is the entrepreneurial orientation (EO) of the academic entrepreneur that precedes the judgement by the role players in the triple helix. In support of this assertion, this thesis refers to the extant literature where EO is supported in both the entrepreneurship and management literatures (Colvin & Miller, 2014) where it forms an important cornerstone in understanding the success of new firms (Wincent, Thorgren, & Anokhin, 2014).

EO identifies the behaviours of entrepreneurs that are able to recognise and exploit opportunities (Martins, 2016) as well as support the overall strategic posture of the university or university department that results in the commercialisation of new innovation (Wales, 2016). Thus, it allows for a representative definition of the organisation's strategic behaviours, managerial philosophies and decision making practices to emerge (Anderson, Covin, & Slevin, 2009).

The extant EO literature has debated the dominant concepts that have emerged from two major schools of thought. The first camp is led by Covin & Slevin (1989), who propose a three-dimensional view of EO. These dimensions are suggested by the authors to be a combination of innovativeness, proactiveness and risk-taking. The second camp argue that competitive aggressiveness and autonomy should be added to Covin and Slevin's 1989 model (Lumpkin & Dess, 1996). Since then, a number of additional different dimensional combinations have been constructed and proposed with limited success (Wales, 2016). It is argued by George & Marino, (2011) that in order for studies to build on extant research and create comparable research findings, researchers should return to the concepts outlined by Covin and Slevin (1989) as core and then supplement those core elements with additional branches to fit the bespoke nature of the research being

undertaken. This method will maintain the element of consistency needed in robust academic research and allow for a number of other important factors that may be needed to ensure conceptual stability and knowledge accumulation in the different contexts being explored and theoretically defined (Anderson, Kreiser, Kuratko, Hornsby, & Eshima, 2015).

Following this argument, while EO success is observed through innovative and proactive initiatives that lead to the commercialisation of new innovation (Wales, 2016), these processes are not uniform across all types of entrepreneurship. The majority of EO success is well documented within large corporations. However, non-profit entities have different focuses. Within the corporate management literature, the EO foundation is based on the ENTRESCALE. This scale has been successfully used to measure EO in private sector firms (Abou-Warda, 2015; Covin & Slevin, 1989). Academics have theorised that the ENTRESCALE has limited applicability in the public and non-profit sectors, in which universities academic spin-offs are positioned. This theorising led to the development of the ENTRE-U scale (Todorovic, McNaughton, & Guild, 2011). The ENTRE-U scale allows for EO to be measured in an academic entrepreneurial environment (Abou-Warda, 2015; Riviezzo, 2014; Todorovic et al., 2011). This model suggests that entrepreneurial activities can be measured by four factors. These are research mobilisation activities, collaboration unconventionality and the perception of university policies.

a. ***Research mobilisation***

Research mobilisation is defined more broadly than pure knowledge mobilisation. It is the ability of the academic entrepreneur to apply knowledge and support the academic entrepreneur to influence how new ideas get initiated and developed (Tang, Kacmar, & Busenitz, 2012). The spin-off firm creation literature identifies universities as the ideal context for the development of new ideas and technologies that drive innovation,

which can then be mobilised towards commercialisation through a spin-off commercial firm (Rorwana & Tengeh, 2015; Wood, 2011).

The developed market literature suggests that the successful mobilisation of research in the developed knowledge economies, enables universities to become influential participants and partners to both industry and government (Etzkowitz, 2003a; Etzkowitz, 2003b), thereby supporting the link between the idea and implementation. The mobilisation of research allows the university-industry relationship to be established through new product development and innovation. Successful commercialisation has been shown to develop by, first, the product originating in the university but being developed by an outside firm (either locally or internationally); secondly, the product originates in the firm but uses academic knowledge to develop it, thereby extending the creation of new ideas to the academic and; thirdly, the commercial product is sourced at a university and the academic involved also becomes involved in the commercialisation of the product, through a new firm (Etzkowitz, 1998). However, for this success to be observed, the academic finding needs to be mobilised towards a conceptual outcome.

Alessandrini et al. (2013) report that while the establishment of an emerging market spin-off emerges in a similar way to the developed market, the process may be interrupted at the mobilisation phase when limited funding and budgetary constraints are observed or when there is a lack of support in the environment, which is observed by the academic through the university's administrative supports. Further, Alessandrini et al. (2013) note that successful spin-off development requires new ideas and the engagement of collaborative diverse communities and networks. The authors argue that these relationships need to be pre-existing before successful and trustworthy engagement between the parties will materialise and support effective research mobilisation.

2.5.1.a.i.1 Market Environment

Theorists suggest that the degree of mobilisation will be influenced by the perception of the market environment as understood in the psychology of the academic entrepreneur (Gaglio & Katz, 2001). The authors suggest that the academic engages with the market environment through pre-existing relationships and university support structures. Further, the literature suggests that innovation is only possible when there is an environment that supports it (Vang, Chaminade, & Coenen, 2007).

It is not only the environment created by the university that is important. The literature shows that even when non-university participants (government and industry) support the academic in their commercial endeavours, that a favourable outcome is observed in both the number and successes of academic spin-off firms (Davey et al., 2015; Liu, Chaminade, & Asheim, 2013). Thus, supportive national and regional environments will encourage the development of new firms. This support can be achieved through policy mechanisms or regional strategies that can be instituted to encourage entrepreneurial firm development (Davey et al., 2015; Klofsten & Jones-Evans, 2000). These mechanisms and policies are expected to create a convergence between the needs of the economy and the interests of the university (Smith & Bagchi-Sen, 2012), thereby supporting the mobilisation of research and facilitating the exchange of knowledge among the participants in the area (Liu et al., 2013), in so far as the network of relationships supports the academic. In the absence of a supportive environment, a poor perception of the market environment may demotivate academics, resulting in lower creativity. Frese, Brantjes, & Hoorn, (2002) found that in Namibia, perceived environmental difficulties impacted the entrepreneurial innovativeness of the academic entrepreneur and in turn, the potential for spin-off development.

2.5.1.a.i.2 Funding

Emerging economies are considered to be dynamic environments. In dynamic environments, there is a high rate of change in market demands, increasing the potential opportunities for innovation development. These abundant opportunities should result in improved performance in spin-offs and an increase in the number of spin-off firms (Wiklund & Shepherd, 2005) . This finding suggests that in emerging markets, the number of spin-offs should be high. However, in emerging economies, these opportunities are also considered by the university against the cost of research projects and the potential for those costs to be recovered. Funding is key to all new entrepreneurial business ventures (Shree, 2007). It is recognised that a diverse and established funding base will act as the foundation for the mobilisation of academic innovation, with the ultimate goal of the funder being value creation for themselves, for the university and society (Gibb & Hannon, 2010). Thus, the authors successfully found that the establishment of funding sources at universities would support the mobilisation of research.

2.5.1.a.i.3 Connection to the global community

Observation by academics at emerging market universities of developed market university academics, where individual spin-off successes have taken place as well as the observed societal benefits received from these spin-off firms (Todorovic et al., 2011), should encourage them to capitalise knowledge. In South Africa, the need for positive benefits from spin-off creation is more prevalent now than at any other time in history (Rorwana & Tengeh, 2015). This desperation for positive benefits has resulted in the belief that the application of knowledge for commercial purposes should overtake the expectation that scientific knowledge should be freely distributed (Rorwana & Tengeh, 2015). It is suggested by these authors that this influence would result in a uniform change in the way South African academic scientists view the outcomes of their research, especially at universities that have a global reach. However, in emerging countries, it has

been observed that internal fragmentation of the academic profession exists. This fragmentation is not observed in developed economies, where all academics belong to the global academic community. In research conducted by Marquina & Ferreiro (2015), it was found that the academic profession in six emerging countries was divided into two categories; those academics that were connected to the global community and those that were connected to the local community. The authors found that influential emerging market academics were part of the global community and were not limited to local working conditions and influences only. These influential global academics had higher levels of productivity and did not share the same limited perception of their profession (Marquina & Ferreiro, 2015). This finding suggests that varying degrees of acceptance into the global academic community will result in different academic focuses in the development of their research for either theoretical or practical outcomes. A focus on only theoretical outcomes will result in a lack of impetus for research mobilisation to occur.

2.5.1.a.i.4 Development of new ideas

While there is an expectation that in emerging markets all academics, in addition to their basic tasks, will play a key role in innovation and the development of new ideas (Todeva, 2013), the literature suggests that new ideas evolve in educational environments, where they need to be recognised and nurtured (Barger , Leffel, Lott. 2021). Thus, new ideas form a baseline for research mobilisation. In addition, Serduykov (2017) suggests that new ideas are only beneficial if they can be applied and implemented; thus, concluding the overall importance of new ideas in the mobilisation of research.

Accordingly, theory has been presented that the concept of research mobilisation is comprised of four key factors, which are a connection to the global community, development of new ideas, the environment of the academic entrepreneur and funding. Therefore, this research will use these factors to explore the relationship between research mobilisation and successful spin-off development in South Africa. Further, given

the extant literature, it is argued that a positive relationship will exist between research mobilisation and successful spin-off development.

In summary, at universities within South Africa, the academic entrepreneur's connection to the global community, their environment, availability of funding and development of new ideas will work together to influence the mobilisation of research, leading to the creation of a spin-off entity.

Accordingly, I hypothesise that:

Hypothesis 1: At South African universities, research mobilisation by the academic will have a positive outcome on the development of academic led spin-offs, such that this relationship gets stronger as the factors supporting research mobilisation work together to support the academic entrepreneur.

b. ***Collaboration***

Collaboration is formed by the pattern of relationships that are created from the direct and indirect connections between participants (Hoang & Antoncic, 2003b). Hoang & Antoncic (2003b) suggest that understanding collaboration within a network should be done by exploring the different parties within the network. This study relies on the triple helix and thus, will include government, industry and the university relationships. It is suggested that a collective involvement of different parties would impact the probability of success of the new firm. In support of this argument, research finds that successful firms rely on interaction with a range of institutions within the innovation; thus, making the firms engagement with its networks a collective approach when working towards the commercialisation of academic innovation (Laursen & Salter, 2006).

It is important to highlight that collaboration has been researched in a multitude of different ways by academic theorists. Common to all the literature is that relationships are important to both the success of entrepreneurs and more specifically, the success of academic entrepreneurs. In early research, Granovetter (1983) supports the suggestions that success would be more likely when the entrepreneur was surrounded by a relationships that offered new ideas and more efficient knowledge. This suggests that the relationship between organisations and individuals that comprise of government, industry and academia, will be influenced in a number of different and distinct ways depending on the information sharing taking place. This position is echoed in more recent research where it is suggested that it is the interactions among innovators, financiers and consumers that accelerate the richness and scope of innovation and discovery (Thursby & Thursby, 2007).

The literature has further confirmed that effective relationships are developed over time and are more important at the outset of the innovation. Pérez & Sánchez (2003) suggest that relationships must be established early in the development phase of the spin-off as the later it is left, the harder it becomes to work with the different parties, thus limiting the success of the firm. In addition, in order to develop an effective relationship between the partners and the academic innovator, the extant research suggests that the parties should introduce themselves to each other through small projects that encourage a large degree of one-on-one interaction (Barnes et al., 2002). The outcome of this is that long-standing pre-existing relationships will be positioned better to support academic spin-off creation, while new or emerging relationships may struggle to gain traction. Thus, the literature suggests the collaborative relationships have a supporting role in the development of commercialisable innovation and will positively influence spin-off firm development.

However, it is also highlighted that the existence of these relationships is insufficient to ensure successful support for the academic entrepreneur. As entrepreneurship is increasingly being recognised as a set of skills that emerges from society, new academic

innovators must convince others that they are credible and legitimate. Gaining legitimacy requires an understanding of rules, norms and objective conditions that facilitate some actions while preventing others (De Clercq & Voronov, 2009). Thus, it is argued that to secure legitimacy, trust must develop between the economic agents. Trust forms the cornerstone of successful collaboration and supports the belief that the research institution's professional credibility across organisational boundaries is maintained (Bouty, 2000; Liyanage & Mitchell, 1994).

Thus, the extant literature highlights that academic innovation requires relationships to develop and assumes that the integration mechanisms that enable legitimacy and trust naturally exist and support the development of these collaborative relationships (Todeva, 2013; Weng, Perra, & Menczer, 2018). However, it is recognised in emerging markets that these interactions are not always present. To overcome this limitation, it is suggested that when there are weak individual relationships, entities such as industry and government may be called upon to support academic research focused on innovation development (Rosenberg & Nelson, 1994). With specific reference to the South African context, there are broad civil calls for government, through their funding programs, to insist that academic research must have a focus on potential commercial applications and should be supportive in the event of a potential failure of the market mechanism (Sibanda, 2009).

Thus, when tackling the theory of collaboration, this research supports the position of Grimpe & Hussinger (2008) when they suggest that personal and organisational relationships act as supportive drivers in spin-off development. The research suggests that personal collaboration must be accompanied by external collaboration (Grimpe & Hussinger, 2008) for it be effective. For effective engagement of personal and organisational collaborative networks, Sibanda (2009) notes that in South Africa, bonds exist between institutions and the individual inventor, technology transfer professionals and the entrepreneurial firm.

While the extant literature has, to some extent, confirmed the importance of collaborative networks in emerging markets, it has been unclear on the role of government vs industry in an environment where the needs of the customer are more dynamic and change regularly. In contrast to Sibanda's findings, in emerging markets, it is suggested that governments are poorly placed to direct innovation (Luu & Ngo, 2019), but the authors highlight that as opportunities are unlikely to emerge in isolation (Luu & Ngo, 2019), opportunities would need to develop through the collaboration with governments, organisations and industry. Thus, collaboration with only one helix in the emerging economies would be inefficient and multiple collaborative engagements with multiple external entities would be needed to support individual relationships and also have a sustainable positive impact on a spin-off business.

In addition to the importance of collaboration with external entities, the literature argues in favour of personal relationships as well. It finds that success is dependent on the relationship between the academic entrepreneur and other individuals that support the formation of the spin-off. A strong relationship is one that leads to successful collaboration, with the parties being able to predict the behaviour of others by uncovering latent needs (Vahlne & Johanson, 2009).

Thus, the extant literature supports the use of individual networks and external networks. Urban & Gamata (2020) argue in favour of organisation factors as having a moderate impact of academic entrepreneurial outputs. In addition, the research done by Luu & Ngo (2019) argues that while academic entrepreneurs are expected to focus on individual relationships that are more likely to support capitalist endeavours, within emerging market environments it is the collectivist external structures that exist alongside the capitalist structures that cannot be ignored. When collectivist external structures influence the collaborative engagements, the academic entrepreneur may find the receptiveness of individual colleagues negative and unresponsive to competitive capitalist entrepreneurial endeavours (Luu & Ngo, 2019). Thus, it is argued that collaboration, if influenced by

collectivists forces, may result in counterproductive outcomes, market unpredictability, volatility, confusion and stress in under-resourced academic entrepreneurs (Tang, Tang, Marino, Zhang, & Li, 2008).

Much of the extant literature concentrates on the developed economies. It is within these economies that the academic will outsource their shortcomings to a trusted individual or entity to foster success of their spin-off (Vahlne & Johanson, 2009). However, while less researched, it is expected that in emerging economies there is often a lack of support from organisations or access to a trusted individual or firm. The coexistence of capitalist and collectivist systems in an emerging economy may create uncertainty that suggests that governments or other collectivist institutions should step aside and allow the business helix to develop relationships with the academic entrepreneur (Tang et al., 2008). In the alternate, the extant literature proposed the use of boundary spanning institutions to facilitate the development of collaborative networks.

Science Parks, Innovation Hubs & Incubators

Science parks, innovation hubs and business incubators are organisations that focus on business development through resource sharing and providing an organisational framework for the support of business through collaboration (Etzkowitz & Kemelgor, 1998; Phan, Siegel, & Wright, 2005). While the importance of intermediaries is well supported in the literature (Siegel et al., 2007), research suggests that their efficacy is affected by the accessibility of these resources by the academic (Mian, 2011) . Research into science parks, hubs and incubators has been undertaken in response to findings that innovation activities at universities are not equally distributed but rather scientific innovation has a tendency to cluster around certain institutions (Diez-Vial & Montoro-Sanchez, 1017).

Research into the advantages of these organisations suggests that due to their proximity to academic institutions, costs associated with the transfer of knowledge are reduced and by allowing knowledge to flow, they reduce complexity and uncertainty (Diez-Vial &

Montoro-Sanchez, 1017). The expectation is that they encourage successive transformation of knowledge into marketable outputs, such as generating new products, services and patents (Siegel, Waldman, & Link, 2003). The literature suggests that there are three aspects that work together to support spin-off creations. These are the growth mechanisms, the degree of integration that these organisations can incorporate into the national value chain and the degree of technological sophistication supported (Koh, Koh & Tschang, 2005). Further, it has been observed that these organisations are embedded in the political system and are regarded as tools for economic development and political bargaining (Koh et al., 2005; Phan et al., 2005). On balance, the literature supports that these organisations have important links to the academic entrepreneurial value chain. Phan et al. (2005) argue that these organisations need to be considered in studies that account for the social environment in which they are imbedded.

There are a number of theories that support the importance of these institutions. The theory of entrepreneurial processual perspective argues that supportive conditions for undertaking and developing a new business must be present, including proximity to support networks (Jack, Dodd, & Anderson, 2008; Laukkanen, 2003). In addition, the management literature focuses on how firms can use their internal characteristics to influence local externalities (Roper, Love, & Bonner, 2017). Imbedded in these theories is the network perspective, which focuses on the interconnectivity of relationships and how they support firm development (Borgatti & Halgin, 2013; Sousa-Ginel et al., 2017).

Technology transfer offices

Etzkowitz (2003a. p325) declares that the university is a natural business incubator. He argues that universities have flexible resources (including staff) and cheap skilled labour (in the form of students) who can be easily organised to undertake new projects. However, the procedures and policies for new business creation depends on the universities' attitude towards supporting business incubation. Technology transfer is defined by Rogers, Yin & Hoffmann (2000) as the process in which "research-based information is

moved successfully from one individual or organization to another". The majority of the available literature on Technology Transfer Offices (TTOs) suggests that universities view academic entrepreneurship as the responsibility of the TTO. The office is viewed as the specialised intermediary unit tasked with the responsibility for the commercialisation of academic innovation (Clarysse, Wright, Bruneel, & Mahajan, 2014). While generally supported in the extant literature, Clarysse, et al. (2014) argue that these units are largely disconnected with the business acumen required to apply and commercialise academic innovation.

South African academic institutions have had to become more responsive to the needs of the community, resulting in demands for the transformation from an 'ivory tower' mentality to a more social and inclusive open environment (Etzkowitz, Webster, Gebhardt., & Terra 2000; Fourie-Malherbe, 1999). It is argued that greater accountability should to be shown by universities towards government and industry in terms of cost-effectiveness, quality and relevance of research programs (Fourie-Malherbe, 1999), which in turn will result in improvements in spin-off creation and further economic development. In response, universities created TTOs to encourage new "entrepreneurial thinking" (Altbach et al., 2009.p141) and generate new income streams for the university as well as to support academic spin-off development (Perkmann et al., 2013). However, this understanding is now being challenged as it is unclear whether TTOs and their representatives are capable of bridging the social gaps between the academic and industrial networks (Hayter, 2016).

The development of theory for TTOs has been drawn from real-options theory. This theory suggests that ownership by either the university or academic of the innovation will confer future real financial gains. Agency theory supports the purpose that ownership will provide a long-term benefit that will ensure the alignment of the needs of university and business towards the goal of developing a spin-off (Markman et al., 2005; Thursby, Jensen, & Thursby, 2001)

These theories combine to support the position that it is the responsibility of TTOs to oversee the technology and innovation transfer processes at universities. In South Africa, these offices are still in their infancy, having only been adopted for the first time in 2004 (Alessandrini et al., 2013). Research indicates that understanding the effectiveness of South African TTOs is vague in relation to its developed knowledge economy peers (Alessandrini et al., 2013). However, in the developed economies, it is found that TTOs reduce asymmetric information flows and positively affect innovative firm development (Algieri et al., 2013; Macho-Stadler, Pérez-Castrillo & Veugelers, 2007).

In conclusion, the extant literature supports the suggestion that collaboration will complement the ability of the academic to anticipate future demand and act in the pursuit of favourable commercialisable opportunities (Abou-Warda, 2015; Todorovic et al., 2011). It is also supported that collaboration allows for easier information and knowledge sharing and promotes congruency of expectations. This implies that it is important in times of uncertainty, in early phases of innovation development, as well as in the continuation and exploitation of opportunities. When collaboration is present, it promotes productivity and effectiveness and allows for the development of commitment between parties (Madhok, 2006; Vahlne & Johanson, 2009). However, collaboration can fail to develop when there is (1.) a lack of trust and legitimacy between the parties, such as the relationship between government and industry in South Africa; (2.) the parties do not have a long history of prior collaboration, as in South Africa, were historically white and non-white universities were not able to develop relationships with industry and government in the same way; and (3.) where the relationships will not form in systems that exhibit both capitalist and collectivist traits, such as South Africa, where these traits are in part driven by government policy surrounding the commercialisation of academic innovation.

Accordingly, it is clear from the literature that as expressed in the ENTRE-U model, collaboration with have a positive outcome on academic led spin-offs, such that this effect will get stronger as relationships between the parties become more involved in engaging in entrepreneurial endeavours. However, the literature makes a clear distinction between interpersonal collaboration and the external collaboration between an academic and institutional structures and as a result I hypothesise the two forms of collaboration independently.

Thus, I hypothesise that:

Hypothesis 2.1: At South African universities, personal collaboration with the academic will have a positive outcome on the development of academic led spin-offs, such that this relationship gets stronger as the parties become more involved in engaging in entrepreneurial endeavours.

Hypothesis 2.2: At South African universities, external collaboration with the academic will have a positive outcome on the development of academic led spin-offs, such that this relationship gets stronger as the parties become more involved in engaging in entrepreneurial endeavours.

c. *Unconventional Risk-Taking activities*

Academics are faced with observable and known risks when they become career academics. These are noted as dealing with insecurity in research funding, the pressure to publish regularly, rising workloads and time constraints. Academic entrepreneurship introduces otherwise unconventional risks that the academic did not foresee when beginning their academic career. Todorovic et al. (2011) suggest that the ability of the academic to confront these unconventional risks will support spin-off development. This ‘unconventionality’ is the recognition and application of risks associated with the idea or innovation. Risk refers to the propensity of the entrepreneur to take courageous steps

towards projects that have uncertain outcomes (Wiklund & Shepherd, 2005). Within the academic spin-off development literature, the ability of the academic to identify and pursue opportunities outside of the traditional academic research sphere is driven by the unconventional risk taken by the academic. It is further argued that spin-off success exists when the academic entrepreneur is able to manage or cope with the risk inherent in these activities through unconventional problem solving (Abou-Warda, 2015).

Risk in the literature is normally researched in the negative. This means that we look at the downside of the risk when determining its effect. However, in order to establish the relationship, this research will review linkages where the risk taken supported the outcome.

The extant literature identifies four types of risk faced by the academic entrepreneur. These are business risk, reputational risk, financial risk and institutional risk

2.5.1.a.i.1 Business Risk

In order for the new process and products to emerge, academic entrepreneurs must still discover opportunities (Myres, 2008) and engage in behaviours that will enhance opportunities (Lumpkin, Cogliser, & Schneider, 2009), thus they need to accept business risk. Academic innovators will need to use the knowledge that they have discovered (Shane, 2000) as well as their understanding of the economic environment to move an idea from theory to practice. As a typical academic's focus excludes the economic environment, it is expected that the process by which an entrepreneur recognises a commercial opportunity is more complex than traditional entrepreneurship (Teixeira, 2011) and as a result, there is the possibility that an opportunity may go unrecognised by certain individuals but not by others (Shane, 2000). It is argued by Krueger (2007) that this identification is the result of idiosyncratic life experiences that are already possessed by an individual. Thus, the ability of the academic entrepreneur to identify and attempt to commercialise the opportunity and unfulfilled need, may be led by their unique

understanding and experiences that guide their responses to the business environment that they find themselves in (Cai, 2013) and will encourage spin-off success.

2.5.1.a.i.2 Reputational Risk

Extant research also argues that academic entrepreneurs are likely to handle risks differently to other types of firms because the academic is foremost a researcher and teacher rather than focused on business success (Naldi, Nordqvist, Sjöberg, & Wiklund, 2009). The literature suggests that academics' may be reluctant to focus on a commercial aspect of their research, as the spin-off firm may be subject to outside influences and exogenous shocks (Cyert & Goodman, 1997). In developing market research done by Bernasconi (2005), it was found at the *P. Universidad Catolica de Chile*, that while the network and capacity for generating spin-offs was in place and that while there were plenty of business opportunities within published academic research, there was a reluctance among academics to focus on business endeavours, as the institution did not legitimise these endeavours. The reluctance of academics to navigate these risks alone may be driven by the belief within the university that the commercialisation of research innovation poses risks to the institution's reputation. It is observed by Bernasconi (2005) that universities are more risk averse than industry when developing an innovation, that they emphasise academic research and do not engage in activities that may negatively affect the image of the university.

This conclusion can also be inferred from research that suggests that while it is the funder that assumes financial risk for the innovations development and sets the necessary standards by which research is evaluated for commercialisation (Altbach, Reisberg, & Rumbley, 2009), it is the university that bears reputational risk if the focus of the funder on the commercialisable aspects withdraws from the investment leading to its failure. This enhances the prospect for failure and strips the university of some influence in the commercialisation process, thus enhancing the potential for negative reputational

outcomes (Brannback et al., 2008) as a neutral source of knowledge (Fulop & Couchman, 2006). To protect themselves from these outcomes, universities must manage reputational risks. It is expected that South African academic entrepreneurs may engage differently with reputational risk than some of their developed market counterparts, as it is shown in the literature that the failure of a commercialised innovation can significantly harm the trust that underpins their research and may ultimately harm their reputation as a neutral source of knowledge (Fulop & Couchman, 2006).

Thus, it is suggested that universities who are more cautious when engaging in new spin-off entities will have limited success in the development of a spin-off as their focus on protecting their academic reputation will discourage unconventional risk taking.

2.5.1.a.i.3 Financial Risk

The extant literature shows that developed market universities fund or financially support the spin-off process and/or company (Etzkowitz 1998). In South Africa, there is an added focus on the constrained and limited university financial resources, implying less availability of funding.

Insufficient funding may result in the failure of a spin-off, which in turn results in a greater degree of negative staff, student and community push-back driven by the immediate sacrifices that the university would need to make. Further, in South Africa, funding constraints at public-funded universities have been exacerbated by increased pressure on the university and the state to provide free education for poorer students. Funding once allocated to research and the commercialisation of knowledge has been reallocated by universities in support of this need. Many developed and developing market universities are faced with limited income, unbalanced budgets and in the worst case, financial distress (Shore & Mclauchlan, 2012). Faced with these constraints, spin-off firm development in South Africa relies heavily on grants and external funding. It is suggested by Clarysse et al. (2007) that when capital providers are external to the university,

problems of communication in the evaluation of the idea, risks associated with the heterogeneity of the knowledge and differences in organisational structures may lead to an imbalance between entrepreneurs looking to launch a new spin-off company and the suppliers of capital willing to offer funds. Thus, it is suggested that the availability of stable, predictable and consistent funding will support the development of a spin-off.

2.5.1.a.i.4 Institutional Risk

Institutional risk is broadly defined as anything that would disrupt the institution from achieving its objectives. Drawing on the theory of the triple helix relationships, trust in the institutions that support academic entrepreneurial spin-off developments shapes commercialisable outcomes (Etzkowitz 1998). While successful application of institutional risk will foster national systems of innovation, thereby providing the foundation for competitive positions (Laukkanen, 2003), this research considers the academics observations, perceptions and understanding of the support and engagement offered to the academic by their institution.

The development of strong ties between university and academic results from the transformation of the faculty allowing themselves to see their research results from a dual perspective being first, a traditional research perspective in which publishable contributions to the literature and theory are noted and secondly, an entrepreneurial perspective in which results are scanned for a commercial prospect (Etzkowitz, 1998). These dual perspectives are often challenged by the divergent goals of business and academia (Cyert & Goodman, 1997; Siegel et al., 2003a). Thus, successful institutional arrangements will recognise the perceived quality of university researchers through academic and commercialisable successes, which in turn will reward all parties in the helix and enhance the mission and commercialisation culture within the university (O`Shea et al., 2007). This is further supported by Benner & Sandström (2000), who

suggest that a supportive environment for academic innovators will result in recognition across the triple helix.

There is significant support in the literature for the interconnectedness of these risks. By way of example, it is suggested that additional funding (financial risk) leads to additional support for innovation (institutional risk), improvements in reputation (reputational risk) and greater success in commercialisation (business risk). All of which positively influence the spin-off outcome (Algieri et al., 2013; Lockett & Wright, 2005; O'Shea, Allen, Morse, O'Gorman, & Roche, 2007; Zucker, Darby, & Brewer, 1994).

These different areas of risk in decision making suggests that the unconventionality of the academic in their approach to these risks is needed in the process of spin-off formation. This unconventionality is a homogonous process that engages the risk found by the academic entrepreneurs in their environments. This implies that an understanding of the market mechanism in the allocation of risk may be more important than its source. The literature confirms this observation by arguing that the creation of a spin-off venture may be more complex than a pure economic motive (Hsu, 2007).

In South Africa, the universities will have developed their bespoke level of acceptable risk. The level of spin-off creation at South African universities will be associated with the academic entrepreneur's approach and understanding of risk, which in turn will support or limit spin-off development.

Accordingly, I hypothesise that:

Hypothesis 3: At South African universities, unconventionality found in academic entrepreneurial risk practices has a positive outcome on performance of academic led spin-offs, such that this relationship gets stronger with higher levels of risk-taking.

Hypothesis 3.1: At South African universities, unconventionality found in academic entrepreneurial financial risk practices has a positive outcome on performance

of academic led spin-offs, such that this relationship gets stronger with higher levels of risk-taking.

Hypothesis 3.2: At South African universities, unconventionality found in academic entrepreneurial institutional risk practices has a positive outcome on performance of academic led spin-offs, such that this relationship gets stronger with higher levels of risk-taking.

Hypothesis 3.3: At South African universities, unconventionality found in academic entrepreneurial business risk practices has a positive outcome on performance of academic led spin-offs, such that this relationship gets stronger with higher levels of risk-taking.

Hypothesis 3.4: At South African universities, unconventionality found in academic entrepreneurial reputational risk practices has a positive outcome on performance of academic led spin-offs, such that this relationship gets stronger with higher levels of risk-taking.

d. ***University Support & Bureaucracy***

University policies are expected to encourage the engagement of the academic entrepreneur towards academic entrepreneurship (O'Shea, Allen, Chevalier, Roche 2005; Todorovic et al., 2011). The extant literature suggests that university governance mechanisms should be designed to support spin-off activity (Hoang & Antoncic, 2003b). Further, the creation of an environment at a university through robust governance mechanisms would result in implicit contracts that are enforced by the potential for social alienation and loss of reputation, rather than the university bureaucracy. Thus, stable and effective university governance can reduce the cost of accessing resources, reduce bureaucracy and improve competitive advantages (Hoang & Antoncic, 2003a). However, Urban & Gamata (2020) suggest that universities cannot enforce academic

entrepreneurship and that it would need to be held as a voluntary engagement by the academic and university.

In response to this research, as well as challenges experienced by the academic when moving towards the commercialisable aspect of their output, there has been a general rise in policies and practices at universities that facilitate the process of knowledge transfer, improve linkages with industry and assist in the entrepreneurial use of knowledge (Shore & Mclauchlan, 2012). This is especially true in the developed economies. In the developing economies, universities have observed the considerable profits and economic rents earned abroad and look to emulate these successes with similar policies and involvement. However, their success has been intermittent and inconsistent. Today, many research universities in the emerging markets are looking for ways to effectively manage how their ideas and innovations are commercialised (Rorwana & Tengeh, 2015; Thursby & Thursby, 2007).

Extant research has suggested two possible engagements that may result in a favourable outcome for academic spin-off creation. These are noted as bureaucratic involvement by government institutions or interventionist support by the university (Colyvas et al., 2002; Siegel et al., 2007). Bureaucratic involvement involves the regulating of commercialisable academic output.

Universities intervene to regulate and protect intellectual property. This protection by the university will form part of the support mechanism needed to establish an environment conducive to funding spin-off development and encouraging scientific participation (Siegel et al., 2007). This support is rewarded, as it allows for the receipt of annuity rents by the university from the commercialised innovation, thereby allowing for development of future spin-offs through a self-funding mechanism. However, Urban & Chantson (2017) suggest that by focusing on identification and protection, there is a lack of focus on start-up formation.

Although the transfer of knowledge between universities and industry can occur through several modes, research has concentrated on licensing and patents as effective transfer mechanisms (Siegel et al., 2007; Thursby & Thursby, 2007). Traditionally, universities have argued that if they imposed a monopoly on knowledge, it would lead to serious problems in the allocation of economic resources within markets. Thus, the challenge for the university patent system has been to keep a balance between the social objective of ensuring efficient use of knowledge and motivating a provider of capitalistic entrepreneurship (Foray, 2002). Foray (2002) suggests that the balance between commercialisation and free distribution of innovation varies across countries and cultures. He showed that the Japanese university research system is effective in placing large amounts of information in the public domain, with the objective of “collective invention”, while the European system tended to allow less information to be made public and the US system was shown to be the least effective at releasing academic knowledge to industry. Currently, there is limited research on how South African universities balance commercialisation and free distribution.

DiGregorio & Shane (2003) suggest that once a ‘usable’ innovation is identified, patent policy must protect the innovation developed at the university. They found that ineffective policies will create monopolistic pricing and result in socially wasteful expenditures or may encourage academic innovators to invent ‘around’ the patent instead of transferring it to the university (Foray, 2002). Thus, in one potential outcome, the use of patents and copyrights by the university may create licensing activities that result in a net drain on university resources and do not ensure the future revenue stream to the bureaucratic owner of the IP (Thursby & Thursby, 2007).

Rogers, Yin & Hoffman (2000) identify a process consisting of several steps that would allow a university to transfer knowledge for commercialisation. First, the academic innovation would begin at the universities laboratories and research centres as the research is carried out by the faculty members with the aim of advancing knowledge

(Wood, 2011). Secondly, once a university scientist has discovered an economically viable concept, the scientist discloses it and files it with the university IP office. Finally, the academic faculty discloses the innovation to the relevant specialist university staff who will decide if the innovation is worth the time, effort and expense to proceed with, either through local or international intellectual property protection application (Wood, 2011).

Once protected, the university may enter into licensing or sale negotiations for the innovation. Under licensing, the university continues its involvement with the firm as the idea is converted into a commercialised product that will earn the university royalties, while a sale agreement will net a lump sum return for the capital originally invested. Thus, in a second potential outcome, suggests that the use of patents and copyrights by the university may create opportunities that result in a gain to university resources through the control of the future revenue stream (Wood, 2011).

In order to ensure the collection of annuity rents, governments have tried to introduce legislation to protect university IP ownership. The process was pioneered by the Bayh-Dole Act (1980). While the act did not create university patenting or facilitate entrepreneurship, it offered an advantage to non-profit institutions to encourage the patenting and development of academic innovation (Owen-Smith, 2003), which in turn would stimulate spin-off development. It was observed that the legislation accelerated the commercialisation of new technologies and promoted economic development and entrepreneurship (Colyvas et al., 2002; Siegel et al., 2003a) and the effective dissemination of knowledge quickly to the broader economy (Carlsson & Fridh, 2002). This Act proved that governmental sponsors play a vital role in the process of redirecting the normative orientation and actions of university researchers in the United States (Benner & Sandström, 2000).

Following this US legislation, there has been a global move by governments to offer additional regulatory support for university-developed innovation (Nauwelaers & Wintjes, 2002; Rosenberg & Nelson, 1994). With this focus, the South African government, in an attempt to encourage transfer of innovation to industry, passed the Intellectual Property Rights from Publicly Financed Research and Development Act 2008 (IPR-PFRD) and established the National Intellectual Property Management Office (NIPMO), whose aim is to ensure the transfer of innovation through the ultimate ownership of these patents.

Patents and copyrights are the tools used to guarantee exclusivity of access to knowledge. Intellectual property rights are “industrial tools that allow for the creation of markets to stimulate private initiatives” (Foray, 2002. p.71). This process aims at restricting access to knowledge by granting temporary exclusive rights to new knowledge; thus, empowering the creator to set a price for its use (Foray, 2002).

NIPMO has attempted to design innovation systems that integrate the role of governments, industry and universities with one another. It is believed that integration will allow for the sharing or promotion of their combined benefits, while reducing individual limitations (Lester, 2005). The central tenet in understanding spin-off activity is to reflect on the institutional behaviours and norms between the role players in the environment. First, policy makers seek to understand how universities can contribute to national or regional competitiveness and economic growth and secondly, industry seeks to overcome cultural differences and allow for the effective transfer of innovation to firms.

It is clear from the extant research that globally, policy makers have changed their position on higher education from a social development standpoint to one that fosters economic development at both the national and regional economic level (Altbach et al., 2009). National governments are increasingly relying on universities to become an anchor in their innovation systems (Mowery and Sampat, 2005). Urban & Chantson (2017) argue that the literature supports government involvement, as regulations have an influential

role on the perception of how an academic innovation can be successfully commercialised.

The literature has identified two potential reasons for the lack of success in the commercialisation of academic innovation in South Africa. First, faculty members play a very important role in the development of their innovations, however, as many academics are not ready to, or interested in becoming an entrepreneur, many universities take over the rights to innovation with the intention of commercialising the innovation themselves (Thursby & Thursby, 2007). In addition, in South Africa, the university is the sole owner of the IP and is not required to include the faculty. Secondly, direct involvement of the university in patenting and licensing is only one of a number of ways for the transfer of knowledge from universities to industry (Lester, 2005). Academics may also exploit the knowledge created through their university research by acting as consultants that are able to apply well-established knowledge to the development of a particular product or process in industry. In addition, university faculty may collaborate with industry to apply new knowledge developed by researchers at other universities, supplying the students of the leading university in the field to industry.

Accordingly, I hypothesise that:

Hypothesis 4: Supportive engagement and policies that focus on the commercialisation of innovation by the academic entrepreneur have a positive outcome on the development of academic led spin-offs, such that this relationship gets stronger with higher degrees of supportive involvement by the policy makers.

Hypothesis 4.1: Bureaucratic policies that focus on the commercialisation of innovation by the academic entrepreneur have a positive outcome on the development of academic led spin-offs, such that this effect gets stronger with higher degrees of supportive involvement by the policy makers.

As stated at the beginning of this section, the other engagement that has been researched is 'university support'. This concept has been researched in papers that consider support for applied research and incubation of spin-off firms.

This research has observed, in both triple helix theory and the entrepreneurial university theory, that the university is important in the technical advancement and management of innovation. It has been suggested that the creation of a spin-off can be encouraged or inhibited by different processes and policies from the transfer of technology from the university to industry (Colyvas et al., 2002; DiGregorio & Shane, 2003).

Within the university, procedures and policies for new business creation depend on the universities' attitude towards risk as well as the competencies in the supporting departments. Markman, Phan, Balkin and Gianiodis, (2005) suggest that a focus on policies that encourage technology transfer from universities, improves the rate of spin-off creation, while Carlsson & Fridh, (2002) found that policies that allowed joint equity ownership between the university and the entrepreneur would improve the success rates of new spin-offs. In the developed market literature, O'Shea, Allen, Morse, O'Gorman, & Roche, (2007) claim that it was MITs institutional support for entrepreneurial activities that resulted in the development of academic entrepreneurship at MITs.

However, there is an opposing position regarding the involvement of the university. It is suggested by Rosenberg & Nelson (1994) that the university administration should support research aimed at basic understanding (theory) rather than practical short-run profits and that industry would advance the commercial design and development of product and process. This argument assumes that universities will generate increased transaction costs through the commercialisation process, which will drain existing limited resources. The implication of these differing views for this research is that some universities may concentrate on the research side of R&D, while others have expanded

their role from protection of innovation to the facilitation and support in the dissemination of intellectual property to academic entrepreneurs (Siegel et al., 2003a).

Thus, this research highlights that there is supportive extant research to suggest that both involvement and the lack of involvement can support spin-off firm development. The implied outcome from both groups of studies is that university policy needs to be consistent and clear in its engagement with academic innovation.

In contrast to the central role played by the university, triple helix theory highlights the *interaction* of universities with industry and government. Interaction allows university researchers to develop closer and more interdependent relationships with industry (Altbach et al., 2009; Rosenberg & Nelson, 1994). These relationships are found to encourage university-industry knowledge transfer and form the cornerstone of spin-off firm creation (Thursby & Thursby, 2007). Continuous interactions among innovators, financiers and consumers of technology accelerate the richness and scope of innovation and discovery, leading to an increase in the number of spin-off firms (Thursby & Thursby, 2007).

Within the university system, motivation for output is driven by powerful forces compelling normative forms of conduct. Three types of forces have been identified: (i) coercive, driven by external factors; (ii) normative, driven by shared professional standards and (iii) memetic, which allows for organisations to mimic others when they are not certain of their goals (Czarniawska & Genell, 2002).

Coercive forces are the observations by universities of individual spin-off successes from other universities that have either capitalised knowledge themselves or capitalise knowledge with the help of industry (Rorwana & Tengeh, 2015). This capitalisation of knowledge appears to many universities to have overtaken the expectation that scientific knowledge should be freely distributed. This results in a change in the way academic

scientists view the results of their research and changes the role of the university in relation to industry and government.

The normative processes regulate conduct within organisations. For the successful commercialisation of academic innovation to emerge, it has been suggested in the literature that universities must undergo a change in their normative routines and administrative structures (Algieri et al., 2013; Etzkowitz, 1998). In knowledge-based economies, there has been an increase in the number of researchers seeking support but finding little. To overcome this limit, researchers are more creative in their search for support (Etzkowitz, 1998). Siegel et al. (2003) note that although the primary motive for academic scientists is recognition within their community and a desire to secure additional research funding for further research and equipment, a new academic ethos needs to emerge that combines the researchers interest in fundamental discovery with its application (Etzkowitz, 2003a; Friedman & Silberman, 2003). Only once this process is achieved will it be possible for a successful spin-off firm to be created.

Mimetic processes promote standardised policies and procedures that result in researchers and universities imitating the way in which their successful counterparts manage challenging aspects of their organisational environment (Benner & Sandström, 2000). In response to the changes experienced by the academic faculty on the focus of their output, there has been a general rise in policies and practices that facilitate knowledge transfer, improve linkages with industry and assist in the entrepreneurial use of knowledge (Shore & Mclauchlan, 2012).

As already noted in this section, triple helix theory suggests that product development and innovation emerges in two different ways. First, the product may originate in the university and then be developed and secondly, the problem originates in the firm but requires academic knowledge and expertise to develop it (Etzkowitz, 1998). Either way, the extant literature suggests that innovation needs to be incubated or nurtured in order

to develop into a spin-off. It is suggested that the ability to transform and assimilate knowledge between academics, universities and spin-off firms can be fostered through wide-ranging development programs (Davenport, Davies, & Grimes, 1998; Wolson, 2007). The scope of these programmes is far-reaching in the literature and includes focus on academics and entrepreneurs.

The programmes that have been researched include: sabbaticals, that may serve as a stimulus for ideas for both industry and the university (Jain et al., 2009); research grants, that provide a platform for university academics and industry to coordinate research in areas that are of mutual interest in a pre-competitive domain (Siegel, Waldman, & Link, 2003); organised research units, such as laboratories, that offer an interdisciplinary approach to research (e.g. national science foundation) (Rhoten, 2004); student internships, that allow for the interaction with industry, which can be expanded on when returning to the university (Todeva, 2013) and information exchange forums, that create opportunities to network and exchange knowledge (Bloedon & Stokes, 1994). Programmes that support entrepreneurial development offer the academic entrepreneur the ability to earn an improved living through a ‘part time’ job, the opportunity to use the resources of the university free of charge and the receipt of free business management training (Sternberg, 2014).

Due to the advancement of certain disciplines, scientists have argued for the need to link fields to facilitate application of knowledge in a specific area (Aboelela et al., 2007). This recognition has encouraged the scientific community to develop new applied knowledge through research that combines the skills and perspectives of multiple disciplines. Aboelela et al. (2007) suggest that the combining of skills may be partly the result of a wider societal interest in holistic perspectives that encourage human experience to be understood through multiple dimensions.

Interdisciplinary research centres aim to shift the epistemological values and intellectual curiosities of academic researchers. Through the integration of the strengths of two or more disparate scientific disciplines with the purpose of developing more robust outcomes for their research, has emerged an increase in the focus for future funding by government and industry (Rhoten, 2004). These discoveries have been valued by government and industry to the extent that they have been "*proclaimed, demanded, hailed and written into funding programs*" (Rhoten, 2004. p8).

Thus, effective commercialisation will be possible when the university is able to foster systems of knowledge production and development support, thereby providing the foundation for a competitive position for a new spin-off to emerge (Laukkanen, 2003).

Accordingly, I hypothesise that:

Hypothesis 4.2: Supportive university engagement that focuses on the commercialisation of innovation by the academic entrepreneur has a positive outcome on the development of academic led spin-offs, such that this relationship gets stronger with higher degrees of involvement by the university.

2.5.2 *Aspirations of South African Academic Entrepreneurs*

This research links the aspirations of an academic to the success of an academic entrepreneur through the use of how the academic perceives the rank and position of his university. Aspirations of academics are rarely linked in research in academic entrepreneurship, however, the focus of the academic when choosing which university to research and teach at serves as a useful tool to understand demands for accountability, confirmation of prestige and agenda setting of the entrepreneur (Pusser & Marginson 2013). Extant research has concentrated on citing academic entrepreneurial characteristics such as creativity, self-esteem and futuristic thinking in order to explain academic spin-off outcomes (Farrell et al., 2022). Further, Farrell et al. (2022) found that

these characteristics were successful in promoting academic entrepreneurial behaviour as they influenced the attitude of academics. Academic attitudes supported findings by Rusite & Sloka (2019), where they suggest that university rankings mirrored academic staff motivation, aspirations and a willingness to support university led strategic initiatives. Thus, it is argued that university rankings have been omitted from previous research on academic entrepreneurial success and should form part of this study.

In further support of this, university rankings have been suggested to be a window into the perception of the role of higher education in national economic development. Thus, rankings shape how the relationship between governments and business evolve and where power in those relationships exists (Farrell et al., 2022; Pusser & Marginson 2013).

Research has also considered that there may be a link between entrepreneurial success and research publication. Fini, Perkmann & Ross (2022) found that successful academic entrepreneurs were more likely to encounter spill-over research opportunities and future scientific benefits when engaging in academic entrepreneurship. It is also acknowledged that academic rankings have a significant positive correlation with academic publication (Johnes, J. 2018). This finding supports those additional scientific discoveries, which would offer the potential for improved and better university rankings. An argument can be made from this finding that there is a relationship between academic entrepreneurship and research success, which in turn would lead to higher university rankings.

As a result, this research suggests that the aspirations of academic entrepreneurs is largely absent from research on the success of academic entrepreneurship and strives to find an overlap in between the success of a spin-off and the perception of the ranking of the university that the academic works at.

Research has defined aspirations as a process variable when developing theory. Process variables are very difficult to capture and measure, resulting in tentative link between aspirations and the recognition and exploitation of innovation (Zahra, 2007). As a result,

this research has focused on specific aspirational academic motivations, being the university ranking and intellectual imperatives.

The above factors suggest that the development of the spin-off firm is at least in part a result of a conscious choice by the academic entrepreneur. The literature supports this argument and expands to suggest that success is a result of whether or not the firm continues to exist (Shane, 2004), the firm's ability to attract capital (Lockett and Wright, 2005) and the number of patents (Zucker et al., 2002), which are all linked to prior successes and reputation of the university. There is little research to suggest that academic entrepreneurs may not define their success in these terms, but rather may be comfortable pursuing an academic research agenda while being aware of the potential spin-off option, which may emanate from research. O'Gorman et al. (2008) suggest the academics prefer recognition by their peers to the financial success of their firms, but did not find that there was no interest in success of a spin-off firm. It is argued that, even if innovation is still in its development phase, academics that understand the perceived benefits from the project are more likely to pursue it (Barnes et al., 2002).

While it is suggested in the literature that an incentivisation structure will focus the academic entrepreneur on spin-off activity and lead to success in spin-off firm creation (Friedman & Silberman, 2003; Link, Siegel, & Bozeman, 2007; Wood, 2011), some researchers raise questions about whether the current university incentive arrangements support the aspirations of academic entrepreneurs (Grimaldi, Kenney, Siegel, & Wright, 2011) or whether academics create the focuses needed when selecting the university they research at. This may be especially relevant in the South African context, as in research conducted in China, it was found that where universities were the product of historical legacies and global influences, a hybrid system of incentivisation for academics would develop. In part, the incentive would be linked to the aspirations of academics to publish at top ranked globally rated universities. Once published, only then would the academic consider a commercialisable aspect for their research (Wu, 2010). As research

articles are a primary output of academics, universities that support staff in the creation of publishable research would attract top staff, which in turn would result in higher quality of the articles, improving the standing of the academic within their field of expertise (Bhopal, 2014). Thus, academics may position themselves to embrace a research orientation initially (Karmaeva, 2018) to focus on personal career trajectories, which in turn positions them for future spin-off success. An academic's pursuit of a career within a specific university would be dependent on factors pertaining to the ranking of the university in academic output and the standing of the university within the academic community (Altbach, 2015).

As suggested already, the academic entrepreneur's engagement with spin-off activity may be driven in part to his know-how, but also in part by his aspirations. Understanding the academics aspirations may provide a deeper understanding of why spin-offs succeed.

Hypothesis 5: Aspirations of academic entrepreneurs to research at top rated universities has a positive outcome on the development of academic led spin-offs, such that the relationship gets stronger as academic entrepreneurs research at top rated universities.

2.6 Moderating Variables

Frese, Bausch, Schmidt, Strauch, & Kabst, (2012) argue that observing moderating variables is highly recommended when the current research’s focus varies across individual studies. Following the discussion above, there are specific external variables that could moderate the relationship between the social network and development of the academic spin-off firm. It is also found in the review of the extant literature that it is probable that the social network does not hold homogeneously for all contexts. It is likely that external intervening factors may be valuable in the development of an entrepreneurial spin-off and academic entrepreneurial thinking as well as influencing the approach

chosen by the academic entrepreneur. It is likely that moderators may influence the success of an academic spin-off.

In summary, few researchers have systematically and empirically investigated whether the propensity of an academic entrepreneur to develop or engage with their social network is based on or influenced by external incentives. Based on the data available from the literature review, the author has identified the following external incentives that may have a moderating effect on the study. These moderators are summarised as first, level and quality of entrepreneurial education, secondly, the age of the academic entrepreneur, thirdly, the gender of the academic entrepreneur and fourthly, prior experience of the academic entrepreneur. As these factors have been shown as influential in the development of a spin-off, these factors may serve as contingent in the spin-off development.

Control variables need to be fixed or eliminated in this study to ensure that the study is able to clearly identify the relationship between the independent and dependent variables.

2.6.1 *Prior Experience*

Experience in entrepreneurial venture creation affects the entrepreneur's propensity to engage in future entrepreneurial ventures. There is significant literature that suggests that prior entrepreneurial experience is a reasonable predictor in the identification of new business opportunities and the successful development of new firms (Hsu, 2007). Morris, (2015) found that new business creation is a lived experience and that the challenges that face entrepreneurs in prior experiences and the business skills acquired during those lived experiences will impact the ability to recognise opportunity and take decisions about future entrepreneurial endeavours. These results in the literature confirm that entrepreneurs who have been involved in start-up firms before would believe more strongly in their potential to create another successful start-up firm. In research conducted

on academic entrepreneurship and experience, Clarysse et al. (2011) agree with the generic entrepreneurial research findings, that experience is one of the most important predictors in the development of an entrepreneurial businesses. While an important observation, research conducted in the developed markets of Sweden and Ireland found that while there is significant entrepreneurial experience among academics in these countries, this experience was more likely to result in engagement in consultancy and contract research rather than in the development of a spin-off (Klofsten & Jones, 2000).

Hypothesis 6: Prior experience will moderate the relationship between mobilisation and success such that this relationship becomes stronger with more experience.

2.6.2 *Level and Quality of Entrepreneurial Education*

Studies have shown that one of the influential attributes of entrepreneurs is the level and quality of entrepreneurial education (Mentoor, & Friedrich, 2010). The pedagogy of entrepreneurial education has taken many forms in its approach and implementation (Gibb, 1996). While there has been research that has doubted the effectiveness of entrepreneurial education on entrepreneurial outcomes (Dickson, Solomon, & Weaver, 2008), this has been contradicted many times. In research done by Bae, Qian, Miao and Fiet, (2014), it was found that there is a link between entrepreneurial education and individual entrepreneur to accept the risk needed to begin a new venture. Additional studies concur with these results, with research conducted by Rauch & Hulsink, (2015) suggesting that core to explaining the firm creation process, entrepreneurial education resulted in advances in the understanding of risk and the entrepreneurial intentions of students through improvements in the students' attitudes and behaviours (Liñán, Nabi, & Krueger, 2013). In addition, the research suggests that entrepreneurial education is also responsible for the positive perceptions created about entrepreneurship through the changing attitudes and improving understanding of the risks and benefits around the discipline (Rauch & Hulsink, 2015). This research is cognisant that the extant empirical

reviews generally argue for isolated methods and pedagogic outcomes. These reports generally promote individual case studies and focus on singular methods or approaches, which makes definitive generalisable conclusions that can be applied to South African academic spin-offs difficult to find. In the limited research that has been conducted, it is suggested that entrepreneurial education may be positively impacted by the academic entrepreneurs risk taking behaviour leading to the development of a spin-off.

Hypothesis 7: Level and quality of prior entrepreneurial education will moderate the relationship between risk and success such that this relationship becomes stronger with more education

2.6.3 *Age*

The literature points to variations in the degree of entrepreneurship based on age (Rauch, Wiklund, Lumpkin, & Frese, 2009). Liang, Wang, & Lazear (2014) suggest that as age increases so does experience and skill but find that there is also a significant decline in creativity and innovative thinking, which slows entrepreneurship. Empirical studies have found a u-shaped relationship between the propensity of an entrepreneur to start a business and their age, with the most common age for early entrepreneurial activity reported to be 40 years (Parker, 2004). Studies suggest that while an individual's decision to begin a new firm is influenced by their age, it is also influenced by the age demographic of the region where they reside, their access to information and the availability of external resources found from their social network (Bönte, Falck, & Heblich, 2009).

Hypothesis 8: Age will moderate the relationship between bureaucracy and success such that this relationship becomes stronger with more age

2.6.4 *Gender*

There has been a significant amount of interest in the potential for gender bias in spin-off creation. Several studies have shown that male academics are more likely to engage in commercialisation activities with industry (Cunningham, O'Reilly, Dolan, O'Kane, & Mangematin, 2016; Perkmann et al., 2013). This was demonstrated in a study of Irish scientists that found that men had more commercial experience and direct experience in spin-off firms than woman (Cunningham et al., 2016). In research done on the female founders of UK university spinout companies, the proportion of female to male academic entrepreneurs was only 12% (Rosa & Dawson, 2006). However, Hayter et al. (2021) suggest that further research is needed to give additional clarity on how gender could promote the furtherance of academic entrepreneurial behaviour by arguing that the extant literature does not fully explain the impact of gender.

Hypothesis 9: Gender will moderate the relationship between mobilisation and success such that this relationship becomes stronger in males.

2.7 Mediating role of research mobilisation

While the literature does not directly address research mobilisation as acting as a mediator between the antecedents of a spin-off firm and the social networks of an academic entrepreneur. In view of the individual studies reviewed in this thesis, there appears to be a significant support for the role played between the antecedents of research mobilisation (discussed in 2.5.1 a.i.1/2/3/4 early in this chapter) and spin-off success. For instance, in a study complied by Vesperi, Di Fatt, Parra (2018), the authors argued that research mobilisation exists in a complex environment that contributes directly and indirectly towards spin-off success. In particular, that study established that there is a wide range of influences and heterogeneous focuses that are designed to direct research mobilisation towards spin-off success. Other research that give support to the

suggestions that research mobilisation may be a mediator in spin-off success is shown by Gibb & Hannon (2010) who found that it was the funding base that supported academic spin-off development. Marquina & Ferreiro (2015) found that acceptance of the academic into the academic community would support spin-offs. Finally, Barger, Leffel, Lott 2021 argued that the baseline for research mobilisation was the development of new ideas. However, a review of existing literature reveals a lack of knowledge on the impact of the antecedents of research mobilisation on spin-off success. Therefore, the antecedents of spin-off success may be influenced by the potential mediating role of research mobilisation on spin-off success.

H10: Research mobilisation will mediate the relationship between the antecedents of spin-off success and spin-off success

2.8 Conceptual Framework

Following on from the literature that has been reviewed and the theoretical foundations that this research is based on, this thesis has developed a proposed conceptual framework through an integrated approach. The framework has been developed from the foundation of social network theory, a hold-all approach to understanding the effects of interpersonal relationships within communities (Liu et al., 2017). The outcome is expected to explain the influence that social networks have on the propensity of academic entrepreneurs to develop successful spin-off ventures. The framework development has drawn from several disciplines and theories in its development.

According to social systems theory, human behaviour is impacted by the social network the individual is imbedded in, which in turn influences the outcome. The independent variables that have been established from the relevant literature for this conceptual

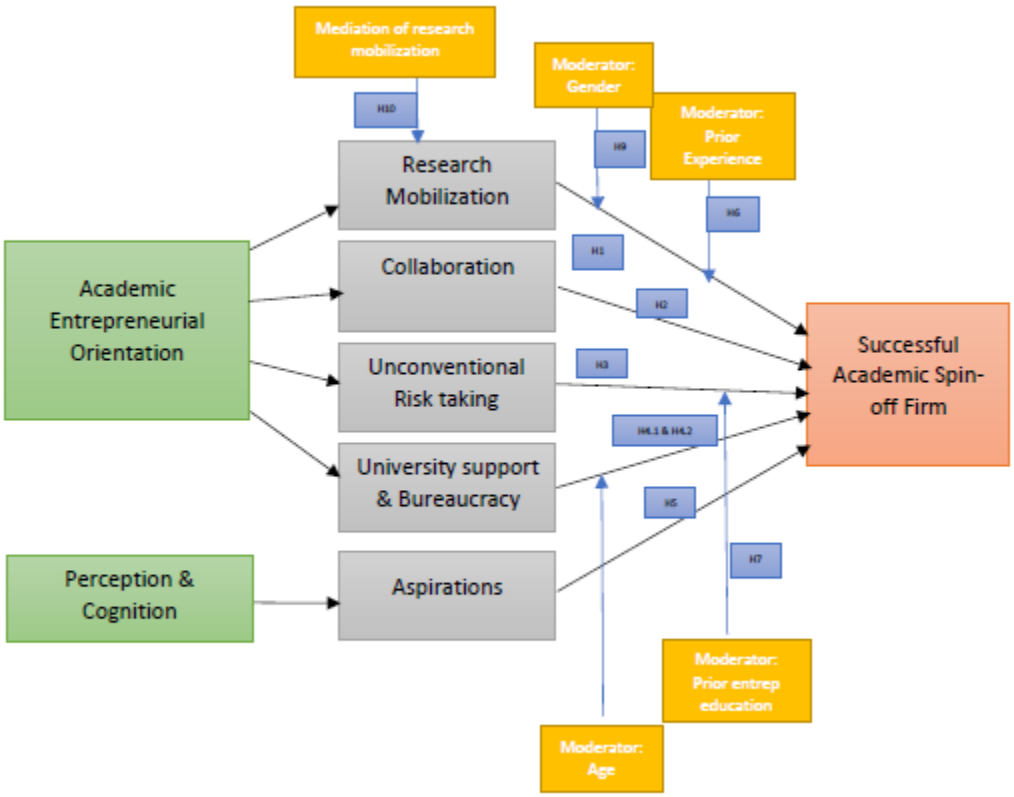
framework development have been operationalised under the ENTRE-U scale, which allows for the entrepreneurial orientation to be measured in an academic environment (Todorovic, McNaughton, & Guild, 2011). As a result, the current study argues that successful academic entrepreneurship is highly dependent on the mobilisation of research (Rorwana & Tengeh, 2015; Wood, 2011), collaboration between the parties in the network (Hoang & Antoncic, 2003b), unconventional risk-taking activities and university support and bureaucracy. These variables have been shown in previous studies to have had a significant relationship in the development of strong social networks and thus are needed in this study's proposed framework.

Cognitive theory provides a theoretical explanation of the processes by which an individual's perception is applied to his actions and decision making. This theoretical framework suggests that for an academic entrepreneur to successfully commercialise research, the academic's perceptions of his environment would influence decision making. This research considers the aspirations of South African academic entrepreneurs through the choice of university that the academic conducts research through (Pusser & Marginson, 2013).

The thesis's proposed conceptual framework is grounded on the hypothesis that each variable in the framework differs in terms of its impact on the likelihood of a spin-off succeeding and the variability of the occurrence of success. To achieve this, the proposed framework aims to understand the interactions and relationships between the academic entrepreneur and their social network with the objective of determining the propensity of academic entrepreneurs to develop spin-off ventures. Therefore, the proposed conceptual framework combines understandings from the different theory bases to establish a model of understanding the impact of the social network on the academic entrepreneur's spin-off success.

Figure 2.7.1 graphically illustrates the influence of social networks on the development of an academic spin-off. This proposed conceptual framework only shows the expected direct relationships and Table 2.7.1 summarises hypotheses tested.

Figure 2.8.1: Expected influence of the social networks on the development of an academic spin-off



Source: Researcher's own model developed from information contained in the literature review. Research Mobilization (Rorwana & Tengeh, 2015); Collaboration (Hoang & Antoncic, 2003b); Unconventional Risk taking (Todorovic et al., 2011); University support & Bureaucracy (Colyvas et al., 2002 & Siegel et al., 2007); Aspirations (Pusser & Marginson 2013).

According to Figure 2.7.1, research mobilisation will cause a positive impact on successful academic spin-off firm creation. This hypothesis is drawn based on the empirical studies that found that a positive relationship between the market environment (Gaglio & Katz 2001), funding (Wiklund & Shepherd, 2005), connection to the global community (Maarquina & Ferreiro, 2015) and development of new ideas (Todeva, 2013) all had a positive impact on the ability of the academic to apply knowledge successfully. Therefore, it is argued that research mobilisation will ensure the successful formation of commercial academic spin-offs.

Figure 2.7.1 suggests that collaboration will positively impact the formation of successful spin-offs. This hypothesis is supported through the empirical studies that found that direct and indirect connections between participants would positively impact the success of a new firm development (Thursby & Thursby, 2007). Extant research also suggests that academic entrepreneurial firm development would be supported when there is a strong existing relationship between industry, government, and universities (Etzkowitz, 1998). In addition, research on the development of incubators and hubs has important links to the academic entrepreneurial value chain (Phan et al., 2005), in that it shows that technology transfer offices reduce asymmetric information flows and support academics in the development of their academic innovation. Thus, this research proposes that collaborative relationships would have a positive impact on spin-off success.

Further, Figure 2.7.1 suggests that successful innovations have unknown and risky outcomes and that for a spin-off to succeed, the academic needs to be bold in the approach to risk (Wiklund & Shepherd, 2005). The extant literature identified four types of risk that would emerge when successfully commercialising an academic innovation. These are business risk (Teixeira, 2011), reputational risk (Brannback et al., 2008), financial risk (Shore & Mclauchlan, 2012) and institutional risk (O'Shea et al., 2007). Also, the literature confirmed the interconnectedness of these risks (Algieri et al., 2013). Thus,

for a successful spin-off to occur, it is hypothesised that the academic would need to approach risk in a manner that is unconventional compared to what is experienced by research-only academics, but that this approach to risk would have a positive outcome on successful academic spin-off creation.

Also, from Figure 2.7.1, it is proposed that university support and bureaucracy, using robust governance mechanisms, would allow for the stable and effective advantages for the academic (Hoang & Antoncic, 2003a). The mechanisms are found through the regulation and protection by the university of intellectual property, which in turn would offer the academic a support mechanism to develop the innovation (DiGregorio & Shane, 2003). Extant research shows that intellectual property protection for academic innovation has been enacted by both governments and universities, with differing levels of success (Foray, 2002; Lester, 2005; Mowery & Sampat, 2005). Thus, bureaucratic policies are expected to offer support to successful spin-offs. Further, the academic's motivation through university policies that can engage both fundamental theoretical discovery and application will motivate academics to adopt a commercialisable focus for their research (Siegel et al., 2003). These enhanced systems of knowledge production and development support would provide enhanced spin-off success. Thus, it is hypothesised that supportive university engagement will have a positive impact on spin-off success.

Finally, in accordance with cognitive theory, the aspirations of South African academics are linked to academic entrepreneurship. It is hypothesised that prestige of the university will offer insight to the demands of the university from the academic while simultaneously offering insight into the role of the university in national economic development (Pusser & Marginson, 2013). The degree of prestige of the institution will influence the ability of the academic to attract capital (Lockett and Wright, 2005), ability to patent successfully (Zucker et al., 2002) as well as linking to long term spin-off firm success (Shane, 2004).

Thus, it is hypothesised that at top rated universities, there is a positive outcome on the success of academic led spin-offs.

Therefore, this study expects to contribute to knowledge by understanding the role that the social networks play in the success of an academic led spin-off in South Africa. The specific hypotheses, as shown in Figure 2.7.1, are summarised in Table 2.7.2:

Table 2.8.1: Summary of research questions and hypotheses

Research question	Research hypotheses
To what extent do South African Academic Entrepreneurs use research mobilisation to commercialise their innovation through the development of spin-off ventures within the South African university context	Hypothesis 1: At South African universities, research mobilisation by the academic will have a positive outcome on the development of academic led spin-offs, such that this effect gets stronger as the factors supporting research mobilisation work together to support the academic entrepreneur.
To what extent do South African Academic Entrepreneurs collaborate to commercialise their innovation through the development of spin-off ventures within the South African university context	Hypothesis 2.1: At South African universities, personal collaboration with the academic, will have a positive outcome on the development of academic led spin-off's, such that this effect gets stronger as relationships between the parties becomes more involved in engaging in entrepreneurial endeavours. Hypothesis 2.2: At South African universities, external collaboration with the academic, will have a positive outcome on the development of academic led spin-off's, such that this effect gets stronger as relationships between the parties becomes more involved in engaging in entrepreneurial endeavours. .
To what extent does the existence of risk and unfavourable outcomes influence South African Academic Entrepreneurs in the commercialisation of their innovation through the development of spin-off ventures within the South African university context.	Hypothesis 3: At South African universities, unconventionality found in academic entrepreneurial risk practices has a positive outcome on performance of academic led spin-offs, such that this effect gets stronger with higher levels of risk-taking.
To what extent does engagement with business and government support South African Academic Entrepreneurs in the commercialisation of their innovation through the development of spin-off ventures within the South African university context.	Hypothesis 4.1 Bureaucratic policies that focus on the commercialisation of innovation by the academic entrepreneur have a positive outcome on the development of academic led spin-offs, such that this effect gets stronger with higher degrees of supportive involvement by the policy makers. Hypothesis 4.2 Supportive university engagement that focus on the commercialisation of innovation by the academic entrepreneur has a positive outcome on the development of academic led spin-offs, such that this effect gets stronger with higher degrees of involvement by the university.

To what extent do South African Academic Entrepreneurs aspiration affect their development of spin-off ventures within the South African university context.	Hypothesis 5: Aspirations of academic entrepreneurs to research at top rated universities has a positive outcome on the development of academic led spin-offs, such that the effect gets stronger as academics entrepreneurs research at top rated universities.

2.9 Conclusion

The literature review chapter has provided a background to the research problem that motivates this study. It has provided a foundation for understanding the characteristics of the social networks imbedded within a successful spin-off, the available theories as well as the extant models and frameworks. It describes their limitations as well as importance in guiding this inquiry into successful academic spin-offs. It is shown in the review that there is a lack of robust theoretical frameworks that can be used to explain successful spin-offs.

The established literature supports the notion that there is a predetermined order in the innovation process whereby academia creates innovation, which is then mobilised through the university to the entrepreneurs, who are able, with the assistance of a stable regulatory and economic environment, to commercialise it. However, in South Africa, there appears to be little evidence that the process is congruent with either of the suggested theories on academic spin-off creation. This may be due to the existing theories' inability to analyse the dynamic interrelationship between the innovation, the different South African social contexts and the academic entrepreneurs. Thus, while South African academic entrepreneurs are the creators of their social networks, they are simultaneously influenced by those same networks.

As entrepreneurial activity forms from a connection between the social and economic domains (Jack & Anderson, 2002), social networks are expected to interact to influence the individual's decision-making and behaviour. As a result, this literature review has

developed an understanding of spin-off creation by drawing from both the social environment and the individual's decisions within that context. Sarason et al. (2006) agree with this approach and argue that entrepreneurial research should consider how meaning is created and communicated through the interpretation of the existing sets of relationships. Thus, this literature review has meta-analysed the network relationships, network structure and network governance, which have all been identified by the scholarly community as being important to entrepreneurial success.

Further, this study's position and analysis have been motivated by the advancement in understanding by academics that entrepreneurship is also a social undertaking that should be understood within the context of social systems (Cai, 2013; Sarason et al., 2006). The literature review confirms that a spin-off is a unique type of business, which is founded in a unique environment that is more academic than business orientated and may engage with social networks in a way that is uniquely influenced by their individual experiences and historical context.

Finally, the literature review shows that in South Africa, dichotomous outcomes in the success of academic spin-off creation from different public research universities have been observed (Kruss & Visser, 2017), which suggests that the individual knowledge producing institutions access different social networks differently or not at all. The literature review indicates that where deficiencies in networks exist, the prospect of success is reduced.

Thus, the literature review has provided a compelling argument in favour of research that considers the impact of social networks on individual academic entrepreneurs as they seek to create a spin-off company. From the extant literature, there are only a few studies that consider social networks within academic spin-offs and none offer an integrative theoretical framework that models the effect of social networks on spin-off success in

developing countries. Therefore, it is the objective of this study to close this gap in the knowledge.

Furthermore, the study has been able to provide insight into extant research methodologies and philosophies that have shaped the research design, research strategy, data collection and analysis.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

The purpose of this chapter is to describe the philosophical foundations of the research, as well as to provide the basis for the strategy of inquiry and the reason for the approach to the research. Research design describes the strategy of how this research attempts to solve the research problem (Leedy & Ormrod, 2010). Creswell (2003) suggests that research should support the philosophical foundation, which will explore what constitutes knowledge claims as well as the philosophical foundations of the enquiry. Once this has been stated, this chapter will outline the general procedures of the research and the methods of data collection and analysis. Finally, this chapter includes a discussion of the steps taken to ensure validity and reliability of the research and safeguard its ethical standards.

3.1 Philosophical Foundations of Entrepreneurial Research

The research philosophy contains important assumptions about how the research views the world and how knowledge will be interpreted and understood by the researcher (Saunders, Lewis, & Thornhill, 2009). There is an ongoing debate in the social sciences regarding research methods for entrepreneurship studies (Aldrich, 2017; Lindgren & Packendorff, 2009; Steyaert, 1997). These debates are linked to the researcher's assumptions about ontology and epistemology (Morgan & Smircich, 1980). Epistemology is described by Morgan & Smircich (1980) as the 'philosophy of knowledge' or how we

come to understand the current reality, while ontology is the philosophy of that reality. Bryman & Bell (2015) suggest that epistemology of the research informs what is considered knowledge that is acceptable in a discipline, while ontology considers the degree of objectiveness that can be applied to social entities or if the observed reality is being subjectively created by individuals.

However, methodological advancements suggest that research should not be driven by method alone, as it is too rigid and we may end up forcing our data into the methodological obligations rather than letting it speak for itself (Cunliffe, 2011). Thus, once researchers have developed the research question, they must decide what methods and methodologies they will employ in the research, what theoretical perspective supports the methodology and what epistemology informs this theoretical perspective (Crotty, 1998).

3.2 Research Paradigm

The philosophical belief that guides this research follows a positivist orientation, indicating that this thesis is quantitative in nature. A positivist approach is used by quantitative researchers that intend to focus on explanatory associations and causal relationships which is expected through its use of large samples, to allow for generalizable inferences and the replication of outcomes (Park, Konge, Artino 2020). Positivism supports the use of hypothesis to deduce functional relationships between dependent and independent variables. Thus, the same authors conclude that the principal outcome of a positivist research should be to generate explanatory associations and/or causal relationships which will assist in answering the research problem. Positivism's ontological stance is that there is a unique individual tangible reality that exists. It further argues that this reality can be understood, explained and predicted (Creswell 2003). Positive epistemology supports the idea the knowledge is certain, real and accurate. In order to achieve this positivists support dualism in research, through the believe that participants and researchers can be separated. Positivist research has become the dominant paradigm

in quantitative research, business and economics (Park, et.al 2020; Ali, Arif, Galani, Ali, Rehman. 2022). Therefore, this approach is suitable for this study in particular.

The literature review performed an analysis of the underlying elements of a social network that are important for the development of a new firm. The review evaluated these elements as being understood through relationships, governance and structure and identified that they could be operationalised for this spin-off study through the entrepreneurial orientation of the researcher; trust and commitment; resource availability; the environment and availability of infrastructure; university networks; incubation and support and traditional culture-social groups. Given these factors, the study determined which engage to facilitate the spin-off process in South Africa. Through the use of numerical data analysed using the quantitative technique described in the chapter, the factors under review were evaluated to answer the hypotheses that have been derived from the literature in Chapter 2. The quantitative research approach will allow the research to gain an objective in-depth understanding of effect of the social networks in the creation of spin-off firms by academic entrepreneurs, while allowing for the findings to derive a conclusion that can be generalised to all South African public universities.

3.3 Research Population and Sampling

The research population is comprised on the individual academic entrepreneurs in South Africa. These academic entrepreneurs was found at publicly funded academic higher learning institutions. individuals were be sourced from all provinces within South Africa.

The focus of this research was to engage with academic entrepreneurs in South Arica. In particular, academics at publicly funded universities who had engaged in business activity motived by academic enquiry. The business could be registered as a company or sole trader, the activity could have been in manufacturing or service industry and it could be at any point in the value chain. This formed the target population of the study.

In South Africa, academics with spin-off business experience are very limited. The academic institutions that were identified as the source of the individual academics chosen for the study, were sourced via internet research. These institutions were chosen because they employ individuals that meet the criteria of fulfilling both an academic research role and an entrepreneurial business role. This process would allow the selection of participants with a clear academic entrepreneurial bias to feature without introducing bias through a larger, less focused population. Each publicly funded university in South Africa required their own ethics clearance certificate in order to engage an academic in their employ.

3.3.1 *Research Population*

The research population was defined as the individual academic entrepreneurs who are currently responsible or have been responsible for the creation of a spin-off company that has been developed using knowledge created through academia at a South African public university. The academic entrepreneur was only be considered as part of the population if the innovation was developed in South Africa at a South African public university and then developed and incorporated by an academic entrepreneurial led spin-off firm in South Africa. The rationale for this selection is guided by the literature review and will help the examination of the main research problem.

It was expected that as academic research will form the foundation of the innovation, the academic entrepreneur will have completed a PhD and/or published research articles in academic journals. According to the South African Department of Higher Education's website, www.dhet.gov, there are 26 registered public universities in South Africa from which the population will exist.

The population of academic entrepreneurs was identified by initially engaging with individual universities. When collecting data from academics, the academic's institution

acts as a gate keeper prior to contact. Once ethical clearance was obtained from the individual universities identified, contact of the academic entrepreneurs that were identified by the universities technology transfer offices, was made.

Guided by the literature review, which highlights the participants as being associated with academic entrepreneurial activity through the engagement with technology transfer offices at South African universities and the extant theoretical models that govern spin-off development, it was proposed that data collected must be sourced from an academic entrepreneur, must have gone through an opportunity analysis phase of business development and have a product or service that is available to their market.

Thus, the population exhibits different combinations of factor influences allowing for a holistic generalisable perspective to develop. These 'factor influences' are guided by the literature review and are of interest when investigating the process of spin-off creation in South Africa.

3.3.2 *Sampling Method*

Yin (2014) suggests that respondents must contribute to the theoretical development and enhance the generalisability of the study. By selecting the sample based on individual involvement in spin-off creation, the study will gain a richer understanding of how the social network affects the creation of academic spin-off firms are initiated (Geiger, 2009). Since there was no known sampling framework for South African academic spin-offs, the study contacted the registrar at each of the 25 South African public universities and requested permission to engage with their academic entrepreneurs. South African public universities were not prepared to offer a list of their academic entrepreneurs but required me to submit a formal request to the registrar and complete their internal ethics clearance committee requirements. Once each university was satisfied with the questionnaire and

process of this study, they granted ethics clearance and then distributed the questionnaire to their list of academic entrepreneurs.

Total population sampling in quantitative research is a purposive sampling technique that involves engaging with the entire population that have a defined set of characteristics (Rai & Thapa, 2015), since the population of academic entrepreneurs within business and academia is very small. In the context of this study the academic entrepreneur was academic research whose research has either been submitted to the technology transfer office for commercialisation or begun one or more academic led spin-off companies.

This sampling technique was necessary because if a small group of academic entrepreneurs were not included, the sample could exclude an important characteristic or engage too few participants to draw robust conclusions. However, the researcher did apply judgement to ensure that the respondents came from historically different university backgrounds, that they were all academics employed at South African public universities and had been involved in the development of successful spin-off firms.

Sampling can be split between probability and non-probability sampling. Probability sampling allows for the nature of the population to be defined and all members have an equal chance of being selected (Marshall, 1996), while non-probability sampling allows the researcher to select the members used in the sample, thus ensuring that no randomisation takes place. When a sample is selected using a non-probabilistic process, it is expected that there are underlying populations within the broader population that are the participants of study, thus inferences may be made about the sub-population (Schreuder, Gregoire, & Weyer, 2001). When selecting a sample, the sample elements need not be chosen at random as long as they are selected based on their population (Etikan, Musa & Alkassim, 2016).

This research used the non-probability purposive sampling process called total population sampling. The purpose is to select individuals that that are experienced, knowledgeable

and interested in the phenomenon (Etikan et al., 2016). The advantages of this is that it it allowed for control over the selection process to enable the inclusion of the different uniqueness's needed for this research (Sharma, 2017) within a very small total population. It is recognised that the risk inherent in non-probability sampling is selection bias. However, total probability sampling helped overcome this risk as the researcher was able to ensure that there are sufficient necessary characteristics present in the sample.

3.3.3 *The Sampling Frame and Size*

The sample frame is defined by Saunders et al. (2009) as a comprehensive list of all the occurrences in the population from which the sample was selected. The sampling frame designed for this research was intended to ensure a representative sample is selected. The sampling frame for this research was a South Africa academic spin-off company that has been created by an academic at a South Africa public research university.

The sample was drawn using total population sampling, from South African public research universities registered with the South African Department of Higher Education and Training. Currently, the department indicates that there are 25 public universities in South Africa (DHET, 2019) of which some were, during apartheid, termed 'technikons' that did not offer degrees.

In order to identify suitable individuals, this research used the TTO at each university to identify researchers that have either submitted innovation to the office or begun one or more spin-offs.

Permission from the Chancellor's office at each university was obtained before participants were contacted.

Ethical clearance from each university was obtained before participants were contacted.

To ensure that the sample covers academic institutions from across the country, suitable academic entrepreneurs were sought from as many diverse institutions as possible. Universities contacted include The University of the Free State, Potchefstroom University, the University of Pretoria, the University of Johannesburg and the University of Stellenbosch, University of Cape Town, university of Kwa-Zulu Natal, Rhodes University and the University of the Witwatersrand, the University of the North and Vista University.

The selection criteria was informed by the need to ensure that the institution uses public funding and is a registered public research facility (Bunting, 2006; DHET, 2019). Other benefits of this selection frame were that it reduced overall costs associated with sample selection, saved time, created an easy to understand and manageable study population.

This selection process allowed for the evaluation of the impact of social networks used in demographically diverse parts of South Africa.

The selection of universities was sourced from public research institutions approved by the South African Department of Higher Education as all universities that receive public funding for research need to be approved by the department (DHET, 2019; UCT, 2019). Once the researcher identified which academic entrepreneurs are suitable to the study, he proceeded to contact academics that have successfully created a spin-off company from innovation developed within the institution. It was initially thought that approximately 200 academic entrepreneurs would be needed. The literature on SEM suggested that an appropriate sample size is dependent on the power of analysis and there are no simple rules that can be applied. In order to determine the correct sample size explicit power calculations must be undertaken (Chin, 1998; Fan et al., 2016). Further, the literature suggests that sample size is extremely important when detecting misspecification in the proposed model, therefore, validation of the model requires a large sample size (Fan et al., 2016).

The unique institutional and environmental factors found within this sample are expected to be significant enough to provide a true understanding of how social networks engage to support or limit spin-off firms in South Africa.

3.4 Research Design

Yin, (2011) describes research designs as logical blueprints for the research. The design should result in a testable and valid theory that has been sourced through the observation of empirical reality (Eisenhardt, 1989). The design of this research is informed by the nature of the research problem in Chapter 1 and the hypotheses proposed in Chapter 2. The use of quantitative methodology is entrenched with certain epistemological assumptions that create an explanatory and universally accepted outcome for social behaviours by using statistics to measure reality (Yilmaz, 2013). As quantitative research focuses on the measurement and analysis of causal variables within a framework, it supports the view that social phenomena can be viewed objectively and the views of the researcher were be kept independent of the research (Yilmaz, 2013).

In addition, the design is based on the observation that the empirical research on this topic is based in the developed economies and does not accurately describe the effect of the social network engagement taking place in South Africa.

Approaches to entrepreneurship research design are diverse, leading to a multidisciplinary approach by scholars (Murphy, 2011). This research proposes that there is a need to achieve an objective, in-depth understanding of how the social network affects the academic entrepreneur in creating a spin-off company from academic innovation. Research highlights the importance of national (Balzat & Hanusch, 2004; Shinn, 2002) and social (Cooke, 2005) contexts when analysing spin-off creation in developing nations (Cai, 2013). It is further suggested that research in Africa is bringing

new perspectives to extant theory through its extension or modification for the African context.

3.4.1 *The Research Instrument*

Creswell (2013) suggests that data collection is a series of interrelated activities aimed at gathering good information to answer the research problem.

Quantitative methodology requires that the researchers use a standardised instrument that has been pre-constructed to capture the different perspectives and experiences of the sample (Yilmaz, 2013). A survey is one of the most widely used and respected methods in quantitative research as it enables large quantities of data to be collected over wide geographical areas (Creswell, 2003; Mcguirk & O'Neill, 2016). Further questionnaires provide insight into values, attitudes, interpretation and social trends. They enable the gathering of original data about people, attitudes, awareness of the environment and understanding of their experiences (Mcguirk & O'Neill, 2016).

The researcher must be aware of the limitations of the use of questionnaires, such as the restriction of the in-depth understanding about the factors used in the study and that respondents may not undertake sufficient cognitive thinking and judgement when faced with pre-determined responses (MacKenzie & Podsakoff, 2012). When the instrument itself causes variability or bias in the responses that will be analysed, this is an indicator that the study may be subject to common method bias. Common method bias contaminates the findings of the study (Podsakoff, Scott, Mackenzie, Lee 2003). This study tested for common method bias using Herman's single factor score in SAS statistical program. This test loaded all latent variables into one common factor. If the variance of this factor is less than 0.5 then the results are not affected by common method bias.

It must also be noted that when collecting data using questionnaires, there are ethical considerations, such as informed consent as well as ensuring privacy and confidentiality, that must be controlled for by the researcher (Mcguirk & O'Neill, 2016).

Extant research supports the assertion that a quantitative design offers the potential for a richer theoretical framework and allows for generalisability and causal explanations to develop (Yilmaz, 2013). Generalisability forms the base for the creation of exemplary knowledge that can be applied to a phenomenon (Thomas, 2011).

Survey methodology has been utilised in prior research that investigates the role of different factors in the development of new firms from academic innovation (Carlsson & Fridh, 2002; Motohashi, 2005; Rorwana & Tengeh, 2015).

This study used a self-administered and predetermined on-line questionnaire with closed ended questions. The advantage of using a self-administered on-line questionnaire was shown by Wright, Aquilino, & Supple (1998) and Gnambs & Kaspar, (2014) to allow for more open and honest data collection when collecting sensitive information. In addition, a questionnaire allowed for objectivity when analysing the data and improved the confidentiality of the respondent.

The questionnaire was divided in three sections; one representing control variables; one representing the four academic entrepreneurial orientation concepts shown in the systematic review of social networks and one representing the aspirations of academic entrepreneurs at South African universities. The use of a multiple questions per construct is supported when each variable is subjective, as is found in this research proposal.

Assuming that the concept under study is one-dimensional in nature, the Likert scale is the most widely used and fundamental tools within the social science research. It can be effectively applied when there is a need to transform subjective reality into objective data (Joshi, Kale, Chandel, & Pal, 2015). The Likert scale is used to measure responses from

positive to negative (Likert, 1932). A five-point Likert scale was used to measure the dependent variables. The scale consisted of strongly agree (1) to strongly disagree (5). The respondents selected their choices on Qualtrics and the data were exported to a statistical software program, SAS.

The instrument was presented in three sections. The first related to the moderators in the study, the second covered the varying academic entrepreneurial orientation characteristics identified in the literature review and the final section considered the aspirations of South African academic entrepreneurs, which was needed to answer the research problem.

Instruments discussed in the literature review (Abou-Warda, 2015; Altbach et al., 2009; Davey et al., 2015; Frese et al., 2002; Shane & Venkataraman, 2000) were used to identify the criteria relevant to the research questions and create the research instrument. These criteria have been detailed in Table 3.4.1 and used to establish the survey instrument (Appendix 3).

Table 3.4.1:References for the research instrument

Constructs	Number of items	Sources
A – Research Mobilisation	16	Abou-Warda, 2015; Altbach et al., 2009; Davey et al., 2015; Etzkowitz & Kemelgor, 1998; Frese et al., 2002; Gaglio & Katz, 2001; A. . Gibb & Hannon, 2010; J. Liu et al., 2013; Marquina & Ferreiro, 2015; Shree, 2007; Smith & Bagchi-Sen, 2012; Tang et al., 2012; Vang et al., 2007
B – Collaboration	16	Abou-Warda, 2015; Barnes et al., 2002; Bouty, 2000; De Clercq & Voronov, 2009; Grimpe & Hussinger, 2008; Laursen & Salter, 2006; Luu & Ngo, 2019; Mark Granovetter, 1983; Marsden & Campbell, 1984; Pérez & Sánchez, 2003; Rosenberg & Nelson, 1994; Sibanda, 2009; Tang et al., 2008; J. G. Thursby & Thursby, 2007; Vahlne & Johanson, 2009

C – Unconventionality in Risk	16	Abou-Warda, 2015; Altbach et al., 2009; Benner & Sandström, 2000; Brannback et al., 2008; Cyert & Goodman, 1997; Fulop & Couchman, 2006; Knockaert, Ucbasaran, Wright, & Clarysse, 2011; Krueger, 2007; Laukkanen, 2003; Lumpkin et al., 2009; Naldi et al., 2009; O`Shea et al., 2007; Siegel, Waldman, Atwater, & Link, 2004; Vohora et al., 2004
D – South African University Policies & Bureaucracy	15	Bloedon & Stokes, 1994; Carlsson & Fridh, 2002; Colyvas et al., 2002; Czarniawska & Genell, 2002; Davenport et al., 1998; DiGregorio & Shane, 2003; Foray, 2002; Jain et al., 2009; Lester, 2005; Markman et al., 2005; Mowery & Sampat, 2005; Nauwelaers & Wintjes, 2002; Owen-Smith, 2003; Rhoten, 2004; Rogers et al., 2000; Rorwana & Tengeh, 2015; Rosenberg & Nelson, 1994; Siegel et al., 2007; Sternberg, 2014; Todeva, 2013; Wolson, 2007; Wood, 2011
E – Aspirations	7	Adato et al., 2006; Boix & Posner, 2016; Bunting, 2006; Kruss & Visser, 2017; Mogues & Carter, 2005; Trojer et al., 2014
Total Items in the instrument	**70**	

Table 3.4.2: Literature support for the selection of each item in the instrument

Construct	Questions per Item	Item Description	Sources
A: Research Mobilisation	4	Connection to the global academic community	(Marquina & Ferreiro, 2015)
	5	Funding	(Gibb & Hannon, 2010; Shree, 2007)

Construct	Questions per Item	Item Description	Sources
	5	Environment	(Davey et al., 2015; Frese et al., 2002; Gaglio & Katz, 2001; J. Liu et al., 2013; Vang et al., 2007)
	2	Development of new ideas	(Tang et al., 2012)
B: Collaboration	5	Personal Collaboration	Barnes et al., 2002; Bouty, 2000; Mark Granovetter, 1983; Marsden & Campbell, 1984; Pérez & Sánchez, 2003; J. G. Thursby & Thursby, 2007
	11	External Collaboration	Abou-Warda, 2015; De Clercq & Voronov, 2009; Grimpe & Hussinger, 2008; Sibanda, 2009 Luu & Ngo, 2019; Rosenberg & Nelson, 1994; Tang et al., 2008; Vahlne & Johanson, 2009
C: Unconventionality	5	Reputational Risk	Abou-Warda, 2015; Cyert & Goodman, 1997; O`Shea et al., 2007
	5	Institutional Risk	Fulop & Couchman, 2006; Laukkanen, 2003; Naldi et al., 2009
	3	Financial Risk	Altbach et al., 2009; Benner & Sandström, 2000; Brannback et al., 2008; Bart Clarysse et al., 2007; Vohora et al., 2004
	3	Business Risk	Krueger, 2007; Lumpkin et al., 2009; Siegel, Waldman, Atwater, et al., 2003b
D: University Policies & bureaucracy	4	University Intellectual Property Policy	Colyvas et al., 2002; DiGregorio & Shane, 2003; Foray, 2002; Link et al., 2007; Nauwelaers & Wintjes, 2002; Owen-Smith, 2003

Construct	Questions per Item	Item Description	Sources
	3	Intellectual Property Licensing	Foray, 2002; Rogers et al., 2000; Wood, 2011
	4	University Support for Applied Research	Carlsson & Fridh, 2002; Colyvas et al., 2002; Czarniawska & Genell, 2002; Markman et al., 2005; Rorwana & Tengeh, 2015; Rosenberg & Nelson, 1994
	4	Incubation	Bloedon & Stokes, 1994; Davenport et al., 1998; Jain et al., 2009; Rhoten, 2004; Sternberg, 2014; Todeva, 2013; Wolson, 2007
E: Social Context of South African Universities	7	Drivers of social inclusion at South African Universities	Adato et al., 2006; Boix & Posner, 2016; Bunting, 2006; Kruss & Visser, 2017; Mogues & Carter, 2005; Trojer et al., 2014
Total	**70**		

The survey instrument consisted of 73 statements defined on the Likert scale from one (not important) to five (very important). The rating scale used an odd number as it was deemed important not to force a respondent into a position of taking a side with each question, but allow for a neutral response, if the respondent believed that this was the most appropriate outcome for the question (Malhotra, 2006). The questionnaire did not ask any sensitive questions (such as the identity of the participant) and randomly distributed questions within each category. The 73 statements are divided into constructs, namely: Aspirations, Bureaucracy, Business Risk taking, Financial Risk taking, Institutional risk taking, Reputational Risk taking, Personal Collaboration, External Collaboration, Research Mobilisation and University Support. The full list of questions can be found in Appendix 3.

3.5 Unit of Analysis

Individual academic entrepreneurs that are currently engaged in a spin-off company from innovation developed within the university.

3.6 Study Area

The area of study: South Africa.

3.7 Procedure for Data Collection

The data collected assisted in testing the proposed conceptual model, which is the relationship between the social network and the creation of a spin-off by an academic entrepreneur. The factors that have been identified in the literature that affect the creation of a social network were used to design a survey questionnaire.

First, consent of the respondents and the registrar of each university to participate in the survey was sought via email, phone call and formal ethical clearance request, prior any distribution of the questionnaire taking place. Once consent was received, the researcher distributed the questionnaire and an informed consent letter to the respondent's requesting permission for the data to be collected. The questionnaire was distributed via e-mail and the data collected through the use of an online web-based survey tool. After quantitative data collection was completed, the responses were exported to SAS, a statistical analysis program for analysis.

A self-administered survey has the advantage of being accessible to participants to complete at a time and place convenient to them and offers a rapid collection of the data

for the analysis. Further, they offer the participants the benefit of remaining anonymous and make it easy and cost effective for the researcher to reach all parts of South Africa. Unfortunately, self-administered surveys have a potentially low response rate

3.8 Data Analysis

This research used the Cronbach's alpha to test for reliability and confirm the internal consistency of the research instrument. Following this, a test for descriptives was done. This consisted of an analysis of the mean, median, mode (etc), which was used to describe the data.

The primary statistical procedure that was undertaken in this research was structural equation modelling (SEM). SEM is a multivariate statistical technique that has extended the reach of regression analysis (Morrison, Morrison, & McCutcheon, 2017). It is described by Weston & Gore, (2006) as hybrid of path and factor analysis that allows for the interrelationship between variables to be tested as well as allowing for hypothesised relationships among constructs to be tested. The reason that structural equation modelling is suitable to this research is that the researcher are looking for a model that fits the data and that can be easily interpreted into practice.

3.8.1 *Validity and Reliability of the Research Design*

The aim of research is to find truth and in, as far as possible, to limit error. Rigour in research considers the lengths taken by the researcher to enhance the quality of the research (Heale & Twycross, 2015). In order to limit potential errors, the research must follow a rigorous evaluation method when analysing the evidence (Roberts & Priest, 2006). Validity and reliability are the practices used when demonstrating to the user of the research, the rigour that has been undertaken during the research process in order to reduce the potential for the research to be misconstrued.

As the data was collected by a multi-scale questionnaire, it is important to test for both validity and reliability of the constructs, scale and instrument to ensure rigour in the research.

a. *Reliability Testing*

Reliability will ensure that the questionnaire used to collect the data will produce similar results if new data was collected under the same conditions; thus, giving confidence that the finding was not a once-off anomaly but can be repeated (Roberts & Priest, 2006). Heale & Twycross (2015) argue that reliability in research ensures that the findings can be trusted and that the results of a study could be replicated by different researchers. The authors suggest that the research must test for internal consistency. Internal consistency is the extent to which the items on the scale measure each construct. Thus, responses by respondents to each question need to be correlated to those of other responses in the questionnaire. In order to test for internal consistency, this research used the most commonly accepted test, the Cronbach's alpha (Heale & Twycross, 2015). This test considers the extent that items testing the constructs have low levels of uniqueness but high commonalities across either all the questions or a sub-group of questions. This test indicated reliability by resulting in a number of 0.7 or greater, which indicates that approximately 70% is true and 30% is error.

Reliability of this research was established in three ways. First, through the methodological coherence of the research created through the integration of the research question, data collection and the analytic procedures (Morse, Barrett, Mayan, Olson, & Spiers, 2008; Rowley, 2002). Secondly, using an appropriate sample, which allowed for the collection of quality data with limited redundancy (Morse et al., 2008). Finally, for a theory to emerge, the researcher allowed for the ideas emerging from the data to be confirmed through the statistical analysis and allowing for the outcome to emerge from a

documented research process, thereby building a solid foundation for theory development through model testing (Morse et al., 2008).

b. ***Validity Testing***

Reliability is a necessary but insufficient condition for validity (Creswell, 2013). Validity indicates that the measuring instrument accurately deals with what it purports to measure and that the researchers approach is consistent (Leedy & Ormrod, 2010). Validity will ensure the credibility, meaningfulness and accuracy of the research. It assures the users of the research that the researcher used the correct tool to measure the phenomena. Creswell (2013) suggests that it is the “validation” or “accuracy” of the process being used in the research and it is described by Yin (2011) as a study where data have been properly collected and interpreted in order to ensure that the conclusions accurately reflect and represent the real world.

Validity is applied to both the method of the investigation and the design.

If validity is present, then the findings of the research are representative of the phenomenon being studied. There are different types of validity. These are external, internal and construct validity.

i. ***Construct Validity:*** is the extent to which the measure is measuring what it is intended to (Modell, 2009). Construct validity can be tested for by using convergent validity. Convergent validity is the extent that the theoretical relationship between the two variables can be confirmed. This can be tested for by doing a factor analysis. Divergent validity is the extent to which constructs that are theoretically not related to each other illustrate no correlation in the research. The purpose of divergent validity is to ensure that each construct is unique and does not represent another construct

in the research and can be tested for by measuring the correlation between different constructs. The correlation should be no more than 0.3.

ii. ***Internal Validity:*** relates to how the design is structured. It confirms the soundness of the measurement tool and the accuracy of the test itself (Creswell, 2013). Internal validity ensures that there is a causal relationship, where certain conditions lead to other conditions and are distinguished from false relationships (Creswell, 2013). To ensure internal validity, this research distributed the identical questionnaire to all participants and participants answered questions that have been used to investigate similar constructs in previous studies.

iii. ***External Validity:*** allows for generalisations about the population group of the study being made (Rowley, 2002). For external validity to be present in the study, it is not a matter of successfully replicating and/or extending an existing theoretical model, it ensures that causal explanations are credible (Modell, 2009). The study collected data across provinces with varying levels of economic development. This diversity will allow the study to obtain results that can be generalised across South African academic spin-off companies.

3.9 Structural Equation Modelling

As will be described in Chapter 4, the factor structure tests will require structural equation modelling of formative factors, as suggested by Figure 3.10.1. Secondly, structural models assessing the paths between main latent constructs, again as seen in Figure 3.10.2, are assessed. The SEM models are performed using maximum likelihood estimation in SAS PROC CALIS.

3.9.1 *Defining the Variables in Structural Equation Modelling*

SEM allows for two types of variables to be measured. Manifest variables are measured directly, while latent variables, that due to their abstract nature are not measured directly (Morrison et al., 2017). Network Relationships, Network Structure and Network Governance are latent variables used in the research as they are inferred from the manifest variables (Klyver et al., 2008; Martins, 2016; Ramachandran & Ramnarayan, 1993). The manifest variables are research mobilisation, collaboration, unconventionality in risk, university policy and bureaucracy and aspirations.

3.9.2 *Rationale for Structural Equation Modelling*

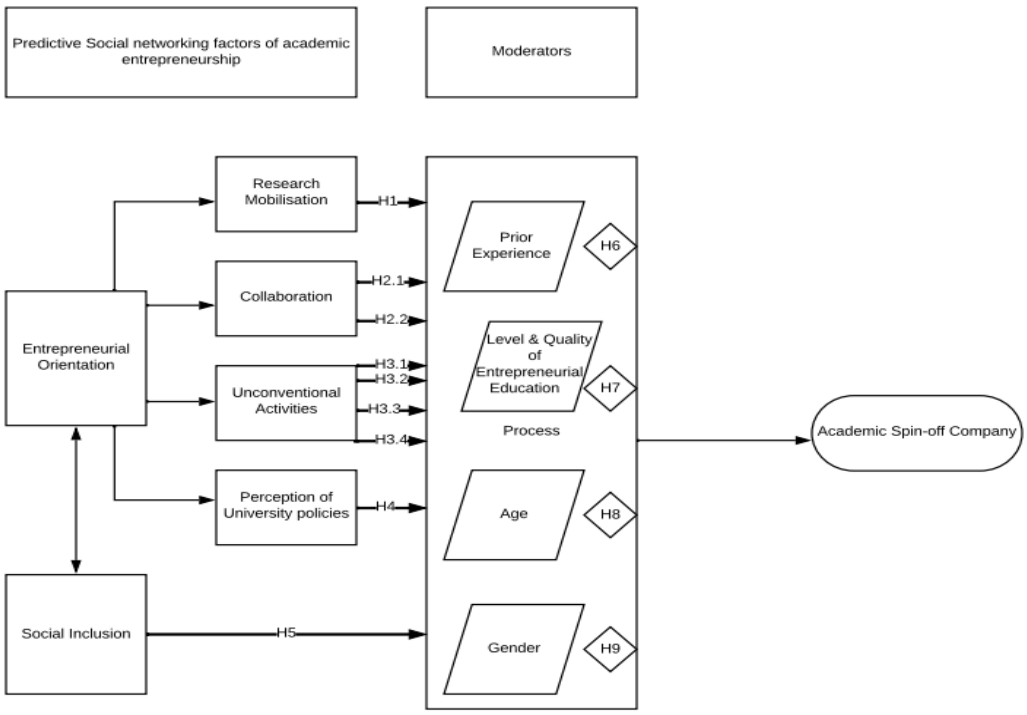
SEM will allow for the data to be tested to confirm whether the model is supported. In addition, it allows for the entire model to be evaluated, which differs from other more standardised statistical analysis such as ANOVA (Morrison et al., 2017; Weston & Gore, 2006). If it is discovered that some or all the constructs are inconsistent with the model, then the model will be modified or abandoned.

3.9.3 *The Measurement and Structural Model*

A structural equation model normally consists of a measurement model. The measurement model describes the relationship between the unobserved and observed variables by connecting the constructs to what they are measuring (Morrison et al., 2017). Thus, the measurement model allows the researcher to determine if, for example, the mobilisation of research and unconventionality in risk combine to identify Network Relationships. Confirmatory factor analysis will allow for determining the pattern of loading of hypothesised factors.

Figure 3.09.1 shows the hypothesised measurement model. The circles represent the latent variables, while the rectangles represent the measured variables.

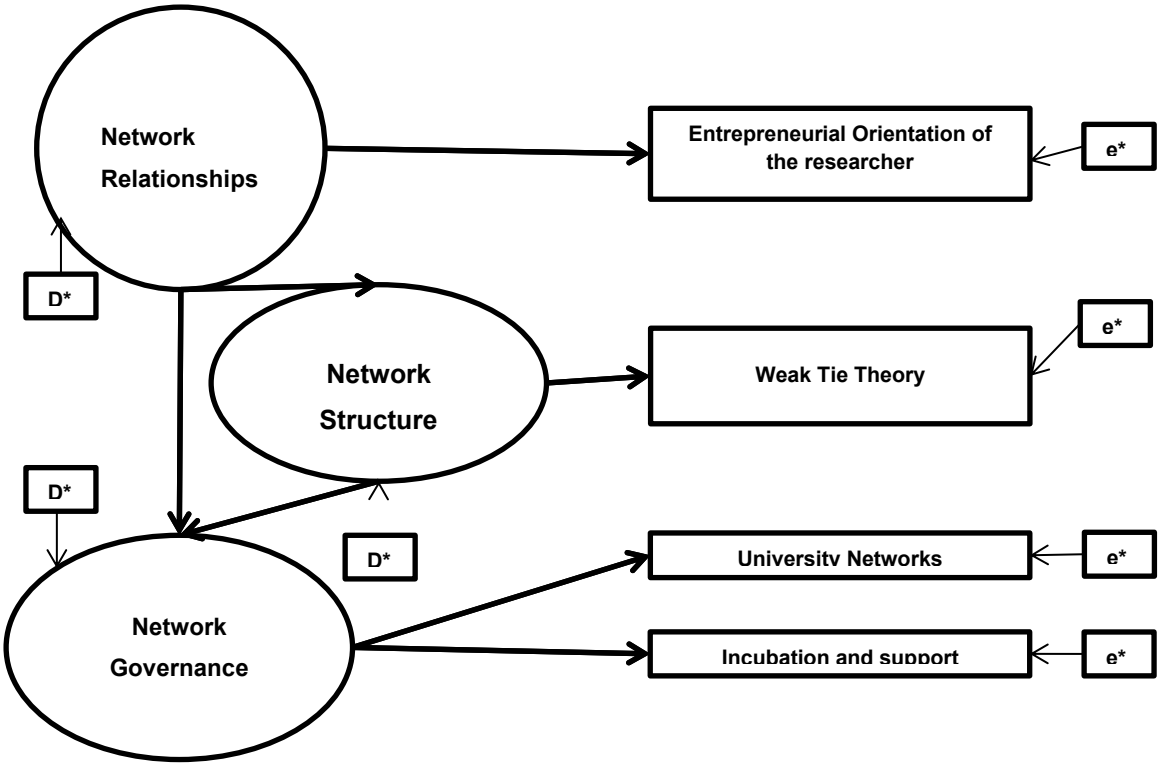
Figure 3.9.1: Hypothesised Confirmatory Factor Analysis (adapted from Morrison et. al., 2017)



Structural equation modelling consists of a structural model. The structural model will allow the researcher to discover the relationships between the latent variables (Morrison et al., 2017; Von der Embse, 2016). Thus, it will determine if there is a relationship between network governance, network structure and network relationships. When combining both models, a complete structural model will emerge (Weston & Gore, 2006) that explains the formation of the South African spin-off firm.

The model indicated in Figure 3.09.2 (adapted from Morrison et al., 2017), shows the observed measure that consists of a true score and an error. An error term is necessary as it is assumed that the dependent variables will have variance that cannot be explained by the latent variable. Thus, each latent variable will be represented by both the true score and an error variance. Each latent variable has a 'disturbance' or D*, which is the error term for the unexplained variance in this variable (Kline, 2011).

Figure 3.9.2: Hypothesised Observed Measure Analysis (adapted from Morrison et al., 2017)



3.9.4 *The Process used when Conducting the Structural Equation Model*

a. *Model Specification*

Specification of the SEM model will be done using all the relevant theory found in Chapter 2, to test the hypotheses that have been drawn from them.

3.9.5 *Model Estimation*

Model estimation allows for the value of the unknown parameter and errors to be determined, which will allow for an understanding of model fit (how well the model explains the data). The will be done using a structural equation modelling program, such as AMOS.

3.9.6 *Model Fit and Interpretation*

Once the model has been estimated, the model's fit to the data must be determined. The purpose of fit is to assess whether the relationships measured between the latent variables and the suggested model adequately reflect the observation observed in the data. Fit will be evaluated in terms of the variance found in the observed and latent variables, how well the model fits the observed data and the strength and significance of the estimated parameters (Weston & Gore, 2006).

The goodness of fit and chi-squared statistical tests will be used to determine the model fit. Should the model indicate an insignificant chi-square value, the researcher will be able to indicate that the implied theoretical model fits the data (Kline, 2011).

a. *SEM Goodness Of Fit Tests*

An integral part of SEM analyses is goodness of fit testing.

As with standard regression, the basic measure of association between variables is the covariance (although mean structures and other refinements are now commonly included) and the dynamics of actually fitting SEM models involve covariance structure modelling. The challenge in a SEM structure is therefore to fit the specified equations, from that calculate the best implied covariance matrix $\hat{\Sigma}(\Theta)$ between the observed variables and compare this for close fit to the sample covariance matrix **S** (Bollen, 1989). Model respecifications would seek to minimise differences between $\hat{\Sigma}(\Theta)$ and **S**.

The most basic test is a test for the rejection of bad fit based on the asymptotically chi-square distributed statistic nF_{ml} where n is sample size and F_{ml} refers to the maximum likelihood fit estimator (Bollen, 1989). However, this test in practise is often ignored since it is directly based on sample size, thus indicates significant deviations from good fit based on sample alone. This dichotomy has led to a large body of work on fit estimators of varied types, which has rapidly advanced covariance structure theory (Boomsma, 2000; McDonald & Ho, 2002). These fit tests include:

1. Global fit tests based on fit between the residual matrices, notably the:

    a) Root Mean Square Error of Approximation (RMSEA), for which scores <.05-.08 are often seen as good fit (Browne & Cudek, 1993; Raykov & Marcoulidis, 2000; Steiger, 1990). It is amenable to estimation of a 90% confidence interval, where researchers generally look for lower bounds < .05 and higher <.10.

    b) Standardised Root Mean Square Residual (SRMSR) (Kline, 2005: 141-142), the normalised square root of average squared differences between $\hat{\Sigma}(\Theta)$ and **S**, where <.05 is often seen as acceptable.

2. Global tests of the current model compared to a ‘null’ or ‘baseline’ model that is the worst possible fit (e.g. $\hat{\Sigma}(\Theta)$ = I). There are a large number of such tests. Several of these are robust for sample size, notably:

a) Bentler Comparative Fit Index (CFI) (Bentler, 1990), for which scores >.90-.95 indicate good fit;

b) Tucker Lewis Index (TLI) / Non-Normed Fit Index (NNFI) (Bentler & Bonnett, 1980), again >.90-.95 is good.

Table 3.10.1 summarises these global fit statistics.

Table 3.9.1: My suggested spread of SEM global fit statistics

Global Fit Statistic	**Conventional although not determinative cut-offs**		
	Good fit	**OK fit**	**Possibly poor**
Chi-square statistic	Non-significant chi-square (e.g. p > .05)	Significant chi-square if sample reasonably large	Significant chi-square if sample small
Standardised Root Mean Square Residual (SRMR)	SRMSR < .05	SRMSR < .08	SRMSR > .10
RMSEA Estimate	RMSEA < .05, especially if upper end of CI < .08	RMSEA < .08, especially if upper end of CI < .10	RMSEA > .10, especially if lower end of CI > .08
CFI (Bentler's Comparative Fit Index)	CFI > .95	CFI > .90	CFI < .90
NNFI/TLI (Non-normed fit index)	NNFI > .95	NNFI > .90	NNFI < .90
Distribution of residuals	Normal distribution	Roughly normal	Highly non-normal

3. Local fit statistics indicating portions of the model, which may contribute particularly to poor or good fit (see Table 3.10.1):

   a) Raw residuals, which indicate fit between specific variable covariances. These are often standardised to aid in interpretation, so that residuals larger than 2-3 may indicate misspecification;

   b) Lagrange multipliers for the significance of the improvement in Chi-Square if a parameter is added (see Kaplan, 2000);

   c) Wald tests for the significance of worsened Chi-square when a parameter is restricted to zero (see Kaplan, 2000).

Table 3.9.2: Suggested spread of SEM local fit statistics

Local Fit Statistic	**Change required?**	
	Probably not needed	***May* suggest a change**
Largest normalised residuals	Largest normalised residuals < ±2, or at least reasonably few > 3, none far from 3	Look at specific residuals > ± 2-3.
R^2 statistics for endogenous variables	Relatively high R^2 (relative to variables / area of study)	R^2 relatively close to 0
Standardised paths	Standardised path moderate to large & significant	Standardised path small / non-significant: path insubstantial. May consider removing path / variable (especially in CFA)

Lagrange multipliers (LM statistics) – modification index	Non-significant LM statistics (not a big chi-square improvement if new path added).	Significant LM p-value suggests substantial improvement to chi-square if new path added.
Wald statistics – modification index	Significant Wald statistic, big deterioration in chi-square if path deleted.	Non-significant Wald statistic (small deterioration in chi-square if effect is deleted).

4. Model comparisons (also called predictive fit indices). These include (see Kline, 2005: 142-153 for an overview):

   a) A test for comparison of nested models, most commonly involving a test of the difference in chi-squares.

   b) Information criteria also exist, including the Akaike Information Criterion (AIC), Schwartz Bayesian Criterion (SBC) and Bozdogen Consistent AIC (CAIC). These penalise more complex models and can be used to compare non-nested models. Smaller scores are superior.

Researchers generally report a range of these fit indices, allowing for wide evidence on fit. The rapid development of these indices has added the advantage of broad interpretability to model fitting and comparison.

Paths in the structural equation models are treated as regression paths and come in standardised beta format (β), which can be read as correlations.

3.9.7 *Multiple Regression Analyses*

Multiple regression is generally well known. The majority of the analyses used SAS PROC REG. There are. However. two particular testing issues or statistics that are worth discussion. The first regards the form of the hierarchical regression used, which was hierarchical set regression (Cohen *et al.*, 2003). Finally, when assessed, particular terms were added to assess the moderation hypotheses involved.

Hierarchical multiple regression is generally well known and will not be discussed in great detail. The majority of the analyses used SAS PROC REG. There are, however, two particular testing issues or statistics that are worth discussion. The first regards the form of the hierarchical regression used, which was hierarchical set regression (Cohen *et al.*, 2003). Finally, when assessed, particular terms were added to assess the moderation hypotheses involved.

At each stage in the hierarchical regression, the change in fit was assessed for significance via adjusted R^2 (higher being better) and information criteria (AIC, BIC and SBC) for which lower scores indicate better models.

Tests of moderation roles, as hypothesised for in H6 – H9, typically involve testing product terms in the relationships (Cohen *et al.*, 2003; Baron & Kenny, 1986; James & Brett, 1984). This is, therefore, the approach taken, in which products of the proposed moderator and the predictor(s) are tested for size and significance, as well as incremental fit value (addition of the interaction term is taken as a worthy addition to fit if the adjusted R^2 improves and information criteria decrease in size compared to the model without the moderator). Moderation requires centred predictors in most cases.

The model is, therefore (where α is the intercept and Bs are slopes) :

$$Dependent\ variable = \alpha + B_1 Predictor + B_2 Moderator + B_3 Predictor \times Moderator$$

Chapter 4 discusses the measures and analyses these for factor structure.

3.10 Ethical Considerations

The reliability and validity of research depends on the ethical judgements of the researcher. Ethics assists the researcher to define morality in their behaviour and is critical to the success of any research project (Saunders et al., 2009). Jones (2000) quotes the Ethical Guidelines for Statistical Practice of the American Statistical Associate in which it is suggested that a quantitative researcher should present their findings objectively and honestly, they should avoid misleading or untrue statements and document data sources used in an inquiry.

The process of sampling a phenomenon is complex and can be easily underestimated. If the sample chosen is too large, then there will be additional respondents included in the sample that are not needed. The consequence of that is that time will be wasted and additional costs incurred. If the sample is too small, the results will have very little practical use and would imply a waste of time, good-will and resources (Jones, 2000).

Respondents will receive fair and professional treatment; guarantees of anonymity and full disclosure of the purpose of the study and background on the researcher. The researcher will obtain informed consent from the participants to participate freely in the study. Further, an undertaking of full confidentiality of any information received will be given to the respondents. The proposed letter of ‘informed consent’ can be found in Appendix 1 and will be signed by every respondent to ensure explicit agreement. Further, the researcher will not emotionally harm or negatively affect the respondent’s self-esteem or put under threat any of their interests.

All participants in this study will be ensured their right to privacy. This research will in no way allow for any individual to be identified in the study. The researcher undertakes to

maintain honesty when interpreting the data and will not misrepresent or mislead the findings of this research to the users. Finally, the researcher undertakes never to fabricate data to support a conclusion.

Ethical clearance was requested from the University of the Witwatersrand Ethics Committee prior to any contact being made with potential respondents or surveys distributed. In addition, ethical clearance was requested from each university's Ethics Committee prior to any contact being made with potential respondents or surveys distributed.

CHAPTER 4: SYSTEMATIC PRESENTATION OF THE RESULTS

4.1 Introduction

In accordance with Chapter 3, this chapter seeks to highlight the analysed results of the survey. The chapter begins by identifying the final sample used. It then progresses by providing the correlation and descriptive statistics, then examining the hierarchical regression models of the antecedent variables on spin-off success. Finally, a main structural equation path model is used to test the primary effects of all the main constructs, including the control variables. Moderation effects are tested in the final section of the chapter.

4.2 Sample Characteristics

The first six months of the study were characterised by low academic participation. As a result, response collection times were collected over the last six months of 2020 and the first four months of 2021, rather than the expected six months of 2020. The initial period of data collection was the result of the COVID-19 pandemic that became the main focus of the latter part 2020. The pandemic lead to a change in how academics executed their teaching responsibilities and thus reduced the amount of time available for them to assist in the research.

The aim of the study was to collect a minimum participation of 200 respondents to enable proper analysis. Given that academic entrepreneurs are a relatively small subset of academics in South Africa, this was an ambitious goal.

4.3 Description of Measures

The following measures are used in this research. All measures utilise a five-point Likert scale ranging from Strongly Disagree to Strongly Agree, unless indicated below. The full list of questions can be found in Appendix 3.

Spin-off success. Three questions were used to measure spin-off success. A sample item is 'My spin-off firm has produced more than five new lines of products and/or services in the past five years or since its establishment'.

Table 4.3.1: Constructs for spin-off success

Constructs	Number of items	Sources
Spin-off success	3	

Research mobilisation. Sixteen questions measured research mobilisation. Sample questions include 'Compared to other similar departments at South African universities, were effective at identifying new commercialisable opportunities from academic research' and 'I typically create new commercialisable ideas by combining existing research with my own innovative spin'.

Table 4.3.2: Constructs for research mobilisation

Construct	Number of items	Sources
Research mobilisation	16	Abou-Warda, 2015; Altbach et al., 2009; Davey et al., 2015; Etzkowitz & Kemelgor, 1998; Frese et al., 2002; Gaglio & Katz, 2001; A. . Gibb & Hannon, 2010; J. Liu et al., 2013; Marquina & Ferreiro, 2015; Shree, 2007; Smith & Bagchi-Sen, 2012; Tang et al., 2012; Vang et al., 2007

Financial risk taking. Three financial risk questions are used. A reversed sample item is ‘Some activities involve 'financial risk'. Starting a spin-off business means there is a chance of losing money. In general, my propensity for accepting 'financial risk' is low.

Business risk taking. This variable is assessed through three items. A reversed sample item is ‘My spin-off firm is very seldom the initial business in the industry to introduce new products/services, techniques and operating technologies’.

Institutional risk taking. Five questions assess institutional risk taking. A sample item is ‘The focus of the university conflicts with my innovative ideas’.

Reputational risk taking. The survey utilises five questions to measure reputational risk. A sample item is ‘When facing a decision that carries some risk, I/we tend to adopt a 'wait and see' approach to avoid risking my/our university’s reputation’.

Table 4.3.3: Constructs for unconventionality

Constructs	Number of items	Sources
Unconventionality	16	Abou-Warda, 2015; Altbach et al., 2009; Benner & Sandström, 2000; Brannback et al., 2008; Cyert & Goodman, 1997; Fulop & Couchman, 2006; Knockaert, Ucbasaran, Wright, & Clarysse, 2011; Krueger, 2007; Laukkanen, 2003; Lumpkin et al., 2009; Naldi et al., 2009; O`Shea et al., 2007; Siegel, Waldman, Atwater, & Link, 2004; Vohora et al., 2004

Government collaboration. This construct uses five questions. A sample item is ‘Creative ideas hardly ever come to me alone. I rely on government to identify potential opportunities.'

Organisational collaboration. Four questions are used to assess organisational collaboration. A sample item is ‘Creative ideas hardly ever come to me alone. I rely on industry to identify potential opportunities.'

Personal collaboration. Six questions are used to measure personal collaboration. A sample item is ‘My partner/s and I have a great relationship, both when deciding on matters related to the spin-off and during our time out of the office’.

Table 4.3.4: Constructs for collaboration

Constructs	Number of questions	Sources
Collaboration	15	Abou-Warda, 2015; Barnes et al., 2002; Bouty, 2000; De Clercq & Voronov, 2009; Grimpe & Hussinger, 2008; Laursen & Salter, 2006; Luu & Ngo, 2019; Mark Granovetter, 1983; Marsden & Campbell, 1984; Pérez & Sánchez, 2003; Rosenberg & Nelson, 1994; Sibanda, 2009; Tang et al., 2008; J. G. Thursby & Thursby, 2007; Vahlne & Johanson, 2009

University support. Seven items define university support. A reverse sample item is ‘My university has no policies and processes in place to support the commercialisation of innovation’.

Bureaucracy is assessed using four items. A sample item is ‘It is not possible for me to bypass standard university operating procedures in the development of the spin-off’.

Table 4.3.5: Constructs for university policies & bureaucracy

Constructs	Number of items	Sources
University policies & bureaucracy	15	Bloedon & Stokes, 1994; Carlsson & Fridh, 2002; Colyvas et al., 2002; Czarniawska & Genell, 2002; Davenport et al., 1998; DiGregorio & Shane, 2003; Foray, 2002; Jain et al., 2009; Lester, 2005; Markman et al., 2005; Mowery & Sampat, 2005; Nauwelaers & Wintjes, 2002; Owen-Smith, 2003; Rhoten, 2004; Rogers et al., 2000; Rorwana & Tengeh, 2015; Rosenberg & Nelson, 1994; Siegel et al., 2007; Sternberg, 2014; Todeva, 2013; Wolson, 2007; Wood, 2011

Aspirations. This variable measures four eclectic items regarding the perceived aspirations of the researcher's institution, including the extent to which the university seeks to lead in academic research, commercialisation of research, national rankings and global versus local influence. Two sample items are 'How would you rank the importance of academic research output at my university' and 'How would you rank the importance of developing innovative and commercialisable ideas that can be used by business and society'.

Table 4.3.6: Constructs for aspirations

Constructs	Number of items	Sources
Aspirations	7	

These items are measured on different scales as seen in Appendix 3.

The initial part of the instrument presented the 11 measures that were related to the classification of the respondent's Academic Entrepreneurial Orientation. The second part

of the instrument presented one measure focused on the aspirations of the academic entrepreneur.

4.4 Tests and Treatment of Missing Data and Scale Structure

4.4.1 *Missing Data Analysis*

The data collected by the researcher does contain some missing data, which is substantial enough to require analysis and treatment, since conventional modelling will discard every row with any missing data.

A multiple imputation approach was adopted, in terms of which 35 datasets were constructed using the two-stage method. Since the missing data were largely monotone, a fully monotone dataset is first constructed using SAS PROC MI's Monte-Carlo Multiple Chain method. Then, a monotone regression method is used to complete all 35 datasets.

Each subsequent analysis is completed on all 35 datasets and results combined using the standard MI methodology described, for instance, by Little and Rubin (2002) and Schafer (1997), through SAS MIANALYZE.

4.4.2 *Scale Structure*

As seen above, all of the major constructs in this thesis are multi-item scales with the exception of demographics.

However, unlike the usual reflective treatment of constructs in a traditional factor analysis way, many of the constructs are deemed to be formative. As noted by Jarvis, MacKenzie & Podsakoff (2003) and Treiblmaier, Bentler & Mair (2011), among others, formative constructs can contain different items that act together to define a construct but are not necessarily equally reflective of the construct, therefore, may not be required to correlate highly. The following constructs are deemed formative:

- *Spin-off success*: The major outcome variable is composed of three questions, as seen in Appendix 3. One asks the number of spin-offs created, another the number of new product lines or services created in a period, the third seeks to understand the success of third-party licencing agreements. Although each of these might suggest success in spinning off research, none need occur for the others to be relevant. This is, therefore, a classic formative latent variable.

- *Collaboration variables*: All three collaboration variables are deemed formative, as, once again, they utilise concepts that may not infer mutual requirement. For example, the government collaboration construct utilises such diverse concepts as government funding, idea stimulation, structures and so on – these are all relevant but not completely interdependent. Similar comments can be made for the organisational collaboration variables. Likewise, personal collaboration invokes concepts such as personal relationships within research teams, relationships of the researcher with relevant university staff and so on, which are not necessarily mutually reflective but are seen as combinatorial.

- *Business and institutional risk factors* were also deemed formative as can be seen from the mix of questions in Appendix 3.

Formative factors essentially involve latent constructs where the ‘causal’ arrows go from the items to the factor, as opposed to reflective factors, which involve the opposite. Formative factors cannot directly be assessed using conventional factor analysis techniques, therefore, the strategy for these variables is different as described below.

This structure, therefore, contains a mix of reflective and formative factors, which requires the following analyses of factor structure:

1. *Internal reliability analysis of reflective factors*: Each first-order reflective factor is assessed for internal reliability through conventional Cronbach alphas, reflecting the standard assumption that these construct items should be relatively highly correlated.

2. *Formative item technique*: The final items for formative factors are constructed using the Treiblmaier, Bentler & Mair (2011) two-step method, as described below.

3. *Final confirmatory factor analysis*: All final items are then subjected to a final confirmatory factor analysis.

The following sections discuss these steps.

i. Internal Reliability of Reflective Factors

In the first step, I assess Cronbach alphas of each reflective factor as a measure of internal reliability of the sub-items. Table 4.4.1 shows the final results of this analysis.

Table 4.4.1: Internal reliability of first-order factors

Factor	Alpha
Research mobilisation	.80
Bureaucracy	.85
University support	.80
Aspirations	.68
Financial risk	.74

As seen in Table 4.4.1, using the commonly held cut off of 0.65 for an acceptable alpha (e.g. Lee, 2015), all factors have acceptable internal reliability.

The next section discusses the factor analysis of first-order factors into second-order factors.

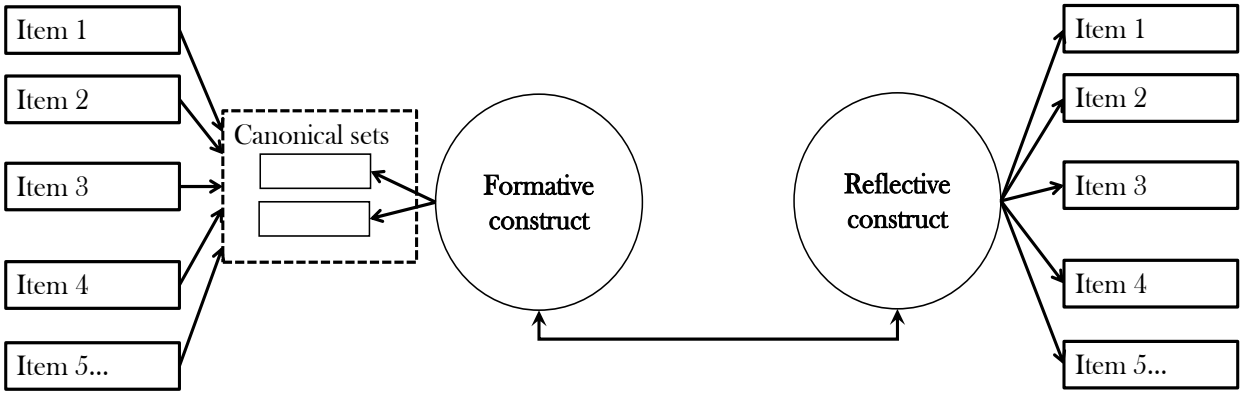
ii. Analysis of Formative Factors

Formative factor fit is assessed here in a structural equation framework. The solution suggested by Treiblmaier, Bentler & Mair (2011) is deployed in terms of which an initial methodology is used to form items into formative sets (they suggest several methods including canonical correlations, principal components and others) and a secondary confirmatory factor analysis portion loads these sets as reflective. See Ping (2010) for a similar suggestion limited to principal components only. This research uses DSAS PROC CANCORR to establish acceptable canonical correlations for each formative subset (all analyses show significant canonical sets). The canonical constructs are then used as reflective inputs into the overall confirmatory factor analysis, as suggested by Treiblmaier et al. (2011).

iii. Final Confirmatory Factor Analysis

As noted above, the reflective and formative canonical sets are finally assessed together in a confirmatory factor analysis, since researcher-allocated survey items are pre-chosen for each construct. As noted previously and displayed in Figure 4.4.1, the CFA uses the canonical sets of the formative items as first-order construct indicators and the items of the reflective constructs directly as first-order indicators.

Figure 4.4.1: Simultaneous treatment of formative and reflective constructs in the CFA



CFA solutions are run in SAS PROC CALIS for each of the 35 multiple imputation datasets, using the two-step robust estimation procedure and combined thereafter using PROC MIANALYZE.

An initial analysis of the CFA suggests strongly that governmental and organisational collaboration should be combined into a single factor, which I rename 'external collaboration'. This itself becomes an interesting finding that is discussed in the final chapter.

The final CFA with the combined external collaboration variable fits well, with Chi-Square/DF = 1.66, SRMR =.063, RMSEA =.07 (90% CI = .057-.086), CFI = .91 and NNFI just below .90 (see the next section for SEM fit guidelines). Therefore, this factor structure is adopted for the final structural equation models.

Having tested and resolved the structure of the main constructs, chapter 5 discusses the main results from testing of the hypotheses.

4.5 Data Capturing and Analysis

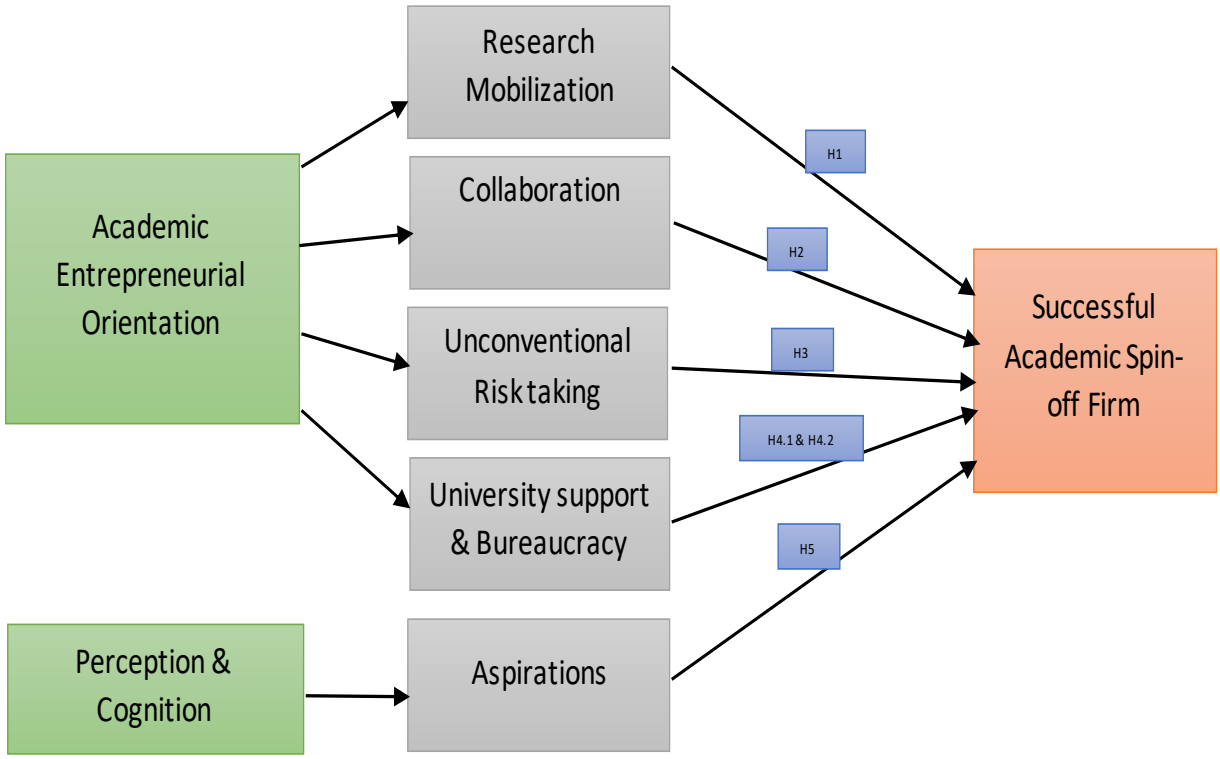
Data were recorded in Qualtrics and transferred to SAS for analysis.

Statistical analysis techniques that stem primarily from the regression/correlational theory are suitable due to the interval nature of the variables and the complex nature of the model. These include correlations, regression with moderation testing (Baron & Kenny, 1986), multiple regression and structural equation modelling. The data analysis was completed in SAS OnDemand for Academics (ODA). The researcher would like to draw your attention to the following procedural matters and method records.

4.5.1 *Structural Equation Modelling Analyses: Method Notes*

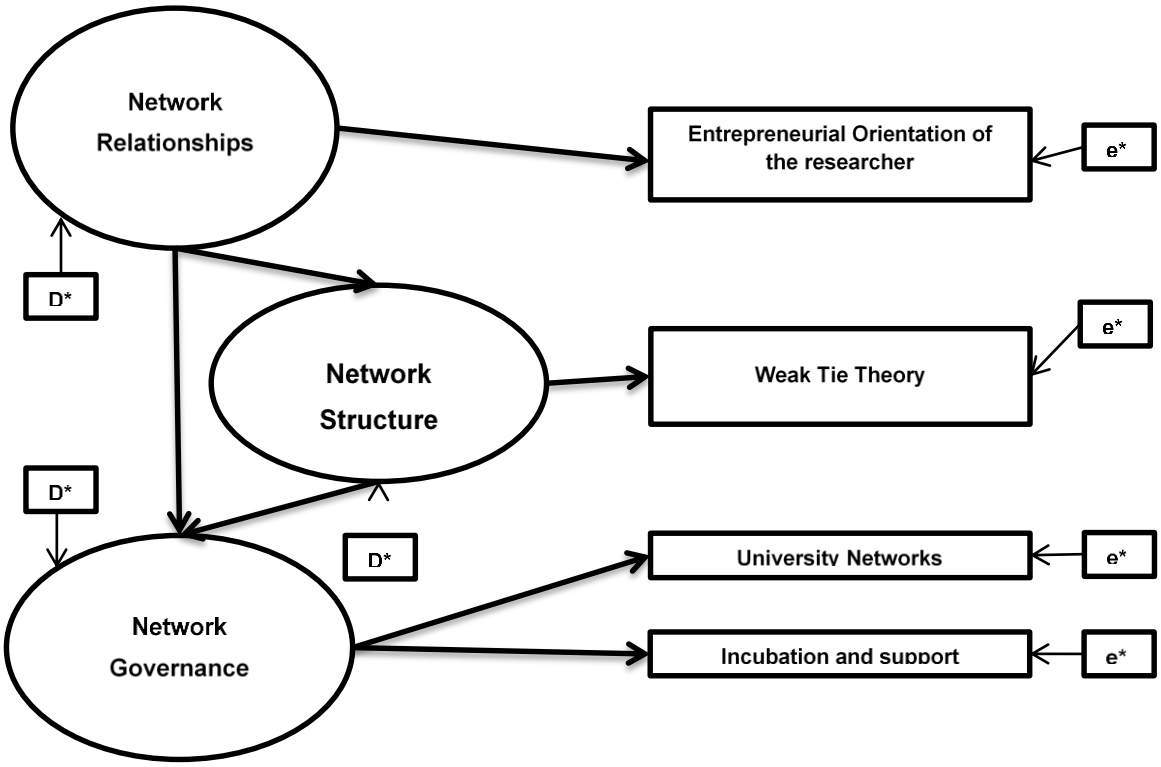
The factor structure tests will require structural equation modelling of formative factors, as suggested by Figure 4.5.1

Figure 4.5.1: Assessing the formative factors between the main latent constructs



Secondly, structural models assessing the paths between main latent constructs, again as seen in Figure 4.5.2 are assessed.

Figure 4.5.2: Structural models assessing the paths between main latent constructs



The SEM models are performed using maximum likelihood estimation in SAS PROC CALIS.

4.5.2 *SEM Goodness Of Fit Tests*

A fundamental part of SEM analyses is to ensure goodness of fit testing is completed.

While mean structures are sometimes included, it is still widely held that the dominant measure of association between variables is the covariance (Lee, 2015). The dynamics

of fitting SEM models involves the use of covariance structure modelling. When performing a SEM analysis, the primary aim is to fit the specified equations. Once the researcher has developed the equations, the researcher can calculate the best implied covariance matrix $\hat{\Sigma}(\Theta)$ between the observed variables and then run a comparison to compare this matrix for a close fit to the sample covariance matrix **S** (Bollen, 1989). Respecifications of the structural model allows for the differences between $\hat{\Sigma}(\Theta)$ and **S** to be minimised.

I suggest that a simple test for the rejection of bad fit based on the asymptotically chi-square distributed statistic nFml, where n is sample size and Fml would highlight the maximum likelihood fit estimator (Bollen, 1989), should be ignored as it is based on sample size. As a result, the outcome of the test will indicate significant deviations from good fit based on sample alone. This dichotomy has led to a large body of work on different fit estimators, which has allowed for a revolution of advanced covariance structure theory (Boomsma, 2000; McDonald & Ho, 2002). These fit tests include:

i. **Global fit tests that are based on the fit between the residual matrices**

a.) *Root Mean Square Error of Approximation (RMSEA)*, any result of <.05-.08 is considered as a good fit (Browne & Cudek, 1993; Raykov & Marcoulidis, 2000; Steiger, 1990). REMSEA is robust to a 90% confidence interval. Researchers argue that it is most effective in the lower bounds < .05 and higher <.10.

b.) Standardised Root Mean Square Residual SRMSR (Kline, 2005: 141-142), is considered a as a good fit when the normalised square root of average squared differences between $\hat{\Sigma}(\Theta)$ and **S**, is <.05.

ii. **Global tests of the current model compared to a 'null' or 'baseline' model that is the worst possible fit (e.g. $\hat{\Sigma}(\Theta) = I$)**

Research suggests that there are a significant number of these tests available to researchers. However this research considered those that are most effective when considering sample size:

a) Bentler Comparative Fit Index (CFI): indicates that scores >.90-.95 are a good fit (Bentler, 1990);
b) Tucker Lewis Index (TLI) / Non-Normed Fit Index (NNFI); Bentler & Bonnett, 1980), where a good fit is indicated where >.90-.95 is observed.

Table 4.5.1 summarises these global fit statistics.

Table 4.5.1: SEM global fit statistics

Global Fit Statistic	Conventional accepted although not determinative cut-offs		
	Good fit	**OK fit**	**Possibly poor**
Chi-square statistic	Non-significant chi-square (e.g. p > .05)	Significant chi-square for significant sample size	Significant chi-square for a small sample size
Standardised Root Mean Square Residual (SRMR)	SRMSR < .05	SRMSR < .08	SRMSR > .10
RMSEA Estimate	RMSEA < .05, especially if upper end of CI < .08	RMSEA < .08, especially if upper end of CI < .10	RMSEA > .10, especially if lower end of CI > .08

CFI (Bentler's Comparative Fit Index)	CFI > .95	CFI > .90	CFI < .90
NNFI/TLI (Non-normed fit index)	NNFI > .95	NNFI > .90	NNFI < .90
Distribution of residuals	Normal distribution	Roughly normal	Highly non-normal

iii. **Local fit statistics highlighting areas of the model that may contribute to poor or good fit (see Table 4.5.2)**

a) Fit between specific variable covariances is highlighted by raw residuals. These standardised variables assist in interpretation and will indicate misspecification when residuals are greater than 2-3;
b) Lagrange multipliers focus on the addition of parameters and will consider the significance of the improvement in Chi-Square when a parameter is added (Kaplan, 2000);
c) Wald tests for the significance of worsened Chi-square when an individual parameter is restricted to zero (Kaplan, 2000).

Table 4.5.2: Suggested spread of SEM local fit statistics

Local Fit Statistic	**Change required?**	
	Probably not needed	***May* suggest a change**
Largest normalised residuals	Largest normalised residuals < ±2, or at least reasonably few > 3, none far from 3	Look at specific residuals > ± 2-3.
R^2 statistics for endogenous variables	Relatively high R^2	R^2 relatively close to 0

Standardised paths	Standardised path moderates to large & significant	Standardised path small / non-significant: path insubstantial. May consider removing path / variable (especially in CFA)
Lagrange multipliers (LM statistics) – modification index	Non-significant LM statistics (small chi-square improvement if a new path added).	Significant LM p-value suggests substantial improvement to chi-square if a new path added.
Wald statistics – modification index	Significant Wald statistic, large deterioration in chi-square if a path deleted.	Non-significant Wald statistic (small deterioration in chi-square if effect is removed).

iv. Model comparisons / predictive fit indices

a) Using the test for the comparison of nested models through the testing of differences in chi-squares;
b) Information Criteria: Bozdogan Consistent AIC (CAIC), Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC) allow for asymptotically consistent models while penalising more complex models in order to select the simplest of the true models and can be used to compare non-nested models. In the analysis smaller scores will superior.

By reporting a range of these fit indices, this research will allow for the wide evidence on the fit of the model to be shown and has added the advantage of allowing for comprehensive interpretability to model fitting and comparisons.

Paths in the structural equation models in this research have been studied as regression paths and are shown in standardised beta format (β), which can be interpreted as correlations.

4.5.3 *Multiple Regression Analyses: Method Notes*

Among the universe of statistical methods, multiple regression analysis is well respected. Regression analysis in this research uses SAS PROC REG.

The researcher wishes to draw your attention to two testing processes and/or outcomes that are worth highlighting. The first considers the use of hierarchical set regression. (Cohen *et al.*, 2003) and second, when analysed, certain terms were added to the model to assess the moderation hypotheses involved.

At each stage in the hierarchical regression, the change in fit was assessed for significance via adjusted R^2 (higher being better) and information criteria (AIC, BIC and SBC) for which lower scores indicate better models. When undertaking tests for the influence of moderation roles, as hypothesised for in GGG, product terms were tested in the relationships (Cohen *et al.*, 2003; Baron & Kenny, 1986; James & Brett, 1984). Thus, products of the proposed moderator and the predictor(s) are tested for incremental fit value as well as size and significance. Adding the interaction term to the model has been done when the adjusted R^2 improves and information criteria decreases in size compared to the model without the moderator. In most instances moderation required centred predictors.

The model is shown as:
$Dependent\ variable = \alpha + B_1 Predictor + B_2 Moderator + B_3 Predictor \times Moderator$
(where α is the intercept and Bs are slopes)

The following chapter discusses the measures and analyses these for factor structure.

CHAPTER 5: RESULTS

5.1 Initial Descriptive and Correlational Analysis

Table 5.1.1 provides ease of reference to the descriptive statistics for the major summated scales and demographic variables. The tables clearly indicate that spin-off success has several strong positive correlations, including with financial risk (r = .88, p < .01), bureaucracy (r = .71, p < .01) and external collaboration (r = .43, p < .01).

In the converse, spin-off success also has many substantive negative correlations with variables, including reputational risk (r = -.87, p < .01), personal collaboration (r = -.78, p < .01), institutional risk taking (r = -.69, p < .01), university support (r = -.63, p < .01), experience (r = -.54, p < .01) and research mobilisation.

In turn, research mobilisation has strong, positive associations with institutional risk taking (r = .78, p < .01) and university support (r = .58, p < .01).

Bivariate correlations are associational measures that are not balanced with the simultaneous model estimation of other antecedents. These are thus weak indicators of the real effects. In order to develop more balanced and simultaneous model estimations, I turned to structural equation modelling. Structural equation modelling suggests that many of the strong associations found in correlations will not be as prevalent and may even reverse in size, as they are controlled for by the rest of the model.

Table 5.1.1: Descriptive and correlation statistics

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	4.64	1.07	1.00													
2. Education	3.60	0.88	.36***	1.00												
3. Experience	2.72	1.41	.29***	.13	1.00											
4. Gender	0.63	0.49	-.15*	-.11	.03	1.00										
5. External collaboration	0.00	0.84	-.24***	-.18**	-.28***	-.03	1.00									
6. Personal collaboration	0.00	0.89	.21**	.35***	.36***	-.03	-.25***	1.00								
7. Research mobilisation	0.00	0.92	.05	.07	.25***	.09	-.48***	.43***	1.00							
8. Institutional risk	0.00	0.93	.10	.07	.33***	.07	-.32***	.55***	.78***	1.00						
9. Business risk	0.00	0.91	.10	.01	.41***	-.05	-.10	.40***	.33***	.56***	1.00					
10. Financial risk	0.00	0.92	-.18**	-.18**	-.50***	.02	.12	-.68***	-.27***	-.55***	-.71***	1.00				
11. Reputational risk	0.00	0.88	.27***	.28***	.49***	-.07	-.28***	.76***	.35***	.51***	.76***	-.89***	1.00			

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
12. Bureaucracy	0.00	0.96	-.13	-.11	-.33***	-.06	.15*	-.51***	-.13	-.33***	-.50***	.57***	-.61***	1.00		
13. University support	0.00	0.93	.20**	.26***	.31***	.02	-.26***	.83***	.58***	.64***	.31***	-.49***	.57***	-.28***	1.00	
14. Aspirations	2.20	0.79	-.10	-.25***	-.28***	-.05	.34***	-.36***	-.52***	-.47***	-.23***	.26***	-.32***	.05	-.50***	1.00
15. Spin-off success	0.00	0.95	-.25***	-.22**	-.54***	-.01	.43***	-.78***	-.41***	-.69***	-.70***	.88***	-.87***	.71***	-.63***	.36***

*Notes: *** = p < .01 ** = p < .05 *= p < .1, Cronbach alphas on diagonal in parentheses where appropriate. Gender is a dummy variable (female = 1).*

In addition to the structural equation modelling, the second major analysis done in this research approaches the primary variables through multiple regression analysis, thus enabling the researcher to assess each major variable set through hierarchical entry.

5.2 Initial Multiple Hierarchical Regression Analysis

This section employs hierarchical regression to assess the incremental value of variables on spin-off success. The models proceed as follows:

1. *Model 1*: Demographics are entered first.
2. *Model 2*: This model adds research mobilisation as a required individual step in approaching commercialisation.
3. *Model 3*: Next, characteristics of the organisation are added, namely university support, bureaucracy and aspirations.
4. *Model 4*: Model 4 adds external and personal collaboration.
5. *Model 5*: Finally, in model 5 I add the risk variables.

Table 5.2.1: Hierarchical regressions on activity

	Model 1			Model 2		Model 3		Model 4		Model 5	
Parameter	**B**	**β**	**bl**	**B**	**β**	**B**	**β**	**B**	**β**	**B**	**β**
Intercept	.02			-.01		-.05		-.03		.00	
Age	-.04	-.05		-.05	-.06	-.02	-.02	-.01	-.01	.00	.00
Education	-.15*	-.13		-.13	-.12	-.01	-.01	.07	.07	.01	.01
Experience	-.34***	-.51		-.29***	-.44	-.15***	-.22	-.12***	-.18	-.02***	-.03
Gender	-.03	-.02		.02	.01	.07	.04	.05	.02	.00	.00
Research mobilisation	.02	.00		-.30***	-.29	-.06	-.06	.04	.04	.26***	.25
University support						-.34***	-.34	-.07	-.07	-.10***	-.10
Bureaucracy						.53***	.53	.40***	.41	.23***	.23
Aspirations						.07	.07	.07	.08	.02*	.02
External collaboration								.24***	.21	.36***	.32

Personal collaboration				-.43***	-.41	-.20***	-.19
Institutional risk						-.25***	-.25
Business risk						-.16***	-.15
Financial risk						.47***	.46
Reputational risk						.15***	.14
F	14.51***	16.30***	49.80***	59.10***		841.11***	
R^2	.32	.40	.76	.83		.98	
Adjusted R^2	.30	.37	.75	.82		.97	
AIC	-54.39	-68.45	-184.99	-224.19		-584.36†	
BIC	-51.99	-65.87	-181.66	-220.16		-578.45†	
SBC	-40.09	-51.29	-159.26	-192.73		-541.46†	

*Notes for parameters: B = unstandardised parameters, β = standardised parameters, *** = p < .01, ** = p < .05, * = p < .10. Notes for information criteria: AIC = Akaike's, BIC = Bayesian, SBC = Schwarz Bayesian, PC = Prediction. † = model with best (lowest) score. Dummy variables are Gender (female = 1).*

As can be seen in Table 5.2.1, each model has, in fact, individually good fit. In addition, each subsequent variable set adds significantly to the model, increasing adjusted R^2 substantially and decreasing information criteria (AIC, BIC and SBC). This suggests potentially important roles for each variable set or type in the subsequent models, although the specific variables adding more or less to each set differ.

It is interesting to note from Model 1 through subsequent models that experience begins as a significant factor, but the addition of more individual and institutional variables steadily decreases experience to a trivial factor. However, moderation models may later expose a deeper role for this variable.

It is notable that the final model provides many highly significant effects, which are similar to the correlation results in many respects: financial risk has a substantive positive effect ($\beta = .46$, $p < .01$), as do external collaboration ($\beta = .32$, $p < .01$), research mobilisation ($\beta = .25$, $p < .01$) and bureaucracy ($\beta = .23$, $p < .01$). Institutional risk and personal collaboration are negative antecedents ($\beta = -.25$ and $-.19$ respectively, $p < .01$). However, the more complex SEM model discussed below may differentiate more in terms of which variables are ultimately potent predictors of spin-off success.

5.3 Main Structural Equation Models

As previously highlighted in Chapters 2 and 3, the main structural equation model to be tested is fundamentally a complex mediation model in which research mobilisation acts as a mediator between many of the antecedents and spin-off successes.

Figure 5.3.1 shows the final SEM model results:

Figure 5.3.1: SEM model with mediation

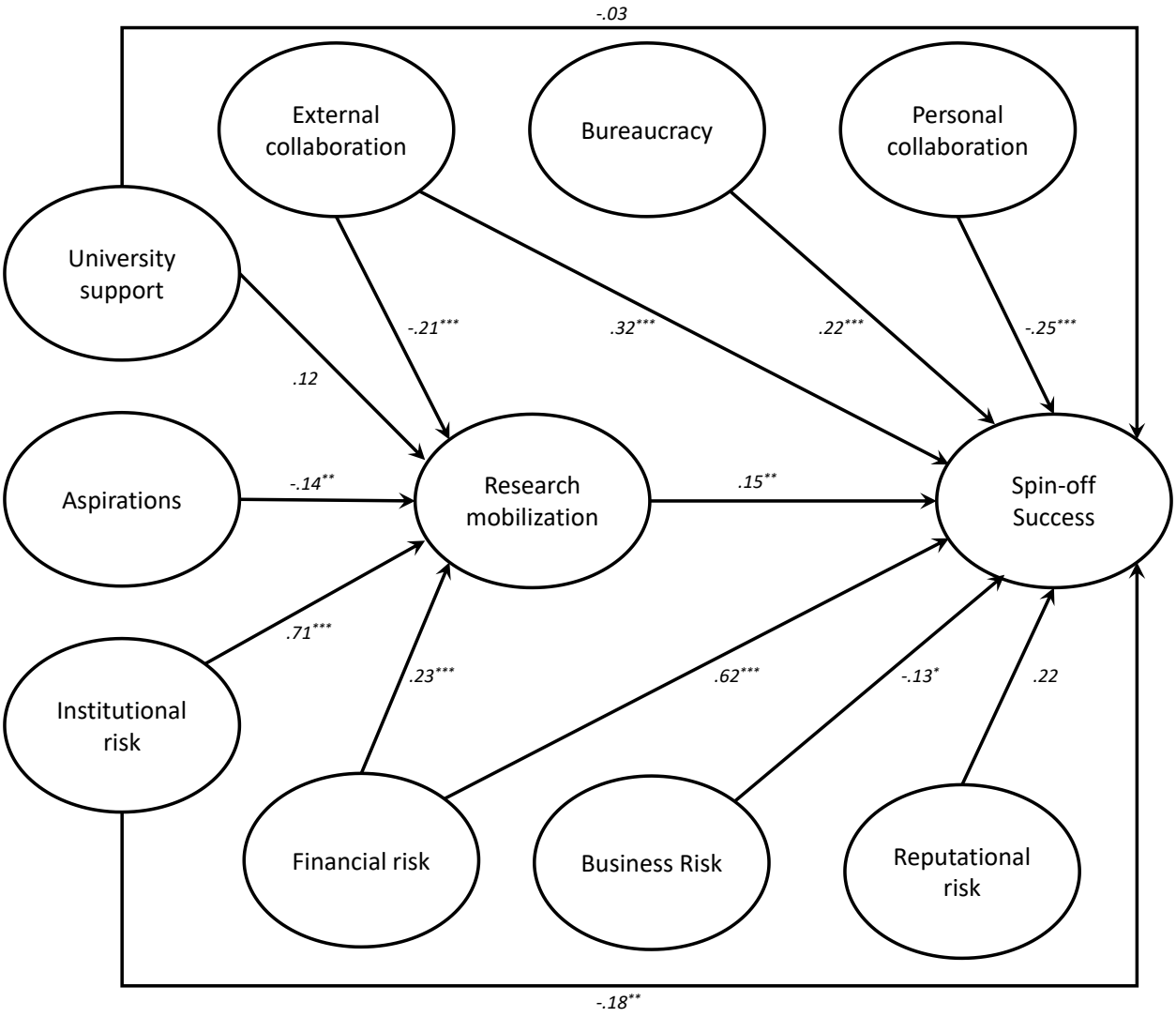


Figure 5.3.1 presents a complex picture of spin-off success. In terms of direct paths, unconventionality / risk factors are the strongest, with very large positive paths existing between institutional risk and research mobilisation ($\beta = .71$, $p < .01$) and between financial risk and spin-off success ($\beta = .62$, $p < .01$). These results suggest good support for the hypotheses that test bureaucracy, external collaboration, research mobilisation,

financial risk and reputational risk. All other paths are modest to moderate in size. Crucially, as it acts as a key mediator, research mobilisation has a modest positive relationship with spin-off success of β = .15, p < .05, therefore, mediation effects are relatively small. External collaboration has the next most powerful association with spin-off success (*β* = .32, p < .01). With regard to direct effects on spin-off success, there are several results that contradict hypotheses:

- Personal collaboration actually evidences a negative association with spin-off success (β = -.25, p < .01) , which is contradictory to H2;
- Bureaucracy has a modest positive association with spin-off success (β = .22, p < .01), which is supportive of H4.1;
- Institutional risk is negatively albeit modestly directly associated with spin-off success (*β* = -.18, p < .01), which contradicts H3.
- Business risk is slightly negatively associated with spin-off success (β = -.13, p < .10), which is contradictory to H3. However, this is a very weak result and can probably be discounted.

These contradictory results will be discussed further in the discussion chapter.

Finally, university support has effectively no direct effect on spin-off success and reputational risk taking is positively associated with spin-off success (β = -.03), although this is a non-significant result and, therefore, cannot really be assessed in any affirmative way.

With regard to effects on the mediating research mobilisation variable, aside from the strong positive influence of institutional risk discussed earlier, the results show a positive association with financial risk (β = .23, p < .01) and three contradictory results:

- A negative association with external collaboration (β = -.21, p < .01), contradicting H2;
- A negative albeit modest association with aspirations (β = -.14, p < .0s), possibly contradicting H5;
- No significant impact from perceived university support.

Again, these contradictory results will be discussed further in the discussion chapter.

It is noteworthy that Lagrange multipliers do not suggest the addition of other paths in this model. Although demographic variables were included, none were found to be significant correlates of major variables.

The direct, indirect and total effects decompositions for complex path variables are displayed in Table 5.3.1:

Table 5.3.1: Decomposition table for SEM effects

		Endogenous Variables	
'Causal' variables		**Research**	**Spin-off Success**
Research mobilisation	*Direct effect*	-	.15***
	Indirect effect	-	-
	Total effect	-	.15***
Financial risk	*Direct effect*	.23***	.62***
	Indirect effect	-	.03

		Endogenous Variables	
'Causal' variables		**Research**	**Spin-off Success**
	Total effect	.23***	.65***
Institutional Risk	*Direct effect*	.71***	-.18**
	Indirect effect	-	.11**
	Total effect	.71***	-.07*
Business Risk	*Direct effect*	-	-.13*
	Indirect effect	-	
	Total effect	-	-.13*
Reputational Risk	*Direct effect*	-	.22
	Indirect effect	-	-
	Total effect	-	.22
External collaboration	*Direct effect*	-.21***	.32***
	Indirect effect	-	-.03
	Total effect	-.21***	.29***
Personal collaboration	*Direct effect*	-	-.25***
	Indirect effect	-	-
	Total effect	-	-.25***
Bureaucracy	*Direct effect*	-	.22***
	Indirect effect	-	-

		Endogenous Variables	
'Causal' variables		**Research**	**Spin-off Success**
	Total effect	-	.22***
Aspirations	*Direct effect*	-.14**	-
	Indirect effect		-.02
	Total effect	-.14**	-.02
University support	*Direct effect*	.12	-
	Indirect effect	-	-
	Total effect	.12	-

Finally, moderation models for experience and education are examined.

5.4 Moderation Models

The final section examines moderation effects as is hypothesised in Hypotheses 6 to hypothesis 9.

Baron & Kenny (1986) suggest an approach to testing interaction that has become a cornerstone in this form of analysis. The authors suggest that all predictor variables be centred and an interaction term that is derived from the product of the independent variable and moderator be created and added to the other predictors.

The researcher tested the multiple interaction effects. In this report, only those with substantial moderation effects are highlighted and explored. By extension of this decision, Table 5.4.1 only summarises the fit of the moderation models tested.

Table 5.4.1: Moderation effects summary

Main effect	Moderator	Fit statistics		Interaction β	Decision
		Δ adj R^2	Information criteria[b]		
Building blocks → Activity	Firm size	.01	All lower for moderation model	-.08***	Some moderation
Building blocks → Activity	Age of firm	.01	Two lower for moderation model	-.02***	Weak moderation
Building blocks → Activity	Sector[a]	All .00	All higher for moderation model	-.01-.02ns	No moderation
Processing → Activity	Employee age	.01	All higher for moderation model	.00ns	No moderation
Processing → Activity	Gender	.01	All lower for moderation model	.05***	Some moderation
Processing → Activity	Career length	.01	Three lower for moderation model	.03**	Weak moderation

Processing → Activity	Tenure	.00	All higher for moderation model	.00^{ns}	No moderation
Processing → Activity	Education	.00	All higher for moderation model	.02^{ns}	No moderation
Alertness → Activity	Employee age	.00	All higher for moderation model	.02	No moderation
Alertness → Activity	Gender	.00	All higher for moderation model	.01	No moderation
Alertness → Activity	Career length	.01	All lower for moderation model	-.04***	Weak moderation
Alertness → Activity	Tenure	.00	All higher for moderation model	.00^{ns}	No moderation
Alertness → Activity	Education	.00	All higher for moderation model	.01^{ns}	No moderation

Notes: ^{ns} = not significant, *** = p < .01, ** = p < .05, * = p < .10. [a] Each sector is used as a dummy variable moderator separately, since the results are substantively identical all are reported in one line. [b] Information criteria used are the Akaike Information Criterion, Bozdogan CAIC, Schwarz Bayesian Criterion and Prediction Criterion, comparison is of moderation model to model without interaction effect.

5.4.1 *Moderations on the Mobilisation → Success Relationship*

The first moderation tested is that for hypothesis 6, which proposes that experience will moderate the relationship between mobilisation and success such that this relationship becomes stronger with more experience. The results can be seen in Table 5.4.2

Table 5.4.2: Moderation of the mobilisation → success relationship

	Firm size as moderator				**Firm age as moderator**			
	Baseline model		**Interaction model**		**Baseline model**		**Interaction model**	
	B	**β**	**B**	**β**	**B**	**β**	**B**	**β**
Intercept	-.08	.00	-.07	.00	-.04	.00	-.04	.00
Firm size	-.04***	-.05	-.04***	-.05	.08***	.05	.09***	.05
Firm age	.02*	.04	.03**	.04	.02*	.04	.02**	.04
Employee	.02	.02	.01	.01	.02	.02	.02	.02
Gender	-.06**	-.04	-.06**	-.04	-.06**	-.04	-.07***	-.04
Career length	-.05	-.03	-.03	-.02	-.05	-.03	-.06	-.03
Tenure	-.02	-.01	-.06**	-.04	-.02	-.01	-.02	-.01
Education	.04*	.03	.04	.02	.04*	.03	.04*	.03
Processing	.01	.01	.01	.01	.01	.01	.01	.01

Alertness	.8***	.90	.8***	.90	.8***	.90	.8***	.90
Blocks	.00	-.01	.01	.01	.00	-.01	.00	.00
Size								
Blocks x Size			.06***	.08			-.02*	-.03
R^2	.85		.86		.85		.85	
Adj R^2	.85		.85		.85		.85	
PC	.15		.15		.15		.15	
AIC	-1813.76		-1836.54		-1813.76		-1815.06	
SBC	-1762.45		-178.57		-1762.45		-1759.08	
BIC	-1811.45		-1834.17		-1811.45		-1812.68	

*Notes: *** = p < .01, ** = p < .05, * = p < .10. PC = Prediction Criterion, AIC = Akaike Information Criterion, CAIC = Bozdogan CAIC, SBC = Schwarz Bayesian Criterion. Dummy variables are Gender (female = 1), Education (postgraduate education = 1), Tenure (> 4 years = 1, shorter = 0), Career length (> 10 years = 1, shorter = 0), Firm size (More than 200 employees = 1, fewer= 0).*

Figure 5.4.1 graphically shows the moderation relationship for experience on the relationship between mobilisation and success. As can be seen, the positive association between mobilisation and spin-off success is stronger for more experienced researchers.

Figure 5.4.1: Moderation of experience on the mobilisation → success relationship

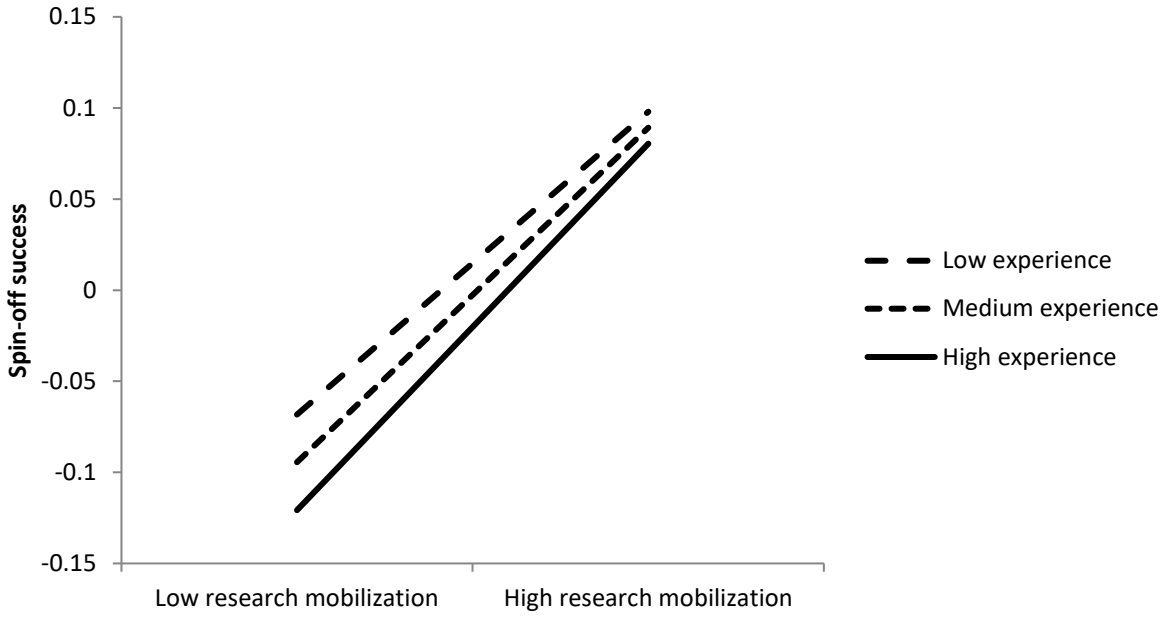
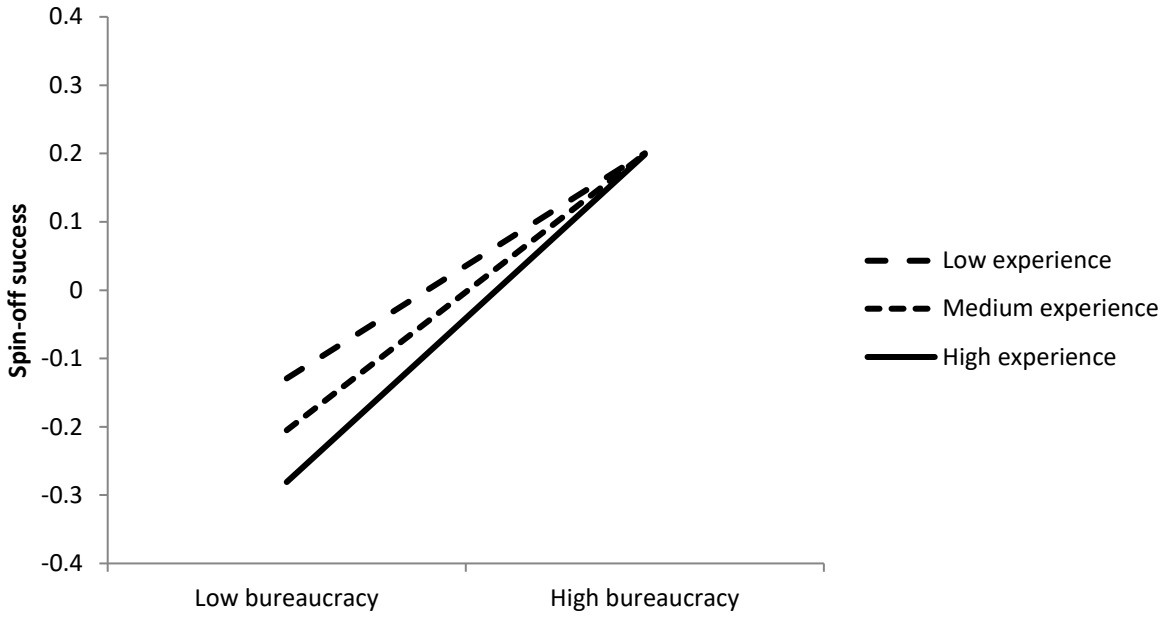


Figure 5.4.2 graphically shows the moderation relationship for experience on the bureaucracy → success relationship. As can be seen, the positive association between bureaucracy and success is slightly stronger for more experienced individuals.

Figure 5.4.2: Moderation of experience on the bureaucracy → success relationship



Next, moderation hypotheses for the association between risk and spin-off success are considered.

5.4.2 *Moderations of the Processing → Activity Relationship*

As seen in Table 5.4.2 (the landscaped comparison of moderations), several hypothesised moderations for the relationship between risk and success have at least some evidence, all based on education as a moderator. Table 5.4.3 shows the models for each of these moderations.

Table 5.4.3: Moderation effects on the association between processing and activity

	Baseline Model		Moderator			
			Gender		Career length	
	B	β	B	β	B	β
Intercept	-.16***	.00	-.14***	.00	-.16***	.00
Large	.08***	.05	.08***	.05	.08***	.05
OrgAge	.02*	.04	.01	.02	.02*	.04
EAge	.02	.02	.02	.02	.02	.02
Gender	.03**	.04	.03**	.04	-.06**	-.04
LongCareer	-.05	-.03	-.05	-.03	.03	.03
LongTenure	-.02	-.01	.00	.00	-.01	.00
Postgrad	.04*	.03	.04*	.02	.05**	.03
Blocks	.00	-.01	.00	.00	-.01	-.01

Alertness	.8***	.90	.79***	.89	.8***	.90
Processing	.01	.01	.01	.02	.02	.02
Processing x Gender			.05***	.06		
Processing x Career_Length					.03**	.03
R^2	.85		.86		.85	
Adj R^2	.85		.85		.85	
PC	.15		.15		.15	
AIC	-1813.76		-1830.33		-1816.98	
SBC	-1762.45		-1774.35		-1761.00	
BIC	-1811.45		-1827.95		-1814.60	

*Notes: *** = p < .01, ** = p < .05, * = p < .10. PC = Prediction Criterion, AIC = Akaike Information Criterion, CAIC = Bozdogan CAIC, SBC = Schwarz Bayesian Criterion. Dummy variables are Gender (female = 1), Education (postgraduate education = 1), Tenure (> 4 years = 1, shorter = 0), Career length (> 10 years = 1, shorter = 0), Firm size (More than 200 employees = 1, fewer= 0).*

Figure 5.4.3 shows the moderation effect of education on the relationship between financial risk and spin-off success. As can be seen, the main (negative) relationship is slightly stronger for less educated individuals, although, success is consistently higher for more educated individuals.

Figure 5.4.3: Moderation effects of education on the financial risk → success relationship

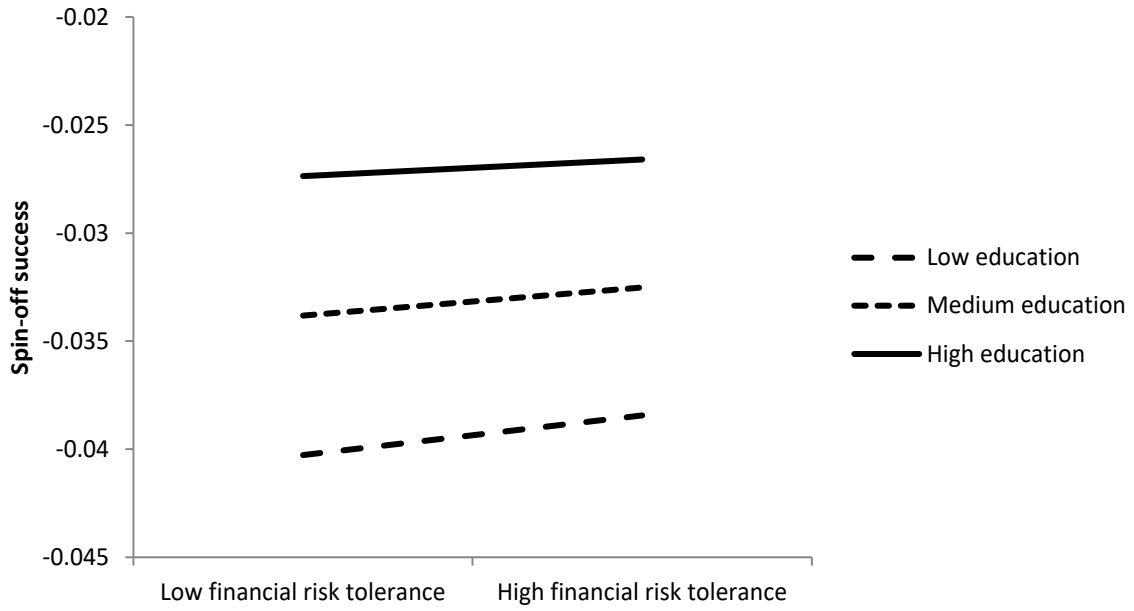
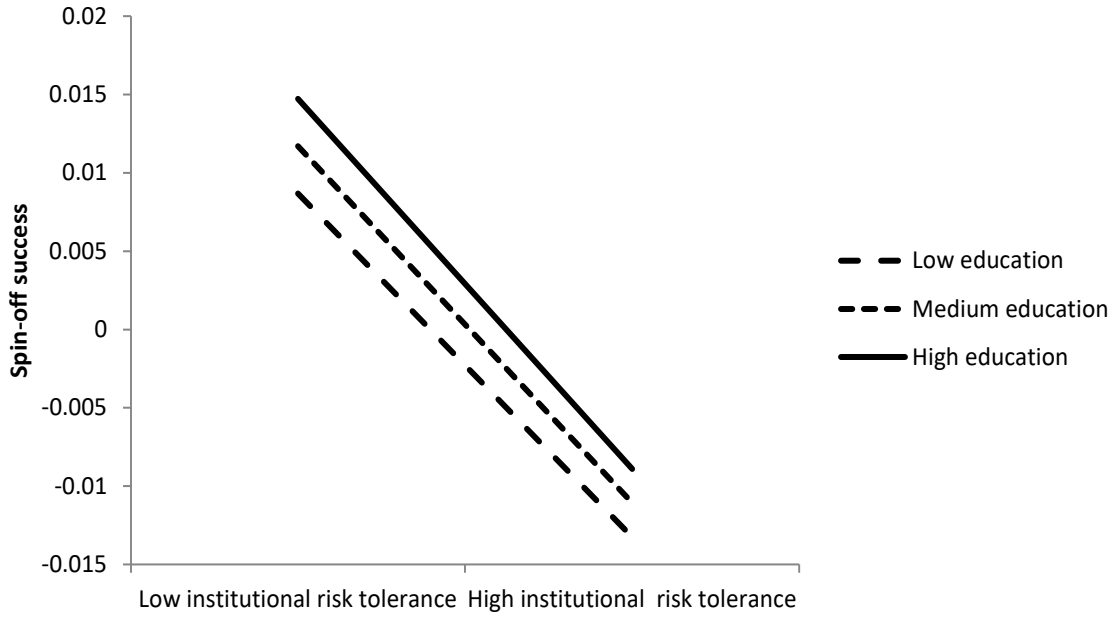


Figure 5.4.4 shows the moderation effect of education on the relationship between institutional risk and spin-off success. As can be seen, the main (negative) relationship is slightly stronger for less educated individuals, although, success is consistently higher for more educated individuals.

Figure 5.4.4: Moderation of education on the institutional risk → success relationship



CHAPTER 6: DISCUSSION OF THE RESULTS

6.1 Introduction

The chapter seeks to explain the findings presented in Chapter 5, with reference to the existing literature in order to test the proposed research hypotheses. The overall purpose of the study was to establish the role of social networks and their influence on the propensity of academic entrepreneurs to develop spin-off ventures. The results are, therefore, discussed according to the hypotheses of the study and comparisons with previous studies are made. The chapter further highlights the implied underlying theoretical explanations and empirical observations of the findings.

6.2 Summary of Findings

The results have a number of important implications for entrepreneurship theory. First, as suggested in the literature review, individual-level characteristics are important for academic entrepreneurship to proceed. In this regard, the findings indicate that research mobilisation, collaboration, risk taking activities, bureaucracy and academic aspirations are needed to support the development of academic led business ventures. These finding are noteworthy as the research has been conducted across disciplines and universities with vastly different resource availabilities.

The findings in accordance with the hypotheses are presented in the Table 6.2.1.

Table 6.2.1: Summary of research findings

Research hypothesis	Path coefficient	Significance level	Confirmed/ not confirmed
H1: At South African universities, research mobilisation by the academic will have a positive outcome on the development of academic led spin-offs, such that this effect gets stronger as the factors supporting research mobilisation work together to support the academic entrepreneur.	0.15	<0.05	Confirmed
H2.1: At South African universities, personal collaboration with the academic, will have a positive outcome on the development of academic led spin-offs, such that this effect gets stronger as relationships between the parties becomes more involved in engaging in entrepreneurial endeavours.	-0.25	<0.01	Not confirmed
H2.2: At South African universities, external collaboration with the academic, will have a positive outcome on the development of academic led spin-offs, such that this effect gets stronger as relationships between the parties becomes more involved in engaging in entrepreneurial endeavours.	0.32	<0.01	Confirmed
H3.1: At South African universities, unconventionality found in academic entrepreneurial financial risk practices has a positive outcome on performance of academic led spin-offs, such that this effect gets stronger with higher levels of risk-taking.	0.62	<0.01	Confirmed
H3.2: At South African universities, unconventionality found in academic entrepreneurial institutional risk practices has a positive outcome on performance of academic led spin-offs, such that this effect gets stronger with higher levels of risk-taking.	-0.18	<0.05	Not confirmed
H3.3: At South African universities, unconventionality found in academic entrepreneurial business risk	-0.13	<0.1	Not confirmed

Research hypothesis	Path coefficient	Significance level	Confirmed/ not confirmed
practices has a positive outcome on performance of academic led spin-offs, such that this effect gets stronger with higher levels of risk-taking.			
H3.4: At South African universities, unconventionality found in academic entrepreneurial reputational risk practices has a positive outcome on performance of academic led spin-offs, such that this effect gets stronger with higher levels of risk-taking.	0.22	Not significant	Not confirmed
H4.1: Bureaucratic policies that focus on the commercialisation of innovation by the academic entrepreneur have a positive outcome on the development of academic led spin-offs, such that this effect gets stronger with higher degrees of supportive involvement by the policy makers.	0.22	<0.01	Confirmed
H4.2: Supportive university engagement that focus on the commercialisation of innovation by the academic entrepreneur has a positive outcome on the development of academic led spin-offs, such that this effect gets stronger with higher degrees of involvement by the university.	0.12	Not significant	Not confirmed
H5: Aspirations of academic entrepreneurs to research at top rated universities has a positive outcome on the development of academic led spin-offs, such that the effect gets stronger as academics entrepreneurs research at top rated universities.	0	Not significant	Not confirmed

6.3 Sample Characteristics

In total, 608 invitations to connect were sent out via email, SMS and LinkedIn, which resulted in 207 acceptances. The survey was sent to academics that had registered with their respective university technology transfer office or were on record with the HR department of their respective university as having been involved in some form of commercialisation of academic innovation or whose name was provided by an

academic who was aware of an individual's participation in academic entrepreneurship.

Respondents to the survey totalled 207. This equated to a participation rate of around 30%.

6.4 Discussion of Findings

The study aimed to investigate the effect that social networks have on the success of academic spin-offs. This was achieved by testing for H1, H2.1, H2.2, H3.1, H3.2, H3.3, H3.4, H4.1, H4.2 and H5. Given the quantitative nature of the research, it was necessary to confirm that validity, reliability and generalisability of the findings were present for each hypothesis, to confirm the predictability of the conceptual model. For H1- H4, this was done by comparing the hypothesised ENTRE-U model for H1-H4 and as suggested by Pusser & Marginson (2013), H5 to establish if there were any significant differences compared to the observed theory. These are summarised in Table 6.2.1.

6.4.1 *Research Mobilisation*

Research mobilisation was measured as a multidimensional theoretical construct that comprised of four dimensions identified in the literature. These were connection to the global community, development of new ideas, environment and funding (Abou-Warda, 2015; Riviezzo, 2014; Todorovic et al., 2011). The Cronbach's alpha analysis and results confirmed the internal consistency and factor structure of research mobilisation. Altogether, the four factors had an alpha of 0.8. This finding contributes to the growing body of the literature through its validation of the factors that describe the construct of research mobilisation.

It is shown through the literature review that research mobilisation is a multi-dimensional construct that impacts the success of spin-off firms. The findings indicate that at South African universities, research mobilisation by the academic

will have a positive outcome on the development of academic led spin-offs. However, while Alessandrini et al. (2013) suggest that its impact on spin-off development would be strongly connected to budgetary constraints, a supportive environment, development of new ideas and the academic's engagement with all parties in the helix, this research finds that this link is not as significant as the literature suggests. Altogether, structural relationship of the four dimensions indicates a modest but significant effect on spin-off success ($\beta = 0.15$; $P < 0.05$). This outcome is less influential than that predicted by Alessandrini et al. (2013). However, the findings do show that a positive and statistically significant correlation between research mobilisation and spin-off success exists, which confirms hypothesis H1, which suggested that research mobilisation would support successful spin-off development.

While this answers the first hypothesis, the derived result is not in line with the individual expectations and outcomes of the studies highlighted in the literature review, which argued in favour of significant influence. For example, Vang et al. (2007) argue that a supportive environment at academic institutions would be key to the development of successful spin-offs. Shree (2007) found that funding stability was key to the development of new firms and Marquina & Ferreiro (2015) confirm that the academics connection to the global community would result in more successful spin-offs, while academics that understand how to apply their knowledge in a commercial setting (Gaglio & Katz 2001) would also be more successful in the spin-off process.

While all of the above are recognised as important and significant findings in the large, developed economies of the world, within the South African context, these factors play a significantly lesser role in the ultimate success of a spin-off. This result affirms the uniqueness observed within the developing economies and specifically South Africa. Therefore, an explanation of this weaker than expected relationship may be manifested from the observation that South African institutions have a significantly higher level of unique financial and social challenges that compete for

the comparably small number of resources (Suzigan & Albuquerque, 2011). With this in mind, it could be suggested that spin-off development should not occur at all at South African institutions, as spin-off development does not feature high enough in the hierarchy of demands at South African public universities. However, the result implies that while these factors are important, the academic entrepreneurial environment has adapted to use a limited amount of research mobilisation support, while finding the additional factors needed for success in other areas. These areas are discussed in the subsequent sections of this chapter. This finding is expected to be unique to the developing markets and may be specific to South Africa only.

A unique outcome that has been observed in this study and an outcome that has added to the body of knowledge, is that at South African academic institutions, there are five factors that have a mediating effect on research mobilisation. Institutional risk taking, financial risk taking and university support were all found to have strong positive effects on research mobilisation, while aspirations and external collaboration had a negative impact.

Institutional risk was found to have the strongest mediating effect ($\beta = 0.71$, $p<.01$). While the majority of the available literature on technology transfer, a core component in institution risk measurement, supports the use of technology transfer offices as integral to the success of spin-off creation (Clarysse et al., 2014), this research has established that in South Africa, technology transfer offices are most effective when encouraging entrepreneurial thinking, supporting academics in creating applied research and bridging the relationships between the industrial and academic networks. In the same regard, this result implies that the use of technology transfer offices should be limited to these responsibilities and not focus on direct company involvement.

This research has also established that financial risk ($\beta = 0.23$, $p<.01$) impacts the academic entrepreneur's propensity to mobilise research through its mediating impact of research mobilisation. While the extant literature supports financial risk as a contributory factor to the success of a spin-off, this research has found that in

addition to those findings, the academic's fear of financial loss may be a contributing factor in seeking stable financial partners. In the absence of being able to tolerate financial uncertainty, the academic may not mobilise the innovation and thereby ignore the spin-off opportunity. These findings are closer aligned to Iazzolino, Greco, Verteramo, Attanasio, Carravetta and Granato (2020) who argued thqt financial risk is among the main risk areas that will materially adversely affect the outcome of innovation commercialisation. Further, research conducted by Hall (2002) found that financial partners were concerned about high levels of financial risk that may be exasperated by the additional monitoring costs as well as information asymmetries. Thus, the academic may concentrate on the theoretical research outcomes only. Another possible explanation for financial risk being a factor influencing a moderating variable may be that, as noted by Shree (2007), funding is core to all new entrepreneurial business ventures. If the academic can identify a funder that is prepared to accept or co-contribute to the financial risk, it gives the academic a confidence boost and allows them to see their research in a commercialisable way, thus fostering the mobilisation of academic innovation. Furthermore, this research is in line with Muscio, Quaglione & Ramaciotti (2016), in concluding that there is an intersection of institutional characteristics and individual level outcomes of academic knowledge transfer. This research extends that argument by finding that academic entrepreneurs at South African academic institutions will need to ensure a stable and growing financial base, supported by stable and engaged financiers, in order to mobilise research towards a commercialisable outcome.

University support for applied research has a modest but statistically significant effect on the mobilisation of research ($\beta = 0.12$, $p<.01$). Thus, this research extends the body of knowledge that investigates the impact that the university will have in supporting the researcher when considering an opportunity to mobilise their research. This research's findings confirm that when a South African academic operates in an academic department that engages, supports, develops, discusses practical outcomes for research, this environment contributes to the academic being

able to identify the practical outcomes of their research. The extant literature on university support explicitly supports that when a university creates a supportive environment, the rate of establishment of academic spin-off firms will improve (Meoli, 2016). It argues that governance mechanisms are the foundation of that support (Hoang & Antonic 2003). However, this research suggests that in the South African context, when the university supports applied research, that support is not found within its governance mechanisms but rather with its engagement with the academic in the early stages of research mobilisation. Thus, when acting as a moderator towards research mobilisation, university support will encourage the academic entrepreneur in a unique way; a way that is not identified in the extant literature (Gaglio & Katz (2201); Hoan & Atonic (2003); Thursby & Thursby (2007); Rorwana & Tengeh (2015)). Thus, at a South African academic institution, it is determined that while some support is necessary to support the mobilisation of research, too much focus on the end result of a successful spin-off or a one-size-fits-all structure will not result in the success of the spin-off firm.

The research found that there were two negative effects on research mobilisation. These are aspirations and external collaboration. The negative relationship of external collaboration is $\beta = -0.21$; $p=<0.1$ and aspirations $\beta = -0.14$; $p<01$. This finding has not been noted in the previous literature and marks an important contribution of this research.

While this research set out to discover which of the important theoretical avenues, namely Granovetter's (1983) weak tie theory that suggests a redundancy of relationships over time and Perez & Sanchez (2003), who argue for a richness that needed to exist within relationships to support spin-off creation, it is found that the extant research has been too focused on the importance of the direct impact of collaboration on the spin-off process, when there is a notable effect that has been overlooked to date and potentially assumed by researchers to exist. This research shows that in South Africa, an academic entrepreneur becomes an entrepreneur as a result of his research findings having a commercialisable aspect and not that he

sought a commercialisable research idea to develop into an academic and applied research idea from his network. This research has been able to contribute to the extant literature base by identifying that in the development of a spin-off in the South African academic environment, that the academic does not require guidance from his network to influence his decision to mobilise the research into a commercialisable idea but will seek support once the commercialisable idea is observed in the research, by the academic. This latter finding will be discussed further in section 6.4.2. However, it is important to note that there is extant research that argues that academic entrepreneurship is a person-oriented outcome, where the entrepreneurial personality of the academic contributes to the shaping of his or entrepreneurial passion (Obschonka, Moeller & Goether (2019).

In support of this contribution, I point to the negative relationship regarding the aspirations of the academic. The negative $\beta = -0.14$; $p<01$ suggests that academic entrepreneurs do not set out to create applied research. It is found in this study that South African academics are not motivated to search for an applied idea before undertaking the theoretical research for publication. They do not consider practical imperatives when deciding on a research platform and consider the purpose of academic research to contribute to the theoretical knowledge base in their discipline.

6.4.2 *Collaboration*

Final confirmatory analysis confirmed the findings of Grimpe & Hussinger (2008) that personal and organisational relationships represent 'collaboration'. This study has confirmed that personal and organisational relationships are effective in the measurement of collaboration, through testing for reliability and validity empirically. Hence, it can be claimed that this study is one of the first to be conducted in the emerging markets using personal and external relationships as the measurement scale for collaboration.

This study focused on establishing the role and influence that personal and external collaboration had in the development of an academic spin-off. The results were mixed.

Although there is limited research on direct collaboration within the triple helix, the research found that personal collaboration evidenced a significant and negative association with spin-off success ($\beta = -0.43$ & $p<0.01$). The result contradicts hypothesis 2.1, which predicted that personal collaboration would positively impact spin-off development. In addition, the result does not support previous findings that suggest a positive and significant impact of spin-off development when engaging with individuals in the triple helix (Weng et al., 2018; Todeva 2013; Vahlne & Johanson, 2009; Laursen & Salter 2006).

These results are interesting in that they suggest that personal collaboration will hinder the development of a spin-off when a prior personal relationship is relied upon. Further, they contradict Luu & Ngo (2019), where they suggest that entrepreneurs would focus on individual relationships that are supportive of capitalist outcomes. Potential explanations of this negative relationship may manifest in the potential that the relationships needed to support spin-off development are overwhelming and time-consuming for the academic entrepreneur. This result implies that academic entrepreneurs prefer not to develop the trusted relationships described in the literature (Todeva, 2013; Weng et al., 2018) and that the extra effort needed by the academic to maintain and support these relationships will result in them shying away from pursuing a secondary commercialisable outcome for their theoretical research. The extant research in support of this finding argues that for relationships to be effective that they need to be easily accessible, and complexity or unfriendliness will adversely impact spin-off development (Segui-Mas, Oltra, Tormo-Carbo & Sarrion-Vines. 2017) and that academic entrepreneurial relationships with international market agents appear to be irrelevant in the success of spinoffs. While this study only focused on international expansion of academic spin-offs, and by extension, the benefit of

international relationships, the finidings confirm that relationship development is not a necessary component for success (Fernandez-Alles, Hernandez-Roque. Villanueva & Diaz-Fernandex (2022).

In regard to external collaboration, the results showed significant positive effect ($\beta = 0.24$ & $p<0.01$). These results are in line with the hypothesis 2.2, that suggested that collaborative engagements with external organisations would support the development of a successful spin-off. Thus, the data suggests that organisational relationships in the South African context do support the development of a successful spin-off. Interestingly, the data finds little support for the engagement of government alone and limited support for the engagement of business alone. A statistically significant positive outcome is found when these two different organisations work together as 'external collaboration'. This is a significant finding that adds to the body of research. It argues in favour of a networked approach to collaboration (Jack et al., 2008; Laukkanen, 2003; Borgatti & Halgin, 2013; Sousa-Ginel et al., 2017). Further, the literature review highlighted a study by Laursen & Salter (2006) that points out that successful firms rely on interaction with a range of institutions within the innovation system to ensure that their ideas are successful. The common thread in the literature on collaboration is that in developed markets, the triple helix innovation system relies on all parties in the helix for success, with collaboration being an implied requirement (Etzkowitz 1998).

However, in the emerging markets, it is often argued that governments are poorly placed to direct innovation (Luu & Ngo 2019) and industry is better equipped to assist academic entrepreneurs (Tang et al., 2008). Thus, this research is able to put forward a new dynamic that suggests that in South Africa, collaborative endeavours should be considered closer to developed market research theory and away from the position that focuses on the investor, technology transfer professional and the spin-off firm (Sibanda 2009). Thus, the result is interpreted to suggest that collaboration with only one party, either organisational or governmental, may be unsuccessful. Rather, academics would need to be able to

work with both government and industrial organisations to ensure successful spin-off creation.

The findings could also be interpreted to mean that in South Africa, the institutions that are needed to ensure collaboration with external networks, are business and government; thus, making the academic entrepreneur's engagement with this network a collective approach when working towards the commercialisation of academic innovation. As highlighted in the literature review, science parks, innovation hubs, incubators and technology transfer offices are important in the facilitation and support of external collaboration. These findings highlight the need for the development and continued support of these boundary spanning institutions. While the initial reaction of an academic entrepreneur may be sceptical of such an institution, due to its limited tenure or the academics' lack of engagement with boundary spanning institutions, the research findings suggest that over time these are important networks that are needed to develop and support innovation. In addition, the results indicate that in line with the findings of Abou-Warda (2015) and Todorovic et al. (2011), that where academics that have not previously engaged actively in the development of academic innovation, focus needs to be placed on directing the academic entrepreneur to developing the relationships with these boundary spanning entities.

The findings also note that collaboration offers a moderating effect on research mobilisation. The findings indicate that external collaboration has a negative moderating effect on research mobilisation ($\beta = -0.21$, $p<0.1$). The effect is statistically significant. This result is contrary to the findings of Vahlne & Johanson (2009) who indicate that a positive effect of collaboration on research mobilisation exists in the developed economy; again, highlighting the differences between developed and developing market spin-off theory. This finding adds to the body of literature as it notes that where the relationship is new and cumbersome, the extra time and effort needed by the academic acts to discourage an entrepreneurial spin-

off focus. This finding supports this report's earlier conclusion that personal collaboration can be overwhelming and time-consuming in its early stages.

The extant literature highlighted in the literature review suggests that different regions, with their different values and cultures, would respond differently to collaborative endeavours (Foray, 2002). This research supports that assertion by finding that in the South African context, early-stage collaboration will initially discourage the academic entrepreneur from commercialisation, as it is probable that when faced with navigating institutions, with their different values and cultures, the different stakeholders may compete in areas that are unfamiliar to the academic. Further, Hayter (2016) suggests that it is unclear whether the technology transfer office is able to bridge the gaps between academic and industrial networks. This research builds on the question by finding that in early stages of commercialisation, gaps due to social differences and focuses are not overcome by the use of a boundary spanning institution. Finally, while the university reward practices are assumed to offer an incentive to engage academics, this research finds that academics are primarily concerned with theoretical research outcomes, which is in line with research by Seigel et al. (2007).

In summary, the finding of this research is that when an academic finds himself in an environment that easily overwhelms and detracts from the mobilisation of innovative and commercialisable research, the academic will quickly loose interest in the commercialisation aspect of his theoretical research.

In conclusion, while an invasive and premature introduction to collaborative networks is counterproductive in mobilisation of research, given the large statistically significant, positive impact on the success of the spin-off from the use of collaborative relationships, there are clearly collaborative support factors that need to be considered as beneficial to the academic entrepreneur. This research highlights that external collaboration is positive for spin-off success and as a result, the value it adds needs to be acknowledged by the academic entrepreneurial community, especially when arguing against the limited benefits from boundary

spanning support institutions, as mandated under the South African legislation. Attention needs to be focused on the potential benefits of collaboration through the engagement of boundary spanning offices, such as science parks, technology transfer offices and incubators that are able to facilitate interdisciplinary, inter-sectoral and inter-professional relationships. It is noted with caution that the effectiveness described above can only be realised once triple helix institutions have had an opportunity to develop trusted relationships with the academic community. These boundary spanning entities are expected to engage collaborative activities that facilitate potentially uncoordinated engagements into an outcome that combines the different skills and knowledge needed to move the spin-off in a common direction and supports the thesis that social engagement is an important and central part of effective spin-off creation.

6.4.3 *Unconventional / Risk Taking Activities*

Contrary to what was hypothesised, the findings indicate that risk is a complex metric that does not enable us to draw binary conclusions across multiple types. However, the data supports that the ability of the academic entrepreneur to engage with risk is important.

On balance, the data suggests that the relationship between risk and spin-off creation is mildly negative.

This study considered four forms of risk that the academic entrepreneur is exposed to. The first was financial risk. This metric was measured by considering the propensity of the academic to back his idea with money. This implied that an academic entrepreneur may need to put some of his savings (by extension, his financial security) at risk in order to pursue the opportunity within the innovation. The questionnaire completed by the academics inquired as to their propensity to accept financial losses both personally and inside the spin-off. The research data shows a statistically significant relationship with spin-off success ($B=0.62$, $p<0.01$). This suggests that the academic entrepreneur's ability to access both their own

personal funds and / or external-source funds will result in spin-off success. The researcher infers from this finding that as academic's access to funding improves, the propensity of an academic entrepreneur to accept financial risk may also increase. In addition, the researcher concludes that when parties within the triple helix make funding available, then more innovation will be successfully commercialised. Iazzolino, et.al (2019) supports this outcome. Their research adopted what they termed a lean approach where they found a limited number of risk variables that had impact on spin-off success. Financial risk and the availability of stable funding was one of four important variables. It would be interesting in future studies to understand if the source of funds impacts spin-off success. It is possible that spin-off success may be enhanced when capital from both the academic and the triple helix are used. This may be due to a 'lower-than-average' risk of losing *just* their own money and that access to a diverse source of funds, both during or after establishing their spin-off, may reduce the fear of personal financial loss.

The data collected on this risk metric also indicated that financial risk positively moderates research mobilisation ($\beta = 0.23$, $p<0.01$). As the data collected used information about the academic entrepreneur's propensity to accept a monetary loss should the venture fail, the outcome suggests that when the idea of losing money does not negatively interfere with decision making about the mobilisation of research and the prospective innovation commercialisation potential, the ability of the academic entrepreneur to take financial risk would support their ability to recognise spin-off potential.

It is shown in this research that financial risk is a significant predictor of spin-off firm creation. Given that financial risk taking is comprised of money-based investments, the academics' subjective attitude toward financial risk can be viewed as a predictor of spin-off creation and a moderating factor in the recognition of spin-off potential. Factors that support financial risk, such as the efficiency of the financial system, availability of funding and access to the system, will promote the successful creation of spin-off firms. These higher levels of financial risk taking appear to be core to

spin-off development. In the converse, obstacles such as the lack of cash flow or investment capital would inhibit the development of the spin-off firm.

The second risk metric studied was business risk. Business risk is the ability of the business to continue to innovate in the face of rising competition and was measured by the propensity of the academic entrepreneur to introduce products and services that required the industry to respond. There was a small statistically significant negative relationship between business risk and the success of a spin-off ($\beta = -0.13$, $p<0.1$). This finding was inconsistent with the literature review, but showed a weak relationship that cannot be confirmed. The finding suggests that the academic entrepreneur is unlikely to identify models or market competition that differ from the firm's current business model, nor be quick to adapt in a dynamic business environment. Business risk requires the academic to span both technical and economic domains; thus, suggesting that the business model of an academic spin-off is more of a proto-type strategy premised on how to deliver an innovation to a customer, rather than a well-formulated, elaborate and clearly understood business strategy. The negative relationship indicates that for an academic entrepreneur, working within the business environment is more complex than understanding the technical uncertainty within the theory. Thus, failure of an academic spin-off may not be prescribed to failure of the technology, but rather a failure to understand business continuity and the competitive and constantly evolving economic landscape. Given the weak significance of this finding, it is possible that this cannot be applied across all spin-off success. Extant literature has investigated business strategy formulation for academic led spin-offs, their findings suggest some support for this finding. It has been suggested that the ability to develop strategy needs to be built and developed within the academic entrepreneurship arena (Hamid, Atikah, Sutopo, Nizam, Muhamad (2015) and Saputra, Sutopo and Zakaria (2018) suggested that the development of business strategy by an academic entrepreneur was challenging.

The third risk factor investigated was institutional risk. Institutional risk was measured by considering the academics' observations and understanding of the support and engagement offered to the academic by the university. The data suggests that institutional risk had a push-pull impact on spin-off creation.

The data shows that there is a small negative statistically significant relationship with successful spin-off creation ($\beta = -0.18$, $p<0.01$) This is inconsistent with hypotheses 3. However, as with financial risk, institutional risk had a moderating effect on research mobilisation. This affect was strong and statistically significant (0.71, $p<0.01$). While this result may seem dichotomous at first glance, it highlights that first, when the academic perceives the support of the university, he is better able to identify the opportunity in his research and engage in the mobilisation of his research with a view to potentially converting it into a spin-off. In fact, institutional risk had the highest positive moderating impact of any factor on research mobilisation. While that is supported in the literature, this study is able to highlight and add to the body of knowledge that once the academic begins the commercialising of the innovation, they do not require the support of the university. The academic looks to the university as a prudent backstop and assists at tempering them from being overly ambitious. Simply explained, the academic entrepreneur does not want the university to push them into the spin-off and join them in the new company, they simply need them to offer early stage guidance and objective review of the innovation.

Finally, the research tested reputational risk. Reputational risk had a modest positive statistically significant relationship with spin-off success ($\beta = 0.22$ $p<0.01$). This outcome adds to the body of knowledge by finding that being vital in the development of an innovate technological product/service is perceived by the academic entrepreneur to increase the status and reputation of both the academic and the academic's university. In addition, this finding further adds to the existing literature by confirming that when the self-esteem of the academic is supported, they will be more likely to engage as a knowledge partner and become more

involved in successfully spinning-off new innovation. In the converse, the absence or destruction of reputation from a breakdown in relations between the stake holders may have long term negative effects on the creation of later spin-off businesses. Academic entrepreneurs are more likely to fear future business failures, which may have occurred due to the complex nature of stakeholder relations within academic circles. Further, it is possible that when the environment does not allow for sufficient risk sharing, the risk of failure may result in missed opportunities.

In conclusion, the results indicate that in the South African context, it is not possible to generalise across one measure of unconventionality and agrees with Nobanee, Alhajjar, Abushairah, & Al Harbi. (2021) that more research is needed in the field of reputational risk. This adds to the body of knowledge that it is necessary to engage with each sub-set of risk separately to understand their individual influence. The data shows that financial risk has the highest impact on spin-off success, with reputation risk having a modest effect. It is important to note that institutional risk is significant in the moderation of research mobilisation, while not a factor in the spin-off successes. Given the $p<0.1$ for business risk, it is unclear if the negative impact shown in the data impacts the success of a spin-off. Finally, hypothesis 3 is rejected, as not all risk metrics result in improved predictability of spin-off creation.

6.4.4 *University Support and Bureaucracy*

This section considered whether either bureaucratic policies or university support have a positive impact on spin-off success, such that, as there is more involvement, the greater the chance of success.

First, the study considered the involvement of bureaucracy on spin-off creation, which affirms that there is a mildly positive outcome in support of H4.1. The study established that there is an interaction between bureaucracy and spin-off success ($\beta = 0.22$, $p<0.01$). Bureaucratic involvement involves the regulating of commercialisable academic output. The data supports the view that suggests that university policies towards intellectual policy as well as the engagement of NIPMO

through regulatory intervention, do encourage the engagement of the academic entrepreneur towards successful academic entrepreneurship. This is in line with several studies that highlight the importance of university policy engagement, for example, Todorovic et al. (2011) and Shore & Mclauchlan (2012) that state that academic entrepreneurs are more likely to develop a spin-off with the existence of an environment in which governance mechanisms support spin-off activity. It further provides an answer to whether the development of a spin-off requires support structures at the university designed to assist the academic entrepreneur to access resources. It shows that a positive impact will be made when those support structures are clear, consistent and readily available.

In the same way, the data supports the assertion that regulatory policies and practices that facilitate knowledge transfer will improve the process of use of entrepreneurial knowledge to facilitate spin-off success.

One of the challenges highlighted in the literature review is for the university to keep a balance between the social objective of ensuring efficient use of knowledge and motivating economic rents without creating monopolistic pricing and socially wasteful expenditures while encouraging academic innovators not to invent 'around' the patent instead of transferring it to the university (Foray, 2002). This research adds to the growing body of knowledge around the engagement of the university and regulators with the academic entrepreneur and argues that the existence of bureaucracy will improve academic spin-off creations in South Africa. Further, it is argued that the existence of bureaucracy may work to assist academics that have both theoretical and practical focuses. In addition, given the complex systems shown in the triple helix needed to successfully spin-off a new venture, the bureaucratic system will facilitate the transformation change needed by the theoretical academic to become more business focused. It will introduce the academic entrepreneur to a supportive, collegial and engaging work environment amid the complexity of the academic world. In summary, it would appear that the academic finds benefit in having the back-stop of the system to guide

entrepreneurial outcomes and shield themselves from potential unintended negative outcomes.

Further, the study considered that supportive university engagement, which focused on the commercialisation of innovation by the academic entrepreneur, would have a positive outcome on the spin-off success. Hypothesis 4.2 found a non-significant and very mildly negative relationship (β = -0.03) between supportive university engagement and spin-off success. As the data showed non-significant coefficients and unpredicted direction, it is rejected. The finding provides insights into the nature of the relationship between the academic entrepreneur and the different contexts of South African universities. While some South African universities may concentrate on theoretical research, their involvement and expertise in the development of spin-offs is limited and the academic entrepreneur gains limited benefit relying on their engagement. In contrast, other South African universities may have expanded their role to include incubation and support, which would benefit new academic entrepreneurs, but may have limited benefit to experienced academic entrepreneurs. Regardless of the context of university, the data are unable to conclude that the shift in the epistemological values of universities argued in the literature has been of any benefit to South African academic spin-off firm successes.

6.4.5 *Aspirations of South African Academic Entrepreneurs*

The fifth question focused on understanding if the aspirations of the academic to succeed at top-rated universities would positively affect the success of an academic led spin-off. Aspirations were measured through the perception that academics have regarding the universities rank.

The result for hypothesis H5 showed there was no significant relationship between the variables (β = -0.02, $p<0.05$). In contradiction to the findings of Pusser & Marginson (2013), universities with a higher rank or intellectual imperatives do not hold power over universities that have not been as successful in intellectual theory

creation, nor do they hold stronger influence when building relationships with other parties in the helix. Further, this finding confirms that academic entrepreneurs do not consider existing spin-off firm's ability to attract capital (Lockett and Wright, 2005), longevity (Shane, 2004) or number of patents (Zucker et al., 2002) to influence their decision to work at a specific university; but rather, it is expected that other factors such the universities focus on a specific research agenda that may attract an academic. Aspiring to be academic entrepreneur appears to hold little importance when selecting a university for a South African academic entrepreneur.

Linked to this explanation, the study also adds to the extant research on the relationship between aspirations and academic led spin-offs by observing that there is evidence of a minor negative effect on research motivation ($\beta = -0.14$, $p<0.05$). These results support the view that when researchers perceive the university that they research at to be highly academically rated, the academic is marginally more likely to focus on theoretical research without taking any additional steps towards the mobilisation of the research. Top-rated academic institutions retain their status through academic publications from their academic staff, thus highlighting that the focus of the academic is driven by theoretical research rather than business acumen. By extension, this research confirms Wu's (2010) suggestion that when universities are the product of historical legacies, the primary focus of the academic is to publish at a top-ranked university and only then to consider its commercialisable potential.

Despite the rhetoric by university management that they support academic entrepreneurs, the question of whether academic aspirations of business success can work alongside or even supersede this focus, appears unlikely. As theoretical research requirements and the demands on the academic to deliver on their theoretical imperatives increase, their secondary goals will only gain traction once the academic community supports and incentives academic entrepreneurs to have a commercial focus to their research.

6.4.6 *Moderation effects on successful spin-off development*

While hypothesising for some potential moderators, additional potential un-hypothesised moderators were explored for. A total of 10 possible interaction effects were identified. However, when these effects were added into the model factors, none returned significant interactions. Of the hypothesised and unhypothesised variables, there were two modest relationships worth mentioning.

The first was a modest relationship between for experience on the relationship between research mobilisation and success. Academic entrepreneurs that are more experienced were more likely to experience success. In chapter 2, it was described through research from Hugh (2015) that entrepreneurship is a lived experience. This report agrees with those findings and suggests that through each spin-off attempt, the ability of the academic entrepreneur to take decisions that would support positive spin-off outcomes. The second was a modest relationship between the effects of education on the acceptance of financial risk as well as institutional risk and spin-of success. The effect of financial and institutional risk tolerance was higher for lower educated individuals while success is higher for more educated individuals. These findings suggest that there is some support within academic entrepreneurship for the relationship between education and risk as described in the extant literature. In research done by Bae, et.al. (2014) they argued in favour of a link between education and the ability of an entrepreneur to accept the risk needed to begin a new venture. This study finds that there is moderate support for Bae, et.al. (2014)'s findings for spin-off success from more educated individuals. This could be explained as while the acceptance of risk may be a personal choice, improved education improves the understanding of risk and thereby allowing for improved outcomes of the acceptance of risk to be established.

CHAPTER 7: CONCLUSIONS & RECOMMENDATIONS

This chapter will provide a discussion of the conclusions of the study based on the research questions that evolved from the research problem. It will achieve this by summarising the key research findings by highlighting the theoretical and methodological contributions of the study as well as the implications for policy and management. The findings will then be adapted to include limitations of the study and suggestions for future research.

7.1 Conclusions of the Study

This study primarily provides empirical evidence that supports extant global research that argues in favour of networks supporting academic spin-off activity. It provides evidence to support the importance of understating the local context of the social network by highlighting which networks need to engage to enable success in South Africa. In particular, this research contributes to the growing body of knowledge on academic entrepreneurship.

The overall purpose of the study was to understand how and to what extent social networks in South Africa influence the success of spin-off activity. In this regard, the study aimed to fill the gap in research on academic entrepreneurial spin-offs, which has traditionally focused on the triple helix and entrepreneurial university, by focusing on social networks. The assumption was that research mobilisation, collaboration, unconventionality, university support and bureaucracy and the aspiration of the academic would provide a better understanding of spin-off success and provide key inputs that would assist in the design of future spin-off policies and practical strategies.

Hence, it is the first time that a model has been able to integrate the importance of the social network into the understanding of the success of a spin-off in a developing country context with particular focus on South Africa. In that regard, the study has

made a contribution towards entrepreneurship theory. The study has also answered practical questions about the importance of the social network in understanding the success of South African spin-off firms.

Consequently, this study has shown that social networks in South Africa are comprised of research mobilisation, which is understood as a multidimensional theoretical construct comprised of the academic connection to the global community, development of new ideas, environment and funding; collaboration, which is understood by studying both external and personal collaboration; unconventionality, which is understood by studying four key risk metrics, namely financial, business, reputational and institutional; university support & bureaucracy; and aspirations of the academic.

In finalisation of the main research question, the results show that research mobilisation, bureaucracy, external collaboration and reputational risk have a positive and statistically significant influence on spin-off success. In addition, financial risk-taking activities showed the largest statistically significant positive influence, whereas the effect of personal collaboration was negative. Therefore, it can be concluded that the ability of the academic entrepreneur to access a funding support network would have the greatest influence of future success, whereas to some extent when the academic does not have a trusted personal network to approach for assistance, this will have the greatest negative influence in the success of a spin-off.

Secondly, this research concludes that while research mobilisation has a positive impact on spin-off success, it also has important moderating variables that influenced it: university support and financial risk taking have a positive impact on research mobilisation, suggesting that the university and funding relationships play a role in the early stages of the innovation idea formation. Institutional risk is the largest moderating variable on research mobilisation, suggesting that the role of the university is to provide the academic entrepreneur with a backstop for the innovation. It is also noted that aspirations and external collaboration negatively

affect research mobilisation, adding to the model the importance of understanding the motivation of the academic towards theoretical or practical engagement with research.

Thirdly, the findings indicate that institutional risk positively impacts research mobilisation while negatively impacting spin-off success. This is an important finding as it is able to highlight the role that the university should play in the support of the academic entrepreneur. Extant research has pulled the universities in different directions in how to best ensure the development of the innovation. It is shown now that South African universities are best suited to offering objective advice and not involving themselves in the workings of the spin-off firm.

Fourthly, external collaboration has a negative impact on research mobilisation but a positive impact on spin-off success. This result adds to the body of knowledge by highlighting the importance that once the innovation has been identified by the academic as having commercialisation potential, a network that includes both government and industry would offer support that ultimately results in spin-off success. It also highlights that it is not necessary for these entities to be involved in the identification of the commercialisation process early on in the mobilisation process.

Fifthly, the aspirations of the academic have no impact on the spin-off success but do detract from the mobilisation of research. This is important as the academic who aspires to strong theoretical research does not have a focus on the commercialisable aspect of their innovation.

Overall, it concluded that

- bureaucracy, research mobilisation, reputational and financial risk supported the success of a spin-off.
- While external collaboration enhanced spin-off success, it detracted from research mobilisation.

- Institutional risk was important in enabling research mobilisation, it reduced the degree of success of the spin-off.
- Aspirations of the academic did not impact the overall success of the spin-off but did have a negative influence on the ability of the academic to mobilise their research.

7.2 Contributions and Implications

7.2.1 *Theoretical Contributions and Implications*

Drawing from the study findings, the results discussed below advance triple helix innovation theory, by moving away from the hegemony of these three participants being able to generate successful outcomes through their basic interactions towards linking social network theory, by expanding on the importance of the social context of the academic entrepreneur. This was done by highlighting that unconventionality and in particular financial risk had the most significant and positive impact on the success of a spin-off. This result advances theory by suggesting that the ability to manage financial uncertainty above all other forms of uncertainty will result in successful spin-off success. In addition, the importance of coping with financial risk has been confirmed. In particular, the result demonstrates that individual academic entrepreneurs can achieve success by engaging with financial uncertainty. This research argues that the overall benefits are tangible and positively influence success.

In addition, the study has confirmed that while financial risk is essential in the development and success of a spin-off, other forms of risk cannot linearly be combined into a single risk-taking 'unconventionality' factor, but those individual factors each have their own merit. The theory is enhanced by this report's determination that: business risk is driven by the academic's ability to keep up in a dynamic market; institutional risk by the continued engagement of the university with the academic; and reputational risk by the effect that a failure could have on

the academic's reputation. Therefore, the results indicate that the academic should engage with a dynamic risk environment rather than focusing on a single risk factor, as described on the ENTRE-U model.

The results show that there are a number of factors that influence spin-off success directly and through research mobilisation. Hence, this study provides an understanding of how academics with limited network reach can focus on specific networks, which provide enhanced benefits, while being aware of those factors that detract from spin-off development. To be successful, the mere availability of these factors does not necessarily enhance success. Too much focus on factors alone and not enough understanding of how these factors engage to create success could be detrimental to spin-off success. Based on the existing literature and the empirical findings of this research, strategies that look to singularly focus on each factor in isolation would not necessarily yield the desired outcome. Therefore, the findings suggest the need for academics and institutions to engage with the model as a whole through an understanding of each factor's push-pull relationship with the success of a spin-off. Further, this result provides a unique point of view to the relationship and highlights the need for future research to explore potentially unintended negative outcomes and points to the question of what the optimal level of engagement within the triple helix for South African academic entrepreneurs is.

Further, the results theoretically distinguish between what matters in the early stage of research mobilisation and the latter stages of spin-off success. It is now clear that rather than relying in the broad-brush strokes of the ENTRE-U model to engage with the development of the social networks for the success of a spin-off in South Africa, that the primary factors that affect success are the ability of the academic to cope with financial and reputational risk, to mobilise their research, engage with bureaucracy and collaborate with external experts.

In addition, the findings of this study disregard the idea that all factors directly and positively affect spin-off success. As already indicated, the results show that significant positive effects are found in financial and reputational risk, research

mobilisation, external collaboration and bureaucracy; however, personal collaboration and business risk have a negative relationship with spin-off success. Although not significant, aspirations have a small negative effect on research mobilisation.

It is also noted that research into the success of South African spin-off firms is still limited, thus the findings provide important insights into the drivers of success. The results indicate that while the extant literature suggests that the engagement of the triple helix will result in a successful spin-off, the social network of the academic entrepreneur significantly contributes to the success of the spin-off. This means that the social network is relevant in success. Social capital provides necessary resources such as knowledge and confidence that allows for the academic to legitimise his innovation into a commercialisable outcome (Fukuyama, 2001).

The study also provides a contribution to the body of knowledge on the mediating effect of multiple factors on the mobilisation of research. First, the support of the university is found in the extant research to have a positive effect on spin-off success; however, this report disproves it and highlights that university support positively impacts the mobilisation of research. Secondly, external collaboration negatively impacts research mobilisation, suggesting that premature engagement of triple helix will detract from the ability of the academic entrepreneur to engage with the commercialisable aspect of their research. Thirdly, it confirms the literature that suggests that when the aspirations of the academic are pushed toward theoretical research, the academic is a poor steward of mobilising their research. Fourthly, support of the institution is very important in the mobilisation of research, but once the academic has identified and supports the commercialisable aspect of the research, they no longer require direct engagement from the institution. Finally, in support of the extant literature, the capability of the academic to manage the financial uncertainty of a business will affect their ability to mobilise their research.

The study has theoretical implications for spin-off development in a developing country context. In particular, the results contribute to the on-going debate on

government involvement and influence in the spin-off process by providing evidence that spin-off success in the South African context requires both government and institutional support. It is interesting to note that the long-held view that government engagement is detrimental to success appears invalid. Thus, the study points to an urgent need for future research in the role that government should play in support of spin-off activity.

Finally, the study provides a conceptual framework that shows how spin-off success is linked to the social network of the academic entrepreneur. This conceptual framework adds to the body of knowledge by presenting an understanding of how social networks enhance spin-off success. The framework provides knowledge of the effect that mediators (age, education, experience, gender) have on spin-off success. Overall, the predictors explain 32% of the variance of spin-off success.

Overall, the study makes a theoretical contribution to the existing literature in support of the importance of the social network in spin-off success and closes the gap on the existing literature that highlights the importance of the triple helix but does not provide a model of how the three parties create a spin-off, given a world of constrained resources.

7.2.2 *Methodological Implications*

The measurement of the individual components identified within the ENTRE-U model lacked adequate development. In order for the generalisability of the findings to emerge, this research sought to expand and understand the required components needed to measure an academics social network. This study's methodological implications relate to the measurement of research mobilisation, collaboration, unconventionality and university support. The study enhanced rigour by using by testing variables and testing their foundational position. This allowed for formative insights that facilitated the expansion of the model and improved its potential for comparative studies to be conducted. The study has determined that first, unconventionality is a multidimensional construct composed of reputation,

business, financial and institutional risk. Secondly, collaboration is a multidimensional construct that is composed of external collaboration and personal collaboration and thirdly, identified that university support and bureaucracy are separate constructs that have different impacts on spin-off success. Therefore, this study has highlighted how unconventionality, collaboration and university support are understood among academic spin-off firms in South Africa. In fact, this study is one of the first studies to have separated these into their component parts and tested these components empirically.

In addition, this research has been able to confirm the key components of spin-off success and research mobilisation. While the reliability and validity of these factors has been confirmed for South African spin-offs, more work needs to be done in other developing countries to confirm whether the results can be generalised and replicated elsewhere.

Finally, the methodology used in this research suggests that generalisation of findings in South Africa is possible, since a large sample was used in the study.

7.2.3 *Managerial Implications*

This research has important findings and implications for academic entrepreneurs, investors, government and universities. First and foremost, this study shows that despite the widely accepted claims that the existence of the triple helixes and regulations to support the existence of a relationship, these are not sufficient to create a successful spin-off.

For academic entrepreneurs and potential academic entrepreneurs, this study has provided information on the networks sought and needed for success at both the evaluation and business spin-off level. It provides clarity for academic entrepreneurs as to which networks will provide the most efficient support, especially when engaging in a competitive, dynamic and for-profit environment. It shows that, at the mobilisation level, the academic considers the network closest to

him at the university, while once they have spun-off the firm, the network dynamic changes.

For investors, this study has provided an understanding of the importance of engaging with the financial uncertainty experienced by the academic innovator and providing the elements needed to support the academic entrepreneur. It shows that the academic may be encouraged and supported in the acceptance of financial risk and the ability to alleviate some of those concerns will support the process of spin-off success.

For government, this study has shown the importance of their position within the network. It has highlighted a need for government to work closely with industry and the academic to offer support other than by setting down a regulatory environment in which to operate. It has highlighted the need for government to offer suggestions and insights to academic entrepreneur about the needs and insights they possess over the environment they observe.

For universities, this study has provided an important road map of the role expected of them in the development of the spin-off. The role is far more complex than the existing literature has noted. Initially, the role of the university is important as the academic entrepreneur looks to the university for support at multiple levels. However, once the academic has been able to access those university networks to mobilise the innovation, their role is diminished and is expected to provide sage advice and critical oversight rather than direct involvement.

7.2.4 *Policy Implications*

The findings of this research suggest that policy involvement has gone far enough and that existing policies may need to be reviewed to engage better with the one-size-fits-all approach. Amendments to existing policies need to focus on the development of the academic support network and not the interconnectedness of the helix.

7.3 Recommendations

The findings of this study have been adapted to offer up relevant and practical recommendations to academics, universities and policy makers.

7.3.1 *Recommendations for Academic Entrepreneurs*

There are two principal recommendations for academic entrepreneurs.

First, as academic entrepreneurship is still trying to find its place within the university ecosystem, it is suggested that successful academic entrepreneurs operate as faculty-champions-of-academic-entrepreneurship. These 'champions' could offer support and guidance to new entrants into the field, especially when fighting internal battles for support and funding. This would develop awareness within the academic research community of the opportunities available to them and provide the initial links to the networks needed to realise those opportunities.

Secondly, it is suggested that these existing academic entrepreneurs work with the university to develop appropriate evaluation methods to evaluate the benefit that successful spin-offs create to society and the institution. This evaluation would need to focus on metrics that provide accreditation to the academic for the benefits created in the local environment.

7.3.2 *Recommendations for Universities*

A paradigm shift is needed in the role of technology transfer offices at South African universities. As most academics do not start their careers expecting their research to develop into commercial opportunities, the first role of the office is to review research and identify potential spin-off companies. Once identified, the role of the technology transfer office is to offer the academic, the networks required for development of their entrepreneurial skills, which in turn will support the

development of the academic's self-efficacy and self-confidence as an entrepreneur. This would equate to a 'how-to' role for the technology transfer office.

At this stage, it will be clear if the academic wishes to proceed with the development of a spin-off. If the academic chooses to pursue the spin-off, the role of the technology office should change to one of being a backstop that offers sage advice and acts as a mentor going forward. The institution will need to remove itself from decision making and involvement in the spin-off.

These recommendations suggest that the university should consider a change in institutional culture, practice and policies that support spin-off development as an important part of the academic societal contributions. This will, over time, result in a paradigm shift of how technology transfer offices operate to a focal network for collaboration.

7.3.3 *Recommendations for Policy Makers*

While the expectation of NIPMO is to create a foundation to stimulate engagement among academics, this research highlights that the regulation is not the missing piece of the puzzle. By simply regulating outcomes and not working with industry and leadership within the universities, the desired results may not be attained to their fullest potential. This research shows that academic entrepreneurship thrives within an ecosystem in which multiple stakeholders, including government, are engaged in spin-off development. This role should include supporting tax incentives to improve the availability of funding and reduce the risk of loss to academics – it is recommended that incentives, like the recently discontinued S12J, should be considered. In addition, tax incentives could be directed at donations that are directly focused on encouraging academic spin-off creation, which would be beneficial in reducing the financial risk implied in a spin-off. Further, the government could underwrite funding initiatives that guarantee sustainability in the event of an early exit by an industrial partner and ensure co-funding is available until the spin-off reaches sustainability.

There needs to be greater efforts by government to communicate with the academic community, not to regulate and legislate further, but to engage on needs, supports and a shared vision.

7.4 Limitations

While this study has been able to enhance theory and make practical contributions, there are a number of factors that limit this research's generalisability. First, this study was conducted using academic respondents from publicly funded universities in a single country context, namely South Africa. Thus, any comparisons made must take into account the differences in the social and cultural contexts of that country. Further, the finding of this thesis will need to be tested in the contexts of other developing country's universities. Responses from these academics may bring new insights and allow for the possibility for comparisons.

Secondly, this study used an online data collection process, where the researcher was completely absent when the forms were completed. The study did not supplement this data with individual interviews. Thus, it is difficult to draw conclusions that offer insight into the 'why' the respondents chose the options they did.

Thirdly, this study sought to understand the spin-off success through the engagement of social networks at an individual level; therefore, it is suggested that research focused on the organisational level be considered.

7.5 Suggestions for Future Research

The existing study has highlighted the importance of extending our understanding of spin-off development from a simple triple helix driven model to a more dynamic model that considers important social network inputs. However, the study did not consider the processes needed to develop these relationships or why specific

networks are more important and influential than others. It is suggested that future qualitative research be carried out to provide deeper insight. The specific focus should be on how to utilise specific networks to contribute positively to the success of spin-offs.

Secondly, future research should focus on testing the role of other mediating variables in the relationship. Insufficient understanding exists on how entrepreneurial attitudes; perceptions of academics or their indirect influences such as industrial cooperation or consulting to industry could affect our understanding of spin-off development. While this research did not consider the impact of secondary mediation relationships such as the influence of the CSIR, there appears to be anecdotal evidence to suggest that inclusion in the model may positively contribute to the improvement in the predictability of the overall model.

Thirdly, this research took a broad view when determining the aspirations of the academic. It considered drivers that could be directed by contributions to society, the focus of the academic and outcomes of commercialisation. However, there is scope to split these into separate variables and study their individual impacts. This is an important investigation as it would further enhance the predictability of the model. This would assist in understanding how other variables such as the characteristics of the spin-offs firm's managerial teams may also have a place in the model.

Fourthly, the research did not consider the impact of future research opportunities through the academic's engagement with his social network. How reciprocal benefits are understood and transferred would improve our understanding as to why some academics are more successful than others in their development of multiple spin-off companies. As a result, further studies are needed to understand if there is an academic research benefit to academic entrepreneurial network engagement in South Africa.

Finally, a few South African spin-offs have just started to show their long-term outcomes and more studies are needed to prove the impact that the social network has in the longer-term success. Longitudinal studies have shown significant benefits in understanding how individuals are able to evolve over time and greatly assist in determining cause-and-effect relationships. As spin-off evolve more temporal measuring points will aid in the future development of our understanding.

CHAPTER 8: REFERENCES

Aboelela, S. W., Larson, E., Bakken, S., Carrasquillo, O., Formicola, A., & Glied, S. (2007). Defining interdisciplinary research: Conclusions from a critical review of the literature. *Health Services Research*, *42*(1), 329–346.

Abou-Warda, S. H. (2015). Entrepreneurial orientation in business schools: A comparative study of higher education systems in Egypt. *International Journal of Educational Management*, *29*(2), 192–212. https://doi.org/10.1108/IJEM-11-2013-0165

Adato, M., Carter, M. R., & May, J. (2006). Exploring poverty traps and social exclusion in South Africa using qualitative and quantitative data. *Journal of Development Studies*, *42*(2), 226–247. https://doi.org/10.1080/00220380500405345

Agrawal, A., & Henderson, R. (2002). Putting Patents in Context: Exploring Knowledge Transfer from MIT. *Management Science*, *48*(1), 44–60. https://doi.org/10.1287/mnsc.48.1.44.14279

Al Ghabid, A. H., Atikah, N., Sutopo, W., Nizam, M., & Muhamad, I. I. (2015). Commercialization strategy formulation for university spin-off: A case study. In *Proceedings of the International MultiConference of Engineers and Computer Scientists* (Vol. 2, pp. 18-20).

Ali, S. B., Arif, K., Galani, S. Q., Ali, H., & Rehman, N. A. (2022). Do All Financial Economists Speak the Language of Positivism?. *International Journal of Social Science & Entrepreneurship*, *2*(2), 532-545.

Altbach, P. G. (2015). Building an academic career. *Young faculty in the twenty-first century: International perspectives*, *5*.

Aldrich, H. (2017). Learning together: National differences in entrepreneurship

research. *The Blackwell Handbook of Entrepreneurship*, 5–25.

Aldrich, H., & Zimmer, C. (1986). *Entrepreneurship through social networks*. *The Art and Science of Entrepreneurship*. APPEARS INCOMPLETE

Alessandrini, M., Klose, K., & Pepper, M. S. (2013). University entrepreneurship in South Africa: Developments in technology transfer practices. *Innovation: Management, Policy and Practice*, *15*(2), 205–214. https://doi.org/10.5172/impp.2013.15.2.205

Algieri, B., Aquino, A., & Succurro, M. (2013). Technology transfer offices and academic spin-off creation: The case of Italy. *Journal of Technology Transfer*, *38*(4), 382–400. https://doi.org/10.1007/s10961-011-9241-8

Altbach, P. G., Reisberg, L., & Rumbley, L. E. (2009). Trends in Global Higher Education : Tracking an Academic Revolution. *UNESCO 2009 World Conference on Higher Education*, (January), 22. https://doi.org/10.1016/j.bse.2004.04.006

Anderson, A. ., Dodd, S. ., & Jack, S. (2010). Network processes, practices and growth. *Scandinavian Journal of Management*, *26*(2), 121–133. https://doi.org/10.1177/0266242610391936

Anderson, A., & Ronteau, S. (2017). Towards an entrepreneurial theory of practice; emerging ideas for emerging economies. *Journal of Enterpreneurship in Emerging Economies*, *9*(2), 110–120. https://doi.org/10.1108/JEEE-10-2015-0058

Anderson, B., Covin, J., & Slevin, D. (2009). Understanding the relationship between entrepreneurial orientation and strategic learning capability: An empirical investigation. *Strategic Entrepreneurship Journal*, *3*, 218–240.

Anderson, B, Kreiser, P., Kuratko, D., Hornsby, J., & Eshima, Y. (2015). Reconceptualizing entrepreneurial orientation. *Strategic Management Journal*,

36, 1579–1596. https://doi.org/10.1002/smj

Anderson, & Obeng. (2017). Enterprise as socially situated in a rural poor fishing community. *Journal of Rural Studies*, *49*, 23–31. https://doi.org/10.1016/j.jrurstud.2016.11.015

Ankrah, S. N., Burgess, T. F., Grimshaw, P., & Shaw, N. E. (2013). Asking both university and industry actors about their engagement in knowledge transfer: What single-group studies of motives omit. *Technovation*, *33*(2–3), 50–65. https://doi.org/10.1016/j.technovation.2012.11.001

Bae, T. J., Qian, S., Miao, C., & Fiet, J. O. (2014). The Relationship Between Entrepreneurship Education and Entrepreneurial Intentions: A Meta-Analytic Review. *Entrepreneurship: Theory and Practice*, *38*(2), 217–254. https://doi.org/10.1111/etap.12095

Balzat, M., & Hanusch, H. (2004). Recent trends in the research on national innovation systems. *Journal of Evolutionary Economics*, *14*(2), 197–210. https://doi.org/10.1007/s00191-004-0187-y

Barger, B, Leffel, K & Lott, M (2021). Plotting Academic Innovation: A content Analysis of Twenty Institutuional Websides. *Journal of Innovative Higher Education, 47, 95-111.* https://doi.org/10.1007/s10755-021-09568-4

Barnes, T., Pashby, I., & Gibbons, A. (2002). Effective university - Industry interaction: A multi-case evaluation of collaborative R&D projects. *European Management Journal*, *20*(3), 272–285. https://doi.org/10.1016/S0263-2373(02)00044-0

Baron, R. and Kenny, D. (1986). The moderator-mediator relationship in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology*, 51, 1173-1182. Check use of & vs "and" with names

Barreira, J. C. D. (2004). *The influence of business knowledge and work experience, as antecedents to entrepreneurial success. incomplete*

Benner, M., & Sandström, U. (2000). Institutionalizing the triple helix: Research funding and norms in the academic system. *Research Policy*, *29*(2), 291–301. https://doi.org/10.1016/S0048-7333(99)00067-0

Bentler, P.M. & Bonnett, D.G. (1980). Significance tests and goodness of fit in the analysis of covariance structures, *Psychological Bulletin*, 88: 588-606.

Bentler, P.M. (1990). Comparative fit indexes in structural models, *Psychological Bulletin*, 107: 238–246.

Bernardes, A., & Albuquerque, E. (2003). Cross-over, thresholds and the interactions between science and technology: Lessons for less-developed countries. *Research Policy*, *32*(5), 867–887.

Bernasconi, A. (2005). University entrepreneurship in a developing country: The case of the P. Universidad Catlica de Chile, 1985-2000. *Higher Education*, *50*(2), 247–274. https://doi.org/10.1007/s10734-004-6353-1

Bhopal, K. (2014) The Experience of BME academics in higher Education: aspirations in the face of inequality. Leadership foundation for higher education 1–32.

Bloedon, R. V, & Stokes, D. R. (1994). Making University-Industry Collaborative Research Succeed. *Research-Technology Management*, *37*(2), 44–48.

Boix, C., & Posner, D. N. (1998). Social capital: Explaining its origins and effects on government performance. *British journal of political science*, *28*(4), 686-693.

Bollen, K.A. (1989). *Structural Equations with Latent Variables*. New York: Wiley.

Bönte, W., Falck, O., & Heblich, S. (2009). The impact of regional age structure on entrepreneurship. *Economic Geography*, *85*(3), 269-287.

Boomsma, A. (2000). Reporting analyses of covariance structures, *Structural Equation Modeling*, 7: 461–483.

Borgatti, S., & Halgin, D. (2013). On Network Theory. *SSRN Electronic Journal*, *22*(5), 1168–1181. https://doi.org/10.2139/ssrn.2260993

Bourdieu. (1990). *The logic of practice*. https://doi.org/10.1007/BF00680104

Bouty, I. (2000). Interpersonal and interaction influences on informal resource exchanges between R&D researchers across organizational boundaries. *Academy of Management Journal*, *43*(1), 50–65. https://doi.org/10.2307/1556385

Browne, M.W. & Cudek, R. (1993). Alternate ways of assessing model fit, In *Testing Structural Equation Models*, Bollen, K.A. and J.S. Long (eds.). Newbury Park, CA: Sage, pp 136–162.

Bramwell, A., Wolfe, D., & Hepburn, N. (2012). *Growing Innovation Ecosystems: University-Industry Knowledge Transfer and Regional Economic Development in Canada*.

Brannback, M., Carsrud, A., Krueger Jr., N., & Elfving, J. (2008). Challenging the triple helix model of regional innovation systems: A venture-centric model. *International Journal of Technoentrepreneurship*, *1*(3), 257–277. https://doi.org/10.1504/IJTE.2008.020539

Bryman, & Bell. (2015). *Business Research Methods*. Oxford University Press, USA.

Bunting, I. (2006). The Higher Education Landscape Under Apartheid, 35–52. https://doi.org/10.1007/1-4020-4006-7_3

Burt, R. (2017). *Structural holes versus network closure as social capital*. Routledge. Usually books have Place: Publisher - check guidelines, as well as

for use of capital first letters for titles

Cai. (2013). Enhancing context sensitivity of the Triple helix model : An institutional logics perspective. *11th International Triple helix Conference*, (July).

Carlsson, B. (2006). Internationalization of innovation systems: A survey of the literature. *Research Policy*, *35*(1), 56–67. https://doi.org/10.1016/j.respol.2005.08.003

Carlsson, B., & Fridh, A. C. (2002). Technology transfer in United States universities. *Journal of Evolutionary Economics*, *12*(1–2), 199–232. https://doi.org/10.1007/s00191-002-0105-0

Carlsson, B., & Stankiewicz, R. (1991). On the nature, function and composition of technological systems. *Journal of Evolutionary Economics*, *1*(2), 93–118. https://doi.org/10.1007/BF01224915

Chaminade, & Edquist. (2010). Rationales for public policy intervention in the innovation process: A systems of innovation approach. *The Theory and Practice of Innovation Policy. An International Research Handbook.*, (December), 95–114. Retrieved from http://staff.circle.lu.se/cristina.chaminade/wp-content/uploads/2015/09/Cham-Edq-Rationales-submitted-dec06-Book-innovation-policy.pdf

Chandrasekhar, A. G., Kinnan, C., & Larreguy, H. (2018). Social networks as contract enforcement: Evidence from a lab experiment in the field. *American Economic Journal: Applied Economics*, *10*(4), 43-78.

Chantson, J., & Urban, B. (2018). Entrepreneurial intentions of research scientists and engineers. *South African Journtal of Industrial Engineering*, *29*(2), 113–126.

Chia, & Holt. (2008). The nature of knowledge in business schools. *Academy of Management o Fmanagement Learning & Education*, *7*(4), 471–486.

Chin, W. W. (1998). Issues and Opinions on Structural Equation Modeling. *Management Information Systems Quarterly*, *22*(1), 1–14.

Cho, D. S., Ryan, P., & Buciuni, G. (2022). Evolutionary entrepreneurial ecosystems: A research pathway. *Small Business Economics*, *58*(4), 1865-1883.

Clarysse, B, Wright, M., Bruneel, J., & Mahajan, A. (2014). Creating value in ecosystems: Crossing the chasm begtween knowledge and business ecosystems. *Research Policy*, *43*, 1164–1176.

Clarysse, Bart, Tartari, V., & Salter, A. (2011). The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. *Research Policy*, *40*(8), 1084–1093. https://doi.org/10.1016/j.respol.2011.05.010

Clarysse, Bart, Wright, M., Lockett, A., Mustar, P., & Knockaert, M. (2007). Academic spin-offs, formal technology transfer and capital raising. *Industrial and Corporate Change*, *16*(4), 609–640. https://doi.org/10.1093/icc/dtm019

Cohen, J., Cohen, P., West, S.G. and Aiken, L.S. (2003). *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences* (3rd Ed.) Mahwah, NJ: Lawrence Erlbaum and Associates.

Cohen, W., & Levinthal, D. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, *35*(1), 128–152. https://doi.org/10.2307/2393553

Colapinto, C., & Porlezza, C. (2012). Innovation in Creative Industries: From the Quadruple Helix Model to the Systems Theory. *Journal of the Knowledge Economy*, *3*(4), 343–353. https://doi.org/10.1007/s13132-011-0051-x

Colvin, J., & Miller, D. (2014). International entrepreneurial orientation: Conceptual considerations, research themes, measurement issues, and future research

directions. *Entrepreneurship, Theory & Practice*, *38*(1), 11–44.

Colyvas, J. A., Crow, M., Gelijns, A., Mazzoleni, R., R, R., Rosenberg, N., … Nelson, R. R. (2002). How do University Inventions Get into Practice ? *Management Science*, *48*(1), 61–72.

Comacchio, A., Bonesso, S., & Pizzi, C. (2012). Boundary spanning between industry and university: The role of Technology Transfer Centres. *Journal of Technology Transfer*, *37*(6), 943–966. https://doi.org/10.1007/s10961-011-9227-6

Cooke, P. (2005). Regionally asymmetric knowledge capabilities and open innovation: Exploring “Globalisation 2” - A new model of industry organisation. *Research Policy*, *34*(8), 1128–1149. https://doi.org/10.1016/j.respol.2004.12.005

Corley, K. G., & Gioia, D. a. (2011). Building Theory about Theory: What Constitutes a Theoretical Contribution? *Academy of Management Review*, *36*(1), 12–32. https://doi.org/10.5465/AMR.2011.55662499

Corolleur, C., Carrere, M., & Mangematin, V. (2004). Turning Scientific and technological human capital into economic capital: The experience of biotec start-ups in France. *Research Policy*, *33*(4), 632–642.

Covin, J., & Slevin, D. (1989). Strategic Management of Small Firms in Hostile and Benign Environments. *Strategic Management Journal*, *10*(1), 75–87.

Creswell, J. (2003). *Research design: qualitative, quantitative, and mixed methods approaches* (2nd Editio). California, USA: Sage Publications.

Creswell, J. (2013). *Qualitative inquiry and research design: choosing among five approaches* (3rd ed.). California, USA: Sage Publications.

Crotty, M. (1998). *The Foundations of Social Research: Meaning and Perspective*

in the Research Process. Sage Publications.

Cunliffe, A. L. (2011). Crafting Qualitative Research: Morgan and Smircich 30 Years On. *Organizational Research Methods*, *14*(4), 647–673. https://doi.org/10.1177/1094428110373658

Cunningham, J., O'Reilly, P., Dolan, B., O'Kane, C., & Mangematin, V. (2016). Female Publicly Funded Principal Investigators. *Gender Issues in Entrepreneurship*.

Cyert, R., & Goodman, P. (1997). Creating effective University-Industry Alliances: An Organizational Learning Perspective. *Organizational Dynamics*, *25*(4), 45–57. https://doi.org/10.1016/S0090-2616(97)90036-X

Czarniawska, B., & Genell, K. (2002). Gone shopping? Universities on their way to the market. *Scandinavian Journal of Management*, *18*(4), 455–474. https://doi.org/10.1016/S0956-5221(01)00029-X

D'Este, P., & Perkmann, M. (2011). Why do academics engage with industry? The entrepreneurial university and individual motivations. *Journal of Technology Transfer*, *36*(3), 316–339. https://doi.org/10.1007/s10961-010-9153-z

Davenport, S., Davies, J., & Grimes, C. (1998). Collaborative research programmes: building trust from difference. *Technovation*, *19*(1), 31–40. https://doi.org/10.1016/S0166-4972(98)00083-2

Davey, T., Rossano, S., & Sijde, P. Van Der. (2015). Does context matter in academic entrepreneurship ? The role of barriers and drivers in the regional and national context. *The Journal of Technology Transfer*, (October), 1–26.

Davidsson, P., & Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. *Journal of Business Venturing*, *8*, 301–333.

De Carolis, D., & Saparito, P. (2006). Social Cpatial, Cognition, and Entrepreneurial

Opportunities: A Theoretical Framework. *Entrepreneurship Theory and Practice*, 41–56. https://doi.org/10.1111/j.1540-6520.2011.00481.x

De Clercq, D., & Voronov, M. (2009). Toward a Practice Perspective of Entrepreneurship. *International Small Business Journal*, *27*(4), 395–419.

DHET. (2019). Universities in South Africa. Retrieved from http://www.dhet.gov.za/SiteAssets/New site Documents/Universities in South Africa1.pdf

Dickson, P. H., Solomon, G. T., & Weaver, K. M. (2008). 2008. Entrepreneurial selection and success: Does education matter? *Journal of Small Business and Enterprise Development*, *15*(2), 239–258.

Diez-Vial, I., & Montoro-Sanchez, A. (1017). Research evolution in science parks and incubators: foundations and new trends. *Scientometrics*, *110*, 1243–1272.

DiGregorio, D., & Shane, S. (2003). Why do some universities generate more start-ups than others? *Research Policy*, *32*(2 SPEC.), 209–227. https://doi.org/10.1016/S0048-7333(02)00097-5

Drucker, P., & Noel, J. (1986). Innovation and Entrepreneurship. Practice and Principles. *The Journal of Continuing Higher Education*, *34*(1), 22–23.

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *Academy of Management Review*, *14*(4), 532–550. https://doi.org/10.5465/AMR.1989.4308385

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. American journal of theoretical and applied statistics, 5(1), 1-4.

Etzkowitz, H. (1998). The norms of entrepreneurial science: cognitive effects of the new university–industry linkages. *Research Policy*, *27*(8), 823–833.

https://doi.org/10.1016/S0048-7333(98)00093-6

Etzkowitz, H. (2003a). Innovation in innovation : the Triple helix of university - industry - government relations. *Social Science Information*, *42*(3), 293–337.

Etzkowitz, H. (2003b). Research groups as “quasi-firms”: The invention of the entrepreneurial university. *Research Policy*, *32*(1), 109–121. https://doi.org/10.1016/S0048-7333(02)00009-4

Etzkowitz, H., Asplund, P., & Nordman, N. (2001). *Beyond Humboldt : Emergence of Academic Entrepreneurship in the Beyond Humboldt : Emergence of Academic U . S . and Sweden*.

Etzkowitz, H., & Kemelgor, C. (1998). The Role of Research Centres in the Collectivisation of Academic Science. *Minerva*, *36*(3), 271–288. https://doi.org/Doi 10.1023/A:1004348123030

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and “Mode 2” to a Triple helix of university–industry–government relations. *Research Policy*, *29*(2), 109–123. https://doi.org/10.1016/S0048-7333(99)00055-4

Etzkowitz, H., Webster, A., Gebhardt, C., & Terra, B. R. C. (2000). The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. *Research Policy*, *29*(2), 313–330. https://doi.org/http://dx.doi.org/10.1016/S0048-7333(99)00069-4

Fagerberg, J. (2009). Innovation: A Guide to the Literature. *The Oxford HandbookInnovation*, 1–22. https://doi.org/10.1093/oxfordhb/9780199286805.003.0001

Fan, Y., Chen, J., Shirkey, G., John, R., Wu, S. R., Park, H., & Shao, C. (2016). Applications of structural equation modeling (SEM) in ecological studies: an updated review. *Ecological Processes*, *5*(1). https://doi.org/10.1186/s13717-

016-0063-3

Farrell, A., Mapanga, W., Chitha, N., Ashton, J., Joffe, M. 2022. Characteristics, enablers and barriers affecting entrepreneurial behaviour for academics in low- and middle - income countries: A scoping review. Development Southern Africa 39(4), 589-603. DOI: 10.1080/0376835X.2022.2027230

Fernández-Alles, M., Hernández-Roque, D., Villanueva-Flores, M., & Díaz-Fernández, M. (2022). The impact of human, social, and psychological capital on academic spin-off internationalization. *Journal of International Entrepreneurship*, *20*(3), 433-473.

Fini, R., Perkmann, M., Ross, J., (2021) Attention to Exploration: The Effect of Academic Entrepreneurship on the Production of Scientific Knowledge. *Organization Science* 33(2):688-715.

Florin, J., Schulze, M., & Lubatkin, W. (2019). A Social Capital Model of High-Growth Ventures. *The Academy of Management*, *46*(3), 374–384.

Foray, D. (2002). Intellectual Property and Innovation in the Knowledge-Based Economy. *Isuma Canadian Journal of Policy Research*, (Spring Printemps), 71–78.

Fourie-Malherbe, M. (1999). Institutional transformation at South African universities : Implications for academic staff. *Higher Education*, (October), 275–290. https://doi.org/10.1023/A

Frese, M., Bausch, A., Schmidt, P., Strauch, A., & Kabst, R. (2012). Evidence-based entrepreneurship: Cumulative science, action principles, and bridging the gap between science and practice. *Foundations and Trends in Entrepreneurship*, *8*(1), 1–62.

Frese, M., Brantjes, A., & Hoorn, R. (2002). Psychological Success Factors of Small Scale Businesses in Namibia: The Roles of Strategy Process, Entrepreneurial

Orientation and the Environment. *Journal of Developmental Entrepreneurship*, *7*(3), 259–282.

Friedman, J., & Silberman, J. (2003). University Technology Transfer: Do Incentives, Management, and Location Matter? *Journal of Technology Transfer*, *28*, 17–30. Retrieved from http://dx.doi.org/10.1023/A:1021674618658

Fukuyama, F. (2001). Social capital, civil society and development. *Third World Quarterly*, *22*(1), 7–20. https://doi.org/10.1080/01436590020022547

Fulop, L., & Couchman, P. K. (2006). Facing up to the risks in commercially focused university–industry R&D partnerships. *Higher Education Research & Development*, *25*(2), 163–177.

Gaglio, C. M., & Katz, J. A. (2001). The Psychological Basis of Opportunity Identification: Entrepreneurial Alertness. *Small Business Economics*, *16*, 95–111. https://doi.org/10.1023/A

Gartner, W. B., Stam, E., Thompson, N., & Verduyn, K. (2016). Entrepreneurship as practice: grounding contemporary practice theory into entrepreneurship studies. *Entrepreneurship & Regional Development*, *28*(9–10), 813–816. https://doi.org/10.1080/08985626.2016.1251736

Geiger, D. (2009). Revisiting the Concept of Practice: Toward an Argumentative Understanding of Practicing. *Management Learning*, *40*(2), 129–144. https://doi.org/10.1177/1350507608101228

George, B. A., & Marino, L. (2011). The epistemology of entrepreneurial orientation: Conceptual formation, modeling, and operationalization. *Entrepreneurship: Theory and Practice*, *35*(5), 989–1024. https://doi.org/10.1111/j.1540-6520.2011.00455.x

Gibb, A. (1996). Entrepreneurship and small business management: Can we afford

to neglect them in the twenty-first cengtury business school? *British Journal of Management*, *7*(7), 309–321.

Gibb, A., & Hannon, P. (2010). *Towards the Entrepreneurial university*. Durham, UK.

Gnambs, T., & Kaspar, K. (2014). Disclosure of sensitive behaviors across self-administered survey modes: a meta-analysis. *Behavior Research Methods*, *47*(4), 1237–1259. https://doi.org/10.3758/s13428-014-0533-4

Golsorkhi, D., Rouleau, L., Seidl, D., & Vaara, E. (2011). What is Strategy as Practice. *Cambridge Handbook of Strategy as Practice*, 1–22.

Gorke, A., & Scholl, A. (2006). Niklas Luhmann's Theoory of Social Systems and Journalism Research. *Journal Stud*, *7*(4), 644–655.

Granovetter, M. (1983). The strength of weak ties : A network theory revisited. *Sociological Theory*, *1*(1983), 201–233.

Greve, A., & Salaf, J. (2003). Social Networks and Entrepreneurship. *Entrepreneurship, Theory & Practice*, *28*(1), 233–252. https://doi.org/10.1007/0-387-23622-8_11

Grimaldi, R., Kenney, M., Siegel, D., & Wright, M. (2011). 30 years after Bayh-Dole: Reassessing academic entrepreneurship. *Research Policy*, *40*(8), 1045–1057.

Grimpe, C., & Hussinger, K. (2008). *Formal and Informal Technology Transfer from Academia to Industry: Complementarity Effects and Innovation Performance*.

Hayter, C. S. (2011). In search of the Profit-Maximizing Actor: Motivations aand Definitions of Success from nascent academic entrepreneurs. Journal of Technology Transfer, 36, 340-352.

Hayter, C. S. (2016). A trajectory of early-stage spinoff success: the role of knowledge intermediaries within an entrepreneurial university ecosystem. *Small Business Economics*, *47*(3), 633–656. https://doi.org/10.1007/s11187-016-9756-3

Hayter, C.S., Fischer, B & Rasmussen, Einar (2021) Becoming an academic entrepreneur: how scientists develop an entrepreneurial identity. *Small Business Economics,* 59(1), 1-19. https://doi.org/10.1007/s11187-021-00585-3

Heale, R., & Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence Based Nursing*, *0*(0), 1–2. https://doi.org/10.1136/eb-2015-102129

Hite, J. (2005). Evolutionary processes and paths of relationally embedded network ties in emerging entrepreneurial firms. *Entrepreneurship: Theory and Practice*, *29*(1), 113–144.

Hoang, H., & Antoncic, B. (2003a). Network-based research in entrepreneurship A critical review. *Journal of Business Venturing*, *18*(2), 165–187. https://doi.org/10.1016/S0883-9026(02)00081-2

Hoang, H., & Antoncic, B. (2003b). Network-based research in entrepreneurship A critical review, *18*, 165–187. https://doi.org/10.1016/S0883-9026(02)00081-2

Hsu, D. H. (2007). Experienced entrepreneurial founders, organizational capital, and venture capital funding. *Research Policy*, *36*(5), 722–741. https://doi.org/10.1016/j.respol.2007.02.022

Hulsbeck, M., Lehmann, E. E., & Starnecker, A. (2013). Performance of technology transfer offices in Germany. *Journal of Technology Transfer*, *38*(3), 199–215. https://doi.org/10.1007/s10961-011-9243-6

Iazzolino, G., Greco, D., Verteramo, S., Attanasio, A. L., Carravetta, G., & Granato, T. (2020). An integrated methodology for supporting the development and the

performance evaluation of academic spin-offs. *Measuring Business Excellence*, *24*(1), 69-89.

Iofrida, N., De Luca, A. I., Strano, A., & Gulisano, G. (2018). Can social research paradigms justify the diversity of approaches to social life cycle assessment? *International Journal of Life Cycle Assessment*, *23*(3), 464–480. https://doi.org/10.1007/s11367-016-1206-6

Ismail, K., Anuar, M. A., Omar, W. Z. W., Aziz, A. A., Seohod, K., & Akhtar, C. S. (2015). Entrepreneurial Intention, Entrepreneurial Orientation of Faculty and Students towards Commercialization. *Procedia - Social and Behavioral Sciences*, *181*, 349–355. https://doi.org/10.1016/j.sbspro.2015.04.897

Jack, S., Dodd, S., & Anderson, A. (2008). Change and the development of entrepreneurial networks over time: a processual perspective. *Entrepreneurship and Regional Development*, *20*(2), 125–159.

Jack, S. L., & Anderson, A. R. (2002). The effects of embeddedness on the entrepreneurial process. *Journal of Business Venturing*, *17*(5), 467–487.

Jack, S. L., Moult, S., Anderson, A. R., & Dodd, S. (2010). An entrepreneurial network evolving: Patterns of change. *International Small Business Journal*, *28*(4), 315–337. https://doi.org/10.1177/0266242610363525

Jacob, M., Lundqvist, M., & Hellsmark, H. (2003). Entrepreneurial transformations in the Swedish University system: The case of Chalmers University of Technology. *Research Policy*, *32*(9), 1555–1568. https://doi.org/10.1016/S0048-7333(03)00024-6

Jain, S., George, G., & Maltarich, M. (2009). Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. *Research Policy*, *38*(6), 922–935. https://doi.org/10.1016/j.respol.2009.02.007

James, L.R. and Brett, J.M. (1984). Mediators, moderators, and tests for mediation. *Journal of Applied Psychology*, 69, 307-321.

Jarvis, C. B., MacKenzie, S. B., & Podsakoff, P. M. (2003). A critical review of construct indicators and measurement model misspecification in marketing and consumer research. *Journal of Consumer Research*, 30(2), 199-218.

Johnes, J. (2018). University rankings: What do they really show?. *Scientometrics*, *115*(1), 585-606

Jones, K. (2000). A Regrettable Oversight or a Significant Omission? Ethical considerations in quantitative research in education. *Situated Ethics in Educational Research*, 147–161. https://doi.org/10.1002/sce.20030

Joshi, A., Kale, S., Chandel, S., & Pal, D. (2015). Likert Scale: Explored and Explained. *British Journal of Applied Science & Technology*, *7*(4), 396–403. https://doi.org/10.9734/BJAST/2015/14975

Kadushin, C. (2012). Introduction to Social Network Theory. *Theories, Concepts, and Findings*, 252. https://doi.org/10.1007/978-1-4614-2254-9

Kahsay, M. (2017). The Links between Academci Researh and economic Development in Ethiopia: The Case of the Addis Ababa University. *European Journal of STEM Education*, *2*(2), 1–10.

Kaplan, D. (2000). *Structural Equation Modeling*. Thousand Oaks, CA: Sage.

Karmaeva, N (2018). Career Aspirations of Young Academics in Russia. European Education 50(3). 283-299.

Khan, K. S., Kunz, R., Kleijnen, J., & Antes, G. (2003). Five steps to conducting a systematic review. *Journal of the Royal Society of Medicine*, *96*(3), 118–121.

Kline, R.B. (2005). *Principles and Practice of Structural Equations Modelling*. 2nd Edition. NY: Guilford Press.

Kline, R. B. (2011). *Principles and practice of structural equation modeling*. New York: Guilford Press. Consistency is important - the reference above has NY and this one is New York

Klofsten, M., & Jones-Evans, D. (2000). Comparing Academic Entrepreneurship in Europe – The Case of Sweden and Ireland. *Small Business Economics*, *14*(4), 299–309. https://doi.org/10.1023/a:1008184601282

Klooster, N. (2022). *The Success Formula for University Spin-Off Founders: how entrepreneurial characteristics can influence university spin-off success throughout different stages of the process* (Master's thesis, University of Twente).

Klyver, K., Hindle, K., & Meyer, D. (2008). Influence of social network structure on entrepreneurship participation-a study of 20 national cultures. *International Entrepreneurship and Management Journal*, *4*(3), 331–347. https://doi.org/10.1007/s11365-007-0053-0

Knockaert, M., Ucbasaran, D., Wright, M., & Clarysse, B. (2011). The relationship between knowledge transfer, top management team composition, and performance: The case of science-based entrepreneurial firms. *Entrepreneurship: Theory and Practice*, *35*(4), 777–803. https://doi.org/10.1111/j.1540-6520.2010.00405.x

Ko, S., & Butler, J. E. (2007). Creativity: A key link to entrepreneurial behavior. *Business Horizons*, *50*(5), 365–372. https://doi.org/10.1016/j.bushor.2007.03.002

Koh, F., & Koh, Winston, Tschang, F. (2005). An analytical framework for science parks and technology districts with an aplication to Singapore. *Journal of Business Venturing*, *20*(2), 217–239.

Kolvereid, L., & Bullvag, E. (1996). Growth intentions and actual growth: The impact

of entrepreneurial choice. *Journal of Enterprising Culture*, 4(1), 1–17

Krueger, N. (2007). The Cognitive Infrastructure of Opportunity Emergence. *Entrepreneurship*, 185–206. https://doi.org/10.1146/annurev.polisci.11.060606.135342

Kruss, G., & Visser, M. (2017). Putting university–industry interaction into perspective: a differentiated view from inside South African universities. *Journal of Technology Transfer*, *42*(4), 884–908. https://doi.org/10.1007/s10961-016-9548-6

Laukkanen, M. (2003). Exploring academic entrepreneurship: drivers and tensions of university-based business. *Journal of Small Business and Enterprise Development*, *10*(4), 372–382. https://doi.org/10.1108/14626000310504684

Laursen, K., & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, *27*(2), 131–150. https://doi.org/10.1002/smj.507

Lee, G.J. (2015). *Business statistics made easy in SAS*. SAS Press.

Lee, Y. S. (1996). “Technology transfer” and the research university: A search for the boundaries of university-industry collaboration. *Research Policy*, *25*(6), 843–863. https://doi.org/10.1016/0048-7333(95)00857-8

Leedy, P. D., & Ormrod, J. E. (2010). *Practical Research* (9th ed.). New York, USA: Pearson Education International.

Lester, R. K. (2005). Universities, Innovation, and the Competitiveness of Local Economies: A Summary Report from the Local Innovation Systems Project—Phase I. *Industrial Performance Center - Massachesetts Institute of Technology*, 33. Retrieved from http://web.mit.edu/lis/

Leyden, D. P., Link, A. N., & Siegel, D. S. (2014). A theoretical analysis of the role

of social networks in entrepreneurship. *Research Policy*, *43*(7), 1157–1163. https://doi.org/10.1016/j.respol.2014.04.010

Leydesdorff, L., & Etzkowitz, H. (1996). Emergence of a triple helix of university-industry-government relations. *Science and Public Policy*, *23*(5), 279–286. https://doi.org/10.1093/spp/23.5.279

Liang, J., Wang, H., & Lazear, E. (2014). Demographics and Entrepreneurship. https://doi.org/10.3386/w20506

Lin, N. (2005). Building a network theory of social capital. *Connections*, *22*(1), 28–51. https://doi.org/10.1108/14691930410550381

Liñán, F., Nabi, G., & Krueger, N. (2013). British and Spanish entrepreneurial intentions: a comparative study. *Revista de Economia Mundial*, *33*, 73–103.

Lindgren, M., & Packendorff, J. (2009). Social constructionism and entrepreneurship: Basic assumptions and consequences for theory and research. *International Journal of Entrepreneurial Behaviour & Research*, *15*(1), 25–47. https://doi.org/10.1108/13552550910934440

Link, A. N., & Siegel, D. S. (2005). Generating science-based growth: An econometric analysis of the impact of organizational incentives on university-industry technology transfer. *European Journal of Finance*, *11*(3), 169–181. https://doi.org/10.1080/1351847042000254211

Link, A. N., Siegel, D. S., & Bozeman, B. (2007). An empirical analysis of the propensity of academics to engage in informal university technology transfer. *Industrial and Corporate Change*, *16*(4), 641–655. https://doi.org/10.1093/icc/dtm020

Little, R. J. A. and Rubin, D. B. (2002). *Statistical analysis with missing data* (2nd ed). John Wiley & Sons.

Liu, J., Chaminade, C., & Asheim, B. (2013). The Geography and Structure of Global Innovation Networks: A Knowledge Base Perspective. *European Planning Studies*, *21*(9), 1456–1473. https://doi.org/10.1080/09654313.2012.755842

Liu, W., Sidhu, A., Beacom, A. M., & Valente, T. W. (2017). Social Network Theory. *The International Encyclopedia of Media Effects*, 1–12. https://doi.org/10.1002/9781118783764.wbieme0092

Liyanage, S., & Mitchell, H. (1994). Strategic management of interactions at the academic-industry interface. *Technovation*, *14*(10), 641–655. https://doi.org/10.1016/0166-4972(94)90111-2

Lockett, A., & Wright, M. (2005). Resources, capabilities, risk capital and the creation of university spin-out companies. *Research Policy*, *34*(7), 1043–1057. https://doi.org/10.1016/j.respol.2005.05.006

Lumpkin, & Dess. (1996). Clarifying the Entrepreneurial Orientation Construct and Linking It to Performance. *The Academy of Management Review*, *21*(1), 135–172.

Lumpkin, G. T., Cogliser, C. C., & Schneider, D. R. (2009). Understanding and Measuring Autonomy: An Entrepreneurial Orientation Perspective. *Entrepreneurship Theory and Practice*, (315), 695–714.

Luu, N., & Ngo, L. (2019). Entrepreneurial orientation and socil ties in transitional economies. *Long Range Planning*, *52*, 103–116.

Macho-Stadler, I., Pérez-Castrillo, D., & Veugelers, R. (2007). Licensing of university inventions: The role of a technology transfer office. *International Journal of Industrial Organization*, *25*(3), 483–510. https://doi.org/10.1016/j.ijindorg.2006.06.001

MacKenzie, S., & Podsakoff, P. (2012). Common Method Bias in Marketing:

Causes, Mechanisms, and Procedural Remedies. *Journal of Retailing*, *88*(4), 556–562. https://doi.org/10.1016/j.jretai.2012.10.002

Madhok, A. (2006). Revisiting multinational firms' tolerance for joint ventures: A trust-based approach. *Journal of International Business Studies*, *37*(1), 30–43.

Malhotra, N. K. (2006). *Questionnaire design and scale development. The handbook of marketing research: Uses, misuses, and future advances.*

Markman, G. D., Gianiodis, P. T., Phan, P. H., & Balkin, D. B. (2005). Innovation speed: Transferring university technology to market. *Research Policy*, *34*(7), 1058–1075. https://doi.org/10.1016/j.respol.2005.05.007

Markman, G. D., Phan, P. H., Balkin, D. B., & Gianiodis, P. T. (2005). Entrepreneurship and university-based technology transfer. *Journal of Business Venturing*, *20*(2), 241–263. https://doi.org/10.1016/j.jbusvent.2003.12.003

Marquina, M., & Ferreiro, M. (2015). The Academic Profession: The Dynamics of Emerging Countries. In W. K. Cummings & U. Teichler (Eds.), *The Relevance of Academic Work in Comparative Perspective* (pp. 179–192). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-11767-6_11

Marsden, P., & Campbell, K. (1984). Measuring Tie Strength. *Social Forces*, *63*(2), 482–501.

Marshall, M. N. (1996). Sampling for Qualitative Research. *Family Practice*, *13*(6), 522–526. https://doi.org/10.1093/fampra/13.6.522

Martins, I. (2016). Network Usage, Entrepreneurial Orientation and Their Effectiveness on SMEs Growth. *Journal of Entrepreneurship*, *25*(1), 18–41. https://doi.org/10.1177/0971355715616230

Mcguirk, P. M., & O'Neill, P. (2016). Using questionnaires in qualitative human

geography. *Qualitative Research Methods in Human Geography*, 246–273. https://doi.org/9780195430158

McDonald, R.P. & Ho, M-H. (2002). Principles and practice in reporting structural equation analyses, *Psychological Methods*, 7: 64-82.

Mentoor, E. R., & Friedrich, C. (2010). Is Entrepreneurial Education at South African Universities Successful? *Industry and Higher Education*, *21*(3), 221–232. https://doi.org/10.5367/000000007781236862

Meyer, M. (2003). Academic entrepreneurs or entrepreneurial academics? research-based ventures and public support mechanisms. *R&D Management*, *33*(April), 107–115. https://doi.org/10.1111/1467-9310.00286

Mian, S. (2011). University's involvement in technology business incubation: What theory and practice tells us? *International Journal of Entrepreneurship and Innovation Management*, *13*(2), 113–121.

Miller, D., Fern, M., & Cardinal, L. (2007). The use of knowledge fro technological innovation within diversified firms. *Academy of Management Journal*, *50*(2), 307–325.

Mitchell, R. K., Busenitz, L. W., Morse, E. A., & Smith, J. B. (2002). Toward a Theory of Entrepreneurial Cognition: Rethinking the People Side of Entrepreneurship Research. *Entrepreneurship Theory and Practice*, (806), 93–104. https://doi.org/10.1111/1540-8520.00001

Modell, S. (2009). In defence of triangulation: A critical realist approach to mixed methods research in management accounting. *Management Accounting Research*, *20*(3), 208-221.

Mogues, T., & Carter, M. R. (2005). Social Capital and the reproduction of Economic Inequality in Polarized Societies. *International Food Policy Research Institute*, *25*, 1–51.

Morgan, G., & Smircich, L. (1980). The Case for Qualitative Research. *Academy of Management Review*, *5*(4), 491–500.

Morris, M. (2015). Entrepreneurship as Experience. *Wiley Encyclopedia of Management*, 1–6.

Morris, M., Kuratko, D., & Covin, J. (2010). *Corporate entrepreneurship & Innovation* (3rd ed.). Mason, OH, USA: Cengage Learning.

Morrison, T. G., Morrison, M. A., & McCutcheon, J. M. (2017). Best Practice Recommendations for Using Structural Equation Modelling in Psychological Research. *The Counseling Psychologist*, *08*(09), 1326–1341. https://doi.org/10.4236/psych.2017.89086

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2008). Verification Strategies for Establishing Reliability and Validity in Qualitative Research. *International Journal of Qualitative Methods*, *1*(2), 13–22. https://doi.org/10.1063/1.2011328

Mosey, S., & Wright, M. (2007). From Human Capital to social capital: A longitudinal study of technology-based academic entrepreneurs. *Entrepreneurship Theory and Practice*, *31*(6), 909–935.

Motohashi, K. (2005). University-industry collaborations in Japan: The role of new technology-based firms in transforming the National Innovation System. *Research Policy*, *34*(5), 583–594. https://doi.org/10.1016/j.respol.2005.03.001

Mowery, D. C., & Sampat, B. N. (2005). Universities in National Innovation Systems. *The Oxford Handbook of Innovation*, 209–239. https://doi.org/10.1093/oxfordhb/9780199286805.003.0008

Murphy, P. J. (2011). A 2×2 Conceptual Foundation for Entrepreneurial Discovery Theory. *Entrepreneurship: Theory and Practice*, *35*(2), 359–374. https://doi.org/10.1111/j.1540-6520.2010.00368.x

Muscio, A, Quaglione, D & Ramaciotti, L (2016) The effects of university rules on spinoff creation: The case of academia in Italy. Research Policy. 45 (7)

Myres, K. (2008). *Venture Creation: building theory from South African case studies*.

Naldi, L., Nordqvist, M., Sjöberg, K., & Wiklund, J. (2009). Entrepreneurial Orientation , Risk Taking , and Performance in Family Firms. *Family Business Review*, (1), 33–47.

Nauwelaers, C., & Wintjes, R. (2002). Innovating SMEs and Regions: The Need for Policy Intelligence and Interactive Policies. *Technology Analysis & Strategic Management*, *14*(2), 201–215. https://doi.org/10.1080/09537320220133866

Nicolaou, N., & Birley, S. (2003). Academic networks in a trichotomous categorisation of university spinouts. *Journal of Business Venturing*, *18*(3), 333–359. https://doi.org/10.1016/S0883-9026(02)00118-0

Nobanee, H., Alhajjar, M., Abushairah, G., & Al Harbi, S. (2021). Reputational Risk and Sustainability: A Bibliometric Analysis of Relevant Literature. Risks, 9(7), 134.

NRF, & Qhobela, D. M. (2017). There is no assault on academic excellence – Professor Bozzoli got it wrong. Retrieved from http://www.nrf.ac.za/media-room/news/there-no-assault-academic-excellence-–-professor-bozzoli-got-it-wrong

O'Gorman, C., O. Byrne, and D. Pandya (2008). "How Scientists Commercialise New Knowledge via Entrepreneurship", Journal of Technology Transfer, 33, 23-43.

O'Shea, R.P., Allen, T.J., O'Gorman, C., & Roche, F. (2004). Universities and Technology Transfer : A Review of Academic Entrepreneurship Literature. *Irish Journal of Management*, *25*, 11–29. https://doi.org/Article

O’Shea, R.P., Allen, T.J., Morse, K.P., O’Gorman, C., & Roche, F. (2007). Delineating the anatomy of an Entrepreneurial University: The Massachusetts Institute of Technology experience. *R and D Management*, *37*(1), 1–16. https://doi.org/10.1111/j.1467-9310.2007.00454.x

O’Shea, R.P., Allen, T.J., Chevalier, A., & Roche, F. (2005). Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities. *Research Policy*, *34*(7), 994–1009. https://doi.org/10.1016/j.respol.2005.05.011

O’Shea, R.P., Chugh, H., & Allen, T.J. (2008). Determinants and consequences of university spinoff activity: A conceptual framework. *Journal of Technology Transfer*, *33*(6), 653–666. https://doi.org/10.1007/s10961-007-9060-0

O'Shea, R. P., Allen, T., Morse, K., O’Gorman, C., & Roche, F. (2007). Delineating the anatomy of an entrepreneurial university: the Massachusetts Institute of Technology experience. *R&D Management*, *37*(1), 16. https://doi.org/10.1111/j.1467-9310.2007.00454.x

Obschonka, M., Moeller, J., & Goethner, M. (2019). Entrepreneurial passion and personality: the case of academic entrepreneurship. *Frontiers in psychology*, *9*, 2697.

Owen-Smith, J. (2003). From separate systems to a hybrid order: Accumulative advantage across public and private science at Research One universities. *Research Policy*, *32*(6), 1081–1104. https://doi.org/10.1016/S0048-7333(02)00111-7

Park, Y., Konge, L., & Artino, A. R. (2020). The Positivism Paradigm of Research.. Academic medicine : journal of the Association of American Medical Colleges, 95 (5). http://dx.doi.org/10.1097/ ACM.0000000000003093

Parker, S. C. (2004). *The economics of self-employment and entrepreneurship.*

Cambridge, U.K.: Cambridge University Press.

Peng, M. W., Campbell, W., & Lee, S. (2014). Entrepreneurs as Intermediaries. *Journal of World Business*.

Pérez, M. P., & Sánchez, A. M. (2003). The development of university spin-offs: Early dynamics of technology transfer and networking. *Technovation*, *23*(10), 823–831. https://doi.org/10.1016/S0166-4972(02)00034-2

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Brostroom, A., D'Este, P., … Sobrero, M. (2013). Academic engagement and commercialisation: A review of the literature on university-industry relations. *Research Policy*, *42*(2), 423–442. https://doi.org/10.1016/j.respol.2012.09.007

Perry-smith, J., & Mannucci, P. (2017). From Creativity To Innovation : the Social Network Drivers of the Four Phases of the Idea Journey. *Academy of Management Review*, *42*(1), 53–79. https://doi.org/10.5465/amr.2014.0462

Phan, P. H., Siegel, D. S., & Wright, M. (2005). Science parks and incubators: Observations, synthesis and future research. *Journal of Business Venturing*, *20*(2), 165–182. https://doi.org/10.1016/j.jbusvent.2003.12.001

Ping, R.A. (2010). "How are Formative Latent Variables estimated with LISREL, EQS, AMOS, etc.?" [on-line paper]. http://www.wright.edu/~ robert.ping/Forma.doc.

Podsakoff, P.M., MacKenzie, S.B., Lee, J-Y., Podsakoff, N.P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5): 879-903.

Pusser, B., & Marginson, S. (2013) University Rankings in Critical Perspective. The Journal of Higher Education, 84(4): 544-568

Rai, N., & Thapa, B. (2015). A study on purposive sampling method in

research. *Kathmandu: Kathmandu School of Law*, *5*.

Ramachandran, K., & Ramnarayan, S. (1993). Entrepreneurial Orientation and Networking: Some Indian evidence. *Jounal of Business Venturing*, *8*(6), 513–524.

Ranga, M., & Etzkowitz, H. (2013). Triple helix systems: an analytical framework for innovation policy and practice in the Knowledge Society. *Industry and Higher Education*, *27*(4), 237–262. https://doi.org/10.5367/ihe.2013.0165

Rasmussen, E., Mosey, S., & Wright, M. (2014). The influence of university departments on the evolution of entrepreneurial competencies in spin-off ventures. *Research Policy*, *43*(1), 92–106. https://doi.org/10.1016/j.respol.2013.06.007

Rasmussen, E., & Wright, M. (2015). How can universities facilitate academic spin-offs? An entrepreneurial competency perspective. *Journal of Technology Transfer*, *40*(5), 782–799. https://doi.org/10.1007/s10961-014-9386-3

Rauch, A., & Hulsink, W. (2015). Putting Intrepreneurship Education where the Intention to Acta lies: An Investigation into the Impact of Entrepreneurship Education on Entrepreneurial Behavior. *Academy of Management Learning & Education*, *14*(2), 187–204. https://doi.org/10.5465/amle.2012.0293

Rauch, A., Wiklund, J., Lumpkin, G. T., & Frese, M. (2009). Entrepreneurial orientation and business performance: An assessment of past research and suggestions for the future. *Entrepreneurship: Theory and Practice*, *33*(3), 761–787. https://doi.org/10.1111/j.1540-6520.2009.00308.x

Raykov, T. & Marcoulidis, G.A. (2000). *A First Course in Structural Equation Modeling.* Mahwah, NJ: Erlbaum.

Rhoten, D. (2004). Interdisciplinary research: Trend or transition. *Items and Issues: Social Science Research Council*, *5*, 6–11. Retrieved from

http://www.ncar.ucar.edu/Director/survey/Interdisciplinary Research Trend or Transition.v2.pdf

Riviezzo, A. (2014). Detecting the Determinant Attributes of Entrepreneurial Orientation within the Italian University Departments. *Journal of Enterprising Culture*, *22*(02), 133–159. https://doi.org/10.1142/s021849581450006x

Roberts, P., & Priest, H. (2006). Reliability and validity in research. *Nursing standard*, *20*(44), 41-46.

Rogers, E., Yin, J., & Hoffmann, J. (2000). Assessing the effectiveness of technology transfer offices at US research universities. *… of University Technology …*, 47–80. Retrieved from ftp://ftp.unicauca.edu.co/Facultades/FIET/Materias/Gestion_tecnologica/2005/Clase 9/research develop.pdf

Roper, S., Love, J. H., & Bonner, K. (2017). Firms' knowledge search and local knowledge externalities in innovation performance. *Research Policy*, *46*(1), 43–56.

Rorwana, A., & Tengeh, R. (2015). The role of academic entrepreneurs in the process of technology transfer and commercialization : the case of a University of Technology in South Africa. *Environmental Economics*, *6*(4), 25–37.

Rosa, P., & Dawson, A. (2006). Gender adn the commercialization of university science: academic founders of spinout companies. *Entrepreneurship & Regional Development*, *18*(4), 341–366. https://doi.org/10.1080/08985620600680059

Rosenberg, N. (1979). Technological interdependence in the american economy. *Technology and Culture*, *20*(1), 25–50.

Rosenberg, N., & Nelson, R. R. (1994). American universities and technical advance in industry. *Research Policy*, *23*(3), 323–348.

Rothaermel, F. T., Agung, S. D., & Jiang, L. (2007). University entrepreneurship: A taxonomy of the literature. *Industrial and Corporate Change*, *16*(4), 691–791. https://doi.org/10.1093/icc/dtm023

Rowley, J. (2002). Using case studies in research. *Management Research News*, *25*(1), 16–27. https://doi.org/10.1108/01409170210782990

Rusite, E & Sloka, B. (2019). Importance of academic staff attitude towards the rankings of higher education institiutions. *37th International Scientific Conference on Economic and Social Development*, 1194-1200

Saputra, I. W., Sutopo, W., & Zakaria, R. (2018, February). A business strategy formulation for commercializing university-created technology: A university spin-offs. In *AIP Conference Proceedings* (Vol. 1931, No. 1, p. 030020). AIP Publishing LLC.

Sarason, Y., Dean, T., & Dillard, J. F. (2006). Entrepreneurship as the nexus of individual and opportunity: A structuration view. *Journal of Business Venturing*, *21*(3), 286–305. https://doi.org/10.1016/j.jbusvent.2005.02.007

Sarason, Y., Dillard, J. F., & Dean, T. (2010). How can we know the dancer from the dance? *Journal of Business Venturing*, *25*(2), 238–243. https://doi.org/10.1016/j.jbusvent.2008.06.003

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research Methods for Business Students*. Pearson Education International.

Schafer, J. L. (1997). *Analysis of incomplete multivariate data*. Chapman and Hall.

Schreuder, H. T., Gregoire, T. G., & Weyer, J. P. (2001). For what applications probability and non-probability can be used? *Environmnetal Monitoring and Assessment*, *66*, 281–291.

Schwarz, G. M., & Stensaker, I. G. (2016). Showcasing phenomenon-driven

research on organizational change. *Journal of Change Management*, *16*(4), 245–264.

Seguí-Mas, E., Oltra, V., Tormo-Carbó, G., & Sarrión-Viñes, F. (2018). Rowing against the wind: how do times of austerity shape academic entrepreneurship in unfriendly environments?. *International Entrepreneurship and Management Journal*, *14*, 725-766.

Serdyukov, P. (2017). Innovation in education: What works, what doesn't, and what to do about it? Journal of Research in Innovative Teaching & Learning, 10(1), 4–33. https://doi.org/10.1108/ jrit-10-2016-0007

Shane, S. (2012). Reflections on the 2010 AMR Decade Award: Delivering on the Promise of Entrepreneurship As a Field of Research. *Academy of Management Review*, *37*(1), 10–20. https://doi.org/10.5465/amr.2011.0078

Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science*, *11*(4), 448–469. https://doi.org/10.1287/orsc.11.4.448.14602

Shane, S, & Venkataraman, S. (2000). The Promise of Entrepreneurship as a Field of Research. *The Acadademy of Management Review*, *25*(1), 217–226.

Shane, Scott. (2004). Encouraging university entrepreneurship? The effect of the Bayh-Dole Act on university patenting in the United States. *Journal of Business Venturing*, *19*(1), 127–151. https://doi.org/10.1016/S0883-9026(02)00114-3

Sharma, G. (2017). Pros and cons of different sampling techniques. *International Journal of Applied Research*, *3*(7), 749–752. Retrieved from www.allresearchjournal.com

Shinn, T. (2002). The Triple helix and New Production of Knowledge: Prepackaged Thinking on Science and Technology. *Social Studies of Science*, *32*(4), 599–614. https://doi.org/10.1177/0306312702032004004

Shore, C., & Mclauchlan, L. (2012). “Third mission” activities, commercialisation and academic entrepreneurs. *Social Anthropology*, *20*(3), 267–286. https://doi.org/10.1111/j.1469-8676.2012.00207.x

Shree, S. (2007). *Internationalisation of South African Smmes : the Role of Capital factors*.

Sibanda, M. (2009). *The Economics of Intellectual Property in South Africa*. Retrieved from http://www.wipo.int/ip-development/en/economics/pdf/wo_1013_e.pdf

Siegel, D. S., Veugelers, R., & Wright, M. (2007). Technology transfer offices and commercialization of university intellectual property: Performance and policy implications. *Oxford Review of Economic Policy*, *23*(4), 640–660. https://doi.org/10.1093/oxrep/grm036

Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2003a). Commercial knowledge transfers from universities to firms: improving the effectiveness of university-industry collaboration. *Journal of High Technology Management Research*, *14*(1), 111–133.

Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2003b). Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration. *The Journal of High Technology Management Research*, *14*(1), 111–133. https://doi.org/10.1016/S1047-8310(03)00007-5

Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2004). Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: Qualitative evidence from the commercialization of university technologies. *Journal of Engineering and Technology Management - JET-M*, *21*(1–2), 115–142. https://doi.org/10.1016/j.jengtecman.2003.12.006

Siegel, D. S., Waldman, D., & Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study. *Research Policy*, *32*(1), 27–48. https://doi.org/10.1016/S0048-7333(01)00196-2

Siegel, D. S., & Wright, M. (2015). Academic Entrepreneurship: Time for a Rethink? *British Journal of Management*, *26*(4), 582–595. https://doi.org/10.1111/1467-8551.12116

Smith, & Bagchi-Sen. (2012). The research university, entrepreneurship and regional development: Research propositions and current evidence. *Entrepreneurship & Regional Development*, *24*(5–6), 383–404.

Sousa-Ginel, E., Franco-Leal, N., & Camelo-Ordaz, C. (2017). The influence of networks on the knowledge conversion capability of academic spin-offs. *Industrial and Corporate Change*, *26*(6), 1125–1144. https://doi.org/10.1093/icc/dtx013

Steffensen, M., Rogers, E. M., & Speakman, K. (1999). Spin-Offs From Research Centers At a Research University. *Journal of Business Venturing*, *15*(98), 93–111. https://doi.org/10.1016/S0883-9026(98)00006-8

Steiger, J.H. (1990). Structural model evaluation and modification: An interval estimation approach, *Multivariate Behavioral Research*, 25: 173-180.

Sternberg, R. (2014). Success factors of university-spin-offs: Regional government support programs versus regional environment. *Technovation*, *34*(3). https://doi.org/10.1016/j.technovation.2013.11.003

Steyaert, C. (1997). A Qualitative Methodology for Process Studies of Entrepreneurship. *International Studies of Management & Organization*, *27*(3), 13–33. https://doi.org/10.1080/00208825.1997.11656711

Suzigan, W., & Albuquerque, E. (2011). The underestimated role of universities for

the Brazilian system of innovation. *Brazilian Journal of Politial Economy*, *31*(1), 3–30.

Tang, J, Tang, Z., Marino, L., Zhang, Y., & Li, Q. (2008). Exploring an inverted U-Shape relationship between entrepreneurial orientation and performance in Chinese ventures. *Entrepreneurship Theory and Practice*, *32*(1), 219–239.

Tang, J., Kacmar, K. M. M., & Busenitz, L. (2012). Entrepreneurial alertness in the pursuit of new opportunities. *Journal of Business Venturing*, *27*(1), 77–94. https://doi.org/10.1016/j.jbusvent.2010.07.001

Teece, D. (1977). Technology transfer by multinational firms: The resource cost of transferring technological know-how. *The Economic Journal*, 242–261.

Teixeira, A. A. C. (2011). Mapping the (in)visible college(s) in the field of entrepreneurship. *Scientometrics*, *89*(1), 1–36. https://doi.org/10.1007/s11192-011-0445-3

Terjesen, S., & Elam, A. (2009). Transnational Entrepreneurs' Venture Internationalization Strategies: A Practice Theory Approach. *Entrepreneurship Theory and Practice*, *33*(5), 1093–1120. https://doi.org/10.1111/j.1540-6520.2009.00336.x

Thomas, G. (2011). The case: Generalisation, theory and phronesis in case study. *Oxford Review of Education*, *37*(1), 21–35. https://doi.org/10.1080/03054985.2010.521622

Thursby, J. G., & Thursby, M. C. (2007). University licensing. *Oxford Review of Economic Policy*, *23*(4), 620–639. https://doi.org/10.1093/oxrep/grm031

Thursby, J., Jensen, R., & Thursby, M. C. (2001). Objectives, Characteristics and Outcomes of University Licensing: A Survey of Major U.S. Universities. *Journal of Technology Transfer*, *26*(1–2), 59–72.

Todeva, E. (2013). Governance of innovation and intermediation in triple helix interactions. *Industry and Higher Education*, *27*(4), 263–278. https://doi.org/http://dx.doi.org/10.5367/ihe.2013.0161

Todorovic, Z. W., McNaughton, R. B., & Guild, P. (2011). ENTRE-U: An entrepreneurial orientation scale for universities. *Technovation*, *31*(2–3), 128–137. https://doi.org/10.1016/j.technovation.2010.10.009

Treiblmaier, H., Bentler, P. M., & Mair, P. (2011). Formative constructs implemented via common factors. *Structural Equation Modeling*, 18(1), 1-17

Trojer, L., Rydhagen, B., & Kjellqvistt, T. (2014). Inclusive innovation processes - experiences from Uganda and Tanzania. *African Journal of Science, Technology, Innovation and Development*, *6*(5), 425–438. https://doi.org/10.1080/20421338.2014.970437

UCT. (2019). Universities South Africa: Funding in South Africa: A fact Sheet. Retrieved from http://www.uct.ac.za/usr/news/downloads/2016/UniversitiesFundingSouthAfrica_FactSheet.pdf

Urban, B., & Chantson, J,. (2019). Academic entrepreneurship in South Africa: testing for entrepreneurial intentions. *Journal of Technology Transfer.* 44(3), 948-980.

Urban, B. & Gamata, S. (2020). Academic entrepreneurship and organisational support factors. South African Journal of Higher Education, 34(1): 249–266.

Vahlne, J., & Johanson. (2009). Uppsala model revisited - from liability of foreigness to liability of outsidership. *Jounal of Interntional Business Studies*, *40*(9), 1411–1431.

Vang, J., Chaminade, C., & Coenen, L. (2007). *Learning from the Bangalore Experience : The Role of Universities in an Emerging Regional Innovation*

System. *Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE) Lund University*.

Vohora, A., Wright, M., & Lockett, A. (2004). Critical junctures in the development of university high-tech spinout companies. *Research Policy*, *33*, 147–175.

Von Bertalanffy, L. (1972). The Hisgtory and Status of General Systems Theory. *The Acadademy of Management Journal*, *15*(4), 407–426.

Von der Embse, N. (2016). What School Psychologists Need to know about Structurl Equation Modelling. *School Psycologists as Consumers of Research*, *44*, 10–12.

Wales, W. J. (2016). Entrepreneurial orientation: A review and synthesis of promising research directions. *International Small Business Journal: Researching Entrepreneurship*, *34*(1), 3–15. https://doi.org/10.1177/0266242615613840

Walker, A., Auer, M., & Ritter, T. (2006). The impact of network capabilities and entrepreneurial orientation on university spin-off performance. *Journal of Business Venturing*, *21*(4), 541–567.

Weng, L., Perra, N., & Menczer, F. (2018). Attention on Weak Ties in Social and Communication Networks. *Complex Spreading Phenomena in Social Systems*, 213–2228.

Westhead, P., Ucbasaran, D., Wright, M., & Binks, M. (2005). Novice, Serial and Portfolio Entrepreneur Behaviour and Contributions. *Small Business Economics*, *25*(2), 109–132. https://doi.org/10.1007/sl

Weston, R., & Gore, P. A. (2006). A Brief Guide to Structural Equation Modeling. *The Counseling Psychologist*, *34*(5), 719–751. https://doi.org/10.1177/0011000006286345

Whittington, R. (2006). Completing the Practice Turn in Strategy Research. *Organization Studies*, *27*(5), 613–634. https://doi.org/10.1177/0170840606064101

Whittington, R. (2012). Strategy-as-Practice - Taking Social Practices Seriously. *Academy of Management Annals*, *6*(1), 285–336.

Wiklund, J., & Shepherd, D. (2003). Aspiring for, and achieving growth: The moderating role of resources and opportunities. Journal of Management Studies, 40(8), 1919–1941.

Wiklund, J., & Shepherd, D. (2005). Entrepreneurial orientation and small business performance: A configurational approach. *Journal of Business Venturing*, *20*(1), 71–91. https://doi.org/10.1016/j.jbusvent.2004.01.001

Williams, L. D. A., & Woodson, T. S. (2012). The Future of Innovation Studies in Less Economically Developed Countries. *Minerva*, *50*(2), 221–237. https://doi.org/10.1007/s11024-012-9200-z

Wincent, J., Thorgren, S., & Anokhin, S. (2014). Entrepreneurial orientation and network board diversity in network organizations. *Jounal of Business Venturing*, *29*(2), 327–344.

Wolson, R. A. (2007). The role of technology transfer offices in building the South African biotechnology sector: An assessment of policies, practices and impact. *Journal of Technology Transfer*, *32*(4), 343–365. https://doi.org/10.1007/s10961-006-9027-6

Wong, P., Ho, Y., & Autio, E. (2005). Entrepreneurship, Innovation and Economic Growth: Evidence from GEM Data. *Small Business Economics*, *24*(3), 335–350. https://doi.org/10.1007/sl

Wood, M. S. (2011). A process model of academic entrepreneurship. *Business Horizons*, *54*(2), 153–161. https://doi.org/10.1016/j.bushor.2010.11.004

Wright, D., Aquilino, W., & Supple, A. (1998). A Comparison of Computer-Assisted and Paper-and-Pencil Self-Administered Questionnaires in a Survey on Smoking, Alcohol, and Drug Debra L . Wright , William S . Aquilino and Andrew J . Supple Source : The Public Opinion Quarterly , Vol . 62 , No . 3 (A. *The Public Opinion Quartley*, *62*(3), 331–353.

Wright, M., Lockett, A., Clarysse, B., & Binks, M. (2006). University spin-out companies and venture capital. *Research Policy*, *35*(4), 481–501. https://doi.org/10.1016/j.respol.2006.01.005

Wu, W. (2010). Managing and incentivizing research commercialization in Chinese Universities. *The Journal of Ttechnology Transfer*, *35*(2), 203–224.

Yilmaz, K. (2013). Comparison of Quantitative and Qualitative Research Traditions: epistemological, theoretical, and methodological differences. *European Journal of Education*, *48*(2), 311–325.

Yin, R. (2011). *Qualitative Research from Start to Finish*. The Gillford Prerss.

Zahra, S. (2007). Contextualizing theory building in entrepreneurship research. *Journal of Business Venturing*, *22*, 443–452.

Zahra, S. A., & Wright, M. (2011). Entrepreneurship' s Next Act. *Academy of Management Perspectives*, 67–83. https://doi.org/10.5465/amp.2010.0149

Zhang, J. (2009). The performance of university spin-offs: An exploratory analysis using venture capital data. *Journal of Technology Transfer*, *34*(3), 255–285. https://doi.org/10.1007/s10961-008-9088-9

Zhao, F. (2005). Exploring the synergy between entrepreneruship and innovation. *International Journal of Entrepreneurial Behavior & Research*, *11*(1), 25–41. https://doi.org/http://dx.doi.org/10.1108/MRR-09-2015-0216

Zucker, L. G., Darby, M. R., & Brewer, M. B. (1994). *Intelectual Capital and the Birth*

of U.S. Biotechnology Enterprises. *NBER Working Paper Series*.

APPENDIX

9.1 Appendix 1: Informed Consent and Questionnaire

9.1.1 *Participant Information Sheet*

Wits Business School

Effect of Social Networks on South African Academic Entrepreneurship

Research Conducted by:

Derek Seely **(9400624F)**

Mobile number: 0824916540

Dear Respondent

You are invited to participate in an academic research study conducted by Derek Seely, a doctoral student from the Wits Business School at the University of the Witwatersrand. It is important that you understand why the research is being done and what it will involve. Please read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information.

The purpose of this study is to investigate the effect that social networks have on South African Academic Entrepreneurship.

This is a quantitative study and will require the completion of a survey.

Please note the following:

1. All components of the study will be treated as strictly **confidential**. Any results will be of such a nature that it will not be possible to identify yourself, your organisation or any individuals in the organisation.
    i. Your name will not appear in any report and the answers you give will be treated in the strictest confidence.
    ii. Your answers will not be discussed with anyone else connected and the answers of other parties will not be discussed with you.
    iii. It is expected that it will take approximately 30 minutes to complete the questionnaire
    iv. The questionnaire will be completed online using the link provided.
2. You and/or your organisation may choose not to participate and you may also stop the participation of your organisation at any time without any negative consequences.
3. The results of the study will be used for academic purposes and may be published in an academic journal or other lay articles. I will provide you a summary of the findings on request.
4. Please contact my supervisor Prof. Urban if you have any questions or comments regarding the study:

    Prof. Boris Urban
    Tel: (011)717-3762
    Email: boris.urban@wits.ac.za
5. The aim is to have collected this information by 3 December 2019

Please note that once you have completed the questionnaire online a button will appear that will advise you that by submitting the information that you have:

- You have read and understand the information provided above
- You give your consent for you and your organisation to participate in the study on a voluntary basis.

9.2 Appendix 2: Questionnaire

Guide for data collection from the academic entrepreneur

1. Personal attributes of the individual – Moderating factors

	Gender	Male
		Female
	Age	
		18-24
		25-32
		33-40
		40-50
		Above 50
	Prior entrepreneurial experience	
		0-2 Years
		2-5 Years
		5-10 Years
		Above 10 years
	Education	
		Undergraduate Degree
		Honours Degree
		Masters Degree
		PhD
	University Employment	Please state which university you are currently employed.

2.

Hypothesis 1 - Entrepreneurial Orientation – Research Mobilization	Strongly agree = 1 Agree =2 Neutral = 3 Disagree = 4 Strongly Disagree = 5

Application of knowledge	I place a strong emphasis on publishing new academic research in Journals
Finance	I am expected to justify the financial cost of the firm development as each stage of the development process
Environment	In general, due to the complex nature of my environment, I prefer to explore new business opportunities using a cautious incremental approach
Environment	It was difficult to convince people in the university that the innovation deserved their support
Environment	It was difficult to get people in other departments at the university to commit resources to the development of the spin-off firm
Environment	It was difficult to get a budget to undertake the development of the spin-off firm
Environment	I look to the university or business for support when starting a new spin-off
Development of New Ideas	I often miss the opportunity in the idea.
Development of New Ideas	It takes me time to identify the opportunity
Environment	My context affects the success of the development of the spin-off firm
Development of New Ideas	When I get a new idea, it takes a while for it to develop.
Development of New Ideas	I typically create new ideas by combining existing strategies
Connection to the global community	Compared to other similar departments in our province, our department has a strong reputation for its contribution to industry or society

Connection to the academic community	Compared to other similar departments in our province, our faculty members are known as very efficient and productive researchers
Convergence of economic and university interests	We try and generate off campus benefits from research projects
	I do not know details of the participants in my spin-off (for example their real name, email address, telephone number)
Funding	Financial support from government was vital in the creation of my Spin-off
Funding	Financial support from industry was vital in the creation of my Spin-off
Funding	There is very little university funding for my research
Funding	My university financially supports all research areas equally
Product development	Compared to other similar departments in this province, we are good at identifying new opportunities
Hypothesis 2 Entrepreneurial Orientation: Collaboration	
Organisational	In general, my university supports a strong emphasis on the marketing of academic innovation to outside entrepreneurs
Personal	I am unable to make key decisions on the spin-off without the involvement of senior university officials
	My firm has produced very few new lines of products and services in the past five years or since its establishment
Personal	I did not trust the ability, commitment and support of the people tasked with assisting me in creating the spin-off firm
Personal	I prefer a team that believes in my ideas, even against others opposition

Governmental	Creative ideas hardly ever come to me alone. I rely on government to identify potential opportunities.
Organisational	Creative ideas hardly ever come to me alone. I rely on industry to identify potential opportunities
Organisational	The university encourages students to seek practical applications for their research
Government	I engage in research with significant implications for industry or society
(Abou-Warda, 2015) Organisational	Many of our faculty members conduct research in partnership with non-academic professionals in industry
Government	Our faculty members are expected to make substantial contributions to society
Organisational	Cooperating with organisations outside the university significantly improves our research activities
	Faculty members that collaborate with non-academic professionals are supported at the university
Government	I am not willing to put myself out to help industry or government solve a problem
Personal	My colleagues and I never socialise outside of the work environment
Personal	My partner/s in the spin-off and I met due to the formulation of innovation and our mutual interest in the spin-off
Personal	My partner/s and I only discuss matters related to the spin-off
Personal	I do not confide personal problems with my partner/s
Hypothesis 3 Entrepreneurial Orientation: Unconventionality	

Business Risk	I proactively initiate actions that force my competitors to respond
Business Risk	My firm's advancements to the product/s and service/s have mainly been of a dramatic nature
Business Risk	My firm is very seldom the initial business in the industry to introduce new products/services, techniques and operating technologies
Business Risk	My firm has produced many new lines of products and services in the past five years or since its establishment
Institutional risk	My leadership directs my firm to avoid conflicting with the universities mission
Financial Risk	In general, I prefer low risk business with known rates of return
Reputational risk	When confronted with decision-making situations involving uncertainty, I adopt a cautious approach in order to reduces the possibility of a negative image being projected on my institution
Institutional risk	The focus of the university conflicts with my innovative ideas
Institutional risk	I do not challenge the status quo.
Institutional risk	Faculty members in our department emphasize applied research
Institutional risk	
Financial risk	Some activities involve a "financial risk". Starting a business means there is a chance of losing money. In general, my propensity for accepting "financial risk" is low
Financial risk	I don't like to place personal funds at risk, I would rather stay on the safe side.
Reputational risk	When facing a decision that carries some risk, we tend to adopt a "wait and see" approach to avoid risking our universities reputation
Reputational risk	When we come upon an unconventional new idea, we usually let someone else try it and see what happens

Reputational risk	I do not know the personal details of the participants involved in the commercialisation of my innovation (e.g. name, email address, telephone number)
Reputational Risk	I am not able to make a difference in my community as there is a risk that my best efforts may have an unintended consequence that could damage the reputation of my institution.
Hypothesis 4: Entrepreneurial Orientation: University Policies	
I.P. Licensing	It is not possible for me to bypass standard university operating procedures in the development of the spin-off
I.P. Licensing	It is not possible for me to bypass any budgetary procedures when sourcing funds in the development of the spin-off
I..P Licensing	It is not possible for me to bypass any personnel procedures when seeking involvement of people committed to the development of the spin-off
University I.P Policy	It is possible for me to create support for a spin-off company before receiving formal approval from the university
University I.P Policy	It was difficult to empower people working on the development of the spin-off to get authority to proceed
incubation	There are a large number of ideas that I have researched that I believe have commercialisation potential, but I have not commercialised them
University support for applied research	When evaluating the progress of our department, we tend to put more emphasis on external standards rather than internal standards
University support for applied research	If the university would not support my applied research interests, I would be keen to change to another university
University support for applied research	I do not feel part of the university structure
University support for applied research	I would not recommend that a close friend join the university staff
Policy maker	Intervention by the government facilitated the exchange of knowledge among the role players
University support for applied research	My university supports academic research only for publication purposes.
incubation	My university does not offer a support network that could assist me in commercialising my research

Incubation	My university has no policies and processes in place to support the commercialisation of innovation
Incubation	My university prefers sole ownership of the academic innovation and will unilaterally facilitate the commercialisation process
Involvement of policy makers	National Innovation Property Management Office (NIPMO) is ineffective in the transfer of innovation into the hands of individuals who have business tools to support their commercial development
Involvement of policy makers	The performance review of our faculty members includes independent off campus activities in addition to research, teaching and service to the university

3. Hypothesis 4 – the social context of the university

	A	**B**	**C**	**D**	**E**	**F**
Position in the national HE system	Strong reputation nationally and globally	Strong national reputation and aspiring global reputation	Aspiring National reputation	Niche reputation in certain fields	Weak national reputation.	
Intellectual imperatives	Enhance reputational status	Aim for a global reputation	Establish a national scientific reputation	Establish a scientific reputation	Address local problems and develop research capabilities	
Financial imperatives	Add value to core activities	Supplement core activities	Basic operations	Constraints on basic operations		
Enrolment in 2019						
Publication per academic						
The type of academic entrepreneurial relationships found at my university	Engaged research	Engaged teaching and outreach	Alternative teaching	Technology transfer		
Importance of academic outputs at my university	Traditional (academic publications, dissertations, collaborations,	Economic and Social (new products and processes,				

	policy documents)	community infrastructure and facilities, spinoff companies)				

9.3 Appendix 3: Survey items

The following survey items were utilised in this research.

Construct	Question	Scale
	How do you believe your university should rank in the national higher education system, when compared to other public universities?	Five point Likert-type scale: *Weak national reputation* to *Strong reputation nationally and globally*
Aspirations	I believe that my university has intellectual imperatives that guide academics to.... (please select option that best fits)	Five point Likert-type scale: *Enhance the existing reputational status* to *Aim for a global reputation that places the university in line with top global academic institutions*
	How would you rank the importance of academic research output at my university	5-point Likert-type scale: *Not at all important* to *Extremely Important*

Construct	Question	Scale
	How would you rank the importance of developing innovative and commercializable ideas that can be used by business and society	5-point Likert-type scale: *Not at all important* to *Extremely Important*
Bureaucracy	It is not possible for me to bypass standard university operating procedures in the development of the spin-off	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	It is not possible for me to bypass any budgetary procedures when sourcing funds in the development of the spin-off	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	It is not possible for me to bypass any personnel procedures (or obligations) when seeking involvement of people committed to the development of the spin-off	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	It is possible for me to create support for a spin-off company before receiving formal approval from the university	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
Business risk	I proactively initiate actions that force my competitors to respond	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

Construct	Question	Scale
	My spin-off firm's advancements to the incumbent product/s and service/s have mainly been of a dramatic nature	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	My spin-off firm is very seldom the initial business in the industry to introduce new products/services, techniques and operating technologies	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
Financial risk	In general, I prefer a low risk business with a known rate of return	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	Some activities involve "financial risk". Starting a spin-off business means there is a chance of losing money. In general, my propensity for accepting "financial risk" is low.	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	I don't like to place personal funds at risk. I would rather not pursue a spin-off business that utilizes my innovation than use my personal funds to finance it.	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

Construct	Question	Scale
Governmental collaboration	Financial support from government was vital in the creation of my Spin-off	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	Creative ideas hardly ever come to me alone. I rely on government to identify potential opportunities	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	I am not willing to deviate from my research agenda to help the government solve a problem	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	It was intervention by the government that facilitated the exchange of knowledge among the role players	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	National Innovation Property Management Office (NIPMO) is ineffective in the transfer of innovation into the hands of individuals who have business tools to support their commercial development	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
Institutional risk	University leadership (or Technology Transfer Office) directs my firm to avoid conflicting with the universities mission	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

Construct	Question	Scale
	I do not challenge the status quo.	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	Faculty members in our department emphasize applied research	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	Our faculty members are willing to take unconventional approaches when working on research problems	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	The focus of the university conflicts with my innovative ideas	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
Organisational collaboration	Financial support from industry was vital in the creation of my Spin-off	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	Creative ideas hardly ever come to me alone. I rely on industry to identify potential opportunities	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

Construct	Question	Scale
	Many of our faculty members conduct research in partnership with non-academic professionals that operate in industry	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	Cooperating with organisations outside the university significantly improves our research activities	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
Research mobilisation	Compared to other similar departments in South African universities, our department has a strong reputation for its contribution to industry and/or society	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	When I participate in research projects, I always focus on generating off campus benefits from the work being carried out.	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	Compared to other similar departments at South African universities, we are effective at identifying new commercializable opportunities from academic research	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

Construct	Question	Scale
	When I get a new academic idea, it takes a while for me to realize its commercialization potential	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	I typically create new commercializable ideas by combining existing research with my own innovative spin	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
Personal collaboration	I am unable to make key decisions on the spin-off without the involvement of senior university officials	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	I did not trust the ability, commitment and support of the people tasked by the university with assisting me in creating the spin-off firm	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	I prefer that the team chosen to assist me in commercialising my ideas always believes in them, even against the opposition of others	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	My colleagues and I never socialise outside of the work environment	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

Construct	Question	Scale
	My partner/s in the spin-off and I met during the formulation of innovation	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	My partner/s and I have a great relationship, both when deciding on matters related to the spin-off and during our time out of the office	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
Reputational risk	When confronted with decision-making situations involving uncertainty, I adopt a cautious approach in order to reduces the possibility of a negative image being projected on my institution	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	When facing a decision that carries some risk, I/we tend to adopt a “wait and see” approach to avoid risking my/our universities reputation	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	When I/we come upon an unconventional new idea, I/we usually let others that we trust critique it and if it passes, we follow through on its development	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

Construct	Question	Scale
	I do not know the personal details of the participants involved in the commercialisation of my innovation (e.g. name, email address, telephone number)	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	I am not able to make a difference in my community as there is a risk that my best efforts may have an unintended consequence that could damage the reputation of my institution.	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
Research mobilisation	Compared to other similar departments in South African universities, our department has a strong reputation for its contribution to industry and/or society	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	When I participate in research projects, I always focus on generating off campus benefits from the work being carried out.	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	Compared to other similar departments at South African universities, we are effective at identifying new commercializable opportunities from academic research	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

Construct	Question	Scale
	When I get a new academic idea, it takes a while for me to realize its commercialization potential	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	I typically create new commercializable ideas by combining existing research with my own innovative spin	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
Spin-off success	My spin-off firm has produced >5 new lines of products and/or services in the past five years or since its establishment	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	How many spin-off firms have I created	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	How many of my ideas have been licensed by business and/or 3rd party outside the university	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
University support	It was difficult to get a budget to undertake the development of the spin-off firm	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

Construct	Question	Scale
	It was difficult to get people in other departments at the university to commit resources to the development of the spin-off firm	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	It was difficult to convince people in the university that the innovation deserved their support	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	It was difficult for the team/individual working on the development of the spin-off to get authority from the university structures (Technology Transfer Office) to proceed	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	My university has no policies and processes in place to support the commercialization of innovation	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	When I think or talk about commercialization of my research, I do not feel part of the university structure	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*
	My university does not offer a support network that could assist me in commercializing my research	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

Construct	Question	Scale
	My university supports academic research only for publication purposes.	5-point Likert-type scale: *Strongly disagree* to *Strongly agree*

9.4 Appendix 4: Ethical Clearance letters

University of Fort Hare
OFFICE OF UNIVERSITY REGISTRAR
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University of Fort Hare
Together in Excellence

28 January 2020

Mr. Derek Seely
University of Witwatersrand
derekseely@gmail.com

Dear Mr. Seely

Approval from the Registrar's Office to Conduct Research

In accordance with the University of Fort Hare Research Ethics Policy and Practice, I hereby grant permission for Mr. D Seely to conduct research relating to his thesis "The role of social network in the creation of university spin-offs: A focus on academic entrepreneurship in the South African university context".

We look forward to reading the research report.

Kind regards,

Mr. N Zuma
University Registrar

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31 March 2020

Dereck Seely
Faculty of Commerce (student # 9400624F)
University of the Witwatersrand
Johannesburg

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Dear Mr Seely

PERMISSION TO CONDUCT RESEARCH AT THE UNIVERSITY OF JOHANNESBURG

The proposal and research instruments for the research study titled: *The role of social networks in the creation of university spin-offs: A focus on academic entrepreneurship in the South African context* were reviewed. Permission is granted to the conduct this study at the University of Johannesburg. You must provide us with a copy of the institutional ethics approval.

Sincerely

Dr Carol Nonkwelo
Executive Director: Research and Innovation
Email: cnonkwelo@uj.ac.za

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Fakulteit Geesteswetenskappe
Lefapha la Bomotho

Humanities 100. Since 1919

11 August 2020

Dear Mr DC Seely

Project Title:	The role of social networks in the creation of university spin-offs: A focus on academic entrepreneurship in the South African university context
Researcher:	Mr DC Seely
Supervisor(s):	
Department:	External department
Reference number:	15393284 (EMS140/20)
Degree:	Doctoral

I have pleasure in informing you that the above application was **approved** by the Research Ethics Committee on 11 August 2020. Data collection may therefore commence.

Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. Should the actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

We wish you success with the project.

Sincerely,

Prof Innocent Pikirayi
Deputy Dean: Postgraduate Studies and Research Ethics
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail: PGHumanities@up.ac.za

Research Ethics Committee Members: **Prof I Pikirayi (Deputy Dean);** Prof KL Harris; Mr A Bizos; Dr A-M de Beer; Dr A dos Santos; Ms KT Govinder; Andrew; Dr P Gutuza; Dr E Johnson; Prof D Maree; Mr A Mohamed; Dr I Noomè; Dr C Puttergill; Prof D Reyburn; Prof M Soer; Prof E Tollard; Prof V Thebe; Ms B Tsebe; Ms D Mokalapa

Date: 11th August 2020

Derek Seely

University of the Witwatersrand

Faculty of Commerce

Law and Management

Dear **Derek Seely**

Permission to conduct Research at the University of Venda

You are hereby granted permission to conduct research at the University of Venda.

The research will be based on your Doctoral research titled: ***The role of social networks in the creation of university spin-offs: A focus on academic entrepreneurship in the South African university context*** registered at the **University of the Witwatersrand.**

The conditions are that all the data pertaining to University of Venda will be treated in accordance with the Ethical Principles and that will be shared with the University. In addition, consent should be sought by you as a researcher from participants.

Attached is our policy on ethics.

Thank you

.....

Senior Prof. G.E. Ekosse

Director Research and Innovation

Cc: Prof JE Crafford (DVC Academic)

UNIVERSITY OF VENDA
OFFICE OF THE DIRECTOR
RESEARCH AND INNOVATION
2020 -08- 11
Private Bag X5050
Thohoyandou 0950

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e: registrar@ru.ac.za

www.ru.ac.za

Mr Derek Seely
Wits Business School
University of Witwatersrand
1 Jan Smuts Avenue
Johannesburg
2000

29 June 2020

Dear Mr Seely

REQUEST FOR GATEKEEPERS PERMISSION TO CONDUCT RESEARCH WITH RHODES UNIVERSITY STAFF AND OR STUDENTS

Name of research proposal: The role of social networks in the creation of university sign-offs: A focus on academic entrepreneurship in the South African University context.

This serves to confirm that you have been granted permission to conduct your proposed research at Rhodes University as requested.

The University is not obliged to make any arrangements in terms of this research. The onus is on the researcher. It is also your responsibility to protect the integrity of the University at all times.

Yours sincerely

AL Moodly

Dr Adéle Moodly
REGISTRAR

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Office of the Registrar

2020-01-27

Mr D Seely
Faculty of Commerce, Law and Management
UNIVERSITY OF THE WITWATERSRAND

Email: derekseely@gmail.com

Dear Mr Seely,

APPROVAL OF RESEARCH STUDY

The UP Survey Coordinating Committee has granted provisional approval for your PhD study titled "The role of social networks in the creation of university spin-offs: A focus on academic entrepreneurship in the South African university context".

The proposed research study has to strictly adhere to the associated study protocol, as well as the UP Survey Policy and the Research Ethics Committee of the Faculty of Humanities instructions.

A final electronic copy of the research outcomes must be submitted to the Survey Coordinating Committee as soon as possible after the completion of the study.

Please liaise with the Market Research Office in the Department of Institutional Planning (carlien.nell@up.ac.za) to officially register the study and to finalise the survey procedures and the field work dates.

Kind regards

Prof CMA Nicholson
REGISTRAR
CHAIRPERSON: SURVEY COORDINATING COMMITTEE

Private Bag X6001, Potchefstroom
South Africa 2520
Tel: +2718 299-1111/2222
Web: http://www.nwu.ac.za
Research Data Gatekeeper Committee

NWU RDGC PERMISSION GRANTED / DENIED LETTER

Based on the documentation provided by the researcher specified below, on 14/07/2020 the NWU Research Data Gatekeeper Committee (NWU-RDGC) hereby grants permission for the specific project (as indicated below) to be conducted at the North-West University (NWU):

Project title: The role of social networks in the creation of university spinoff's: A focus on academic entrepreneurship in the South African context.

Project leader: Prof B. Urban
Researcher/Project Team: D Seely

Ethics reference no: H19/07/33
NWU RDGC reference no: NWU-GK-2020-018

Specific Conditions:

- Due the COVID-19 pandemics the Committee would like to advice the researcher to practice the necessary caution and adhere to the National Covid-19 Guidelines when conducting research with participants.
- The Researcher should request permission from the Director of the Technology Transfer and Innovation Support Department to assist in advertising/sending out an invitation mail on the Researcher's behalf to the designated prospective participants. Prospective participants who are interested in participating in the study may respond directly back to the Researcher.
- No personal information (e.g. contact details) of NWU stakeholders may be given to the Researcher without the stakeholder's consent.

Approval date: 14/07/2020 **Expiry date: 13/07/2021**

General Conditions of Approval:

- The NWU-RDGC will not take the responsibility to recruit research participants or to gather data on behalf of the researcher. This committee can therefore not guarantee the participation of our relevant stakeholders.
- Any changes to the research protocol within the permission period (for a maximum of 1 year) must be communicated to the NWU-RDGC. Failure to do so will lead to withdrawal of the permission.
- The NWU-RDGC should be provided with a report or document in which the results of said project are disseminated.

Please note that under no circumstances will any personal information of possible research subjects be provided to the researcher by the NWU RDGC. The NWU complies with the Promotion of Access to Information Act 2 of 2000 (PAIA) as well as the Protection of Personal Information Act 4 of 2013 (POPI). For an application to access such information please contact Ms Annamarie De Kock (018 285 2771) for the relevant enquiry form or more information on how the NWU complies with PAIA and POPI.

The NWU RDGC would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the NWU RDGC for any further enquiries or requests for assistance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

17 January 2020

Mr Derek Seely
University of the Witwatersrand
Email: derekseely@gmail.com

Dear Mr Seely

RE: PERMISSION TO CONDUCT RESEARCH

Gatekeeper's permission is hereby granted for you to conduct research at the University of KwaZulu-Natal (UKZN), towards your postgraduate studies, provided Ethical clearance has been obtained. We note the title of your research project is:

"The role of social networks in the creation of university spin-offs: A focus on academic entrepreneurship in the South African university context."

It is noted that you will be constituting your sample as follows:

- With a request for responses on the website. The questionnaire must be placed on the notice system http://notices.ukzn.ac.za. A copy of this letter (Gatekeeper's approval) must be simultaneously sent to (govenderlog@ukzn.ac.za) or (ramkissoonb@ukzn.ac.za).

Please ensure that the following appears on your questionnaire/attached to your notice:

- Ethical clearance number;
- Research title and details of the research, the researcher and the supervisor;
- Consent form is attached to the notice/questionnaire and to be signed by user before he/she fills in questionnaire;
- gatekeepers approval by the Registrar.

You are not authorized to contact staff and students using 'Microsoft Outlook' address book. Identity numbers and email addresses of individuals are not a matter of public record and are protected according to Section 14 of the South African Constitution, as well as the Protection of Public Information Act. For the release of such information over to yourself for research purposes, the University of KwaZulu-Natal will need express consent from the relevant data subjects. Data collected must be treated with due confidentiality and anonymity.

Yours sincerely

DR KE CLELAND
REGISTRAR (ACTING)

Office of the Registrar
Postal Address: Private Bag X54001, Durban, South Africa
Telephone: +27 (0) 31 260 8005/2206 **Facsimile:** +27 (0) 31 260 7824/2204 **Email:** registrar@ukzn.ac.za
Website: www.ukzn.ac.za

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DIRECTORATE OF RESEARCH DEVELOPMENT

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MTHATHA 5117
Tel: + 27 47 502 2947/2647
43 708 5458
Fax: +27 47 502 2185

wakpan@wsu.ac.za

Buffalo City
Potsdam Campus
EAST LONDON
Tel: + 43 708 5444
Fax: +

11 June 2020

Mr D Seely
Investigator
Wits Business School
Faculty of Commerce, Law and Management
University of Witwatersrand

Supervisor: Prof Boris Urban

Dear Mr Seely

Re: Gatekeepers Permission Letter to Conduct Research at WSU

Proctocol Number: H19/07/33
Institution: University of Witwatersrand

A Gatekeepers letter is hereby granted for the study entitled " The role of social networks in the creation of university spin-offs: A focus on academic entrepreneurship in the South African University context" provided that copies of your completed study will be submitted to the Campus Rector of the campus in which the study will be conducted and the Directorate of Research & Innovation.

All data pertaining to Walter Sisulu University will be treated confidentially and you are required to abide by ethical principles at all times. It is your responsibility to seek consent from the participants.

Regards

Prof W Akpan
Senior Director: Research and Innovation

Walter Sisulu University

Faculty of Commerce

Private Bag X3, Rondebosch, 7701
2.26 Leslie Commerce Building, Upper Campus
Tel: +27 (0) 21 650 4375/ 5748 Fax: +27 (0) 21 650 4369
E-mail: com-faculty@uct.ac.za
Internet: www.uct.ac.za

@Commerce UCT UCT Commerce Faculty Office

28/12/2019

Derek Seely

External Researcher

Wits Business School

REF: REC 2019/012/021

The role of social networks in the creation of university spin-offs: A focus on academic entrepreneurship in the South African university context

We are pleased to inform you that your ethics application has been approved. Unless otherwise specified this ethical clearance is valid until 31 December 2020

Your clearance may be renewed upon application.

Please be aware that you need to notify the Ethics Committee immediately should any aspect of your study regarding the engagement with participants as approved in this application, change. This may include aspects such as changes to the research design, questionnaires, or choice of participants.

The ongoing ethical conduct throughout the duration of the study remains the responsibility of the principal investigator.

We wish you well for your research.

2019.12.28
09:40:05 +02'00'

Jacques Rousseau
Commerce Research Ethics Chair
University of Cape Town
Commerce Faculty Office
Room 2.26 | Leslie Commerce Building

Office Telephone: +27 (0)21 650 2695 / 4375
Office Fax: +27 (0)21 650 4369
E-mail: com-faculty@uct.ac.za
Website: https://www.commerce.uct.ac.za/Pages/Ethics-in-Research

NELSON MANDELA
UNIVERSITY

PO Box 77000, Nelson Mandela University, Port Elizabeth, 6031, South Africa mandela.ac.za

Chairperson: Research Ethics Committee (Human)
Tel: +27 (0)41 504 2347
Sharlene.Govender@mandela.ac.za

NHREC registration nr: REC-042508-025

Ref: [H20-BES-BUS-EAP-001]

27 January 2020

Dear Prof Urban

TITLE: **THE ROLE OF SOCIAL NETWORKS IN THE CREATION OF UNIVERSITY SPIN-OFFS: A FOCUS ON ACADEMIC ENTREPRENEURSHIP IN THE SOUTH AFRICAN UNIVERSITY CONTEXT**

REF NR: **H19/07/33 (R14/49 Seely)**
PRP: **Prof B Urban**
PI: **Mr D Seely**

Your application for ethics approval to conduct research at Nelson Mandela University has been considered by the REC-H on the basis that the study has been duly vetted and approved by the University of the Witwatersrand Ethics Committee.

Kindly use the following ethics reference number **H20-BES-BUS-EAP-001** together with your University's ethics clearance number in any correspondence with gatekeepers and participants at the University. Ethics clearance is valid for one year.

Please inform the REC-H, of any changes that may arise during the execution of the study, particularly to the methodology.

It must be noted that the Nelson Mandela University assumes that the Research Ethics Committee responsible for providing the original ethics approval/clearance has undertaken both ethics and scientific review of the protocol according to the National Health Research Ethics Committee (2015) Guidelines, and assumes primary responsibility for oversight with regard to any ethical issues that may arise in the course of the study. The Nelson Mandela University would also wish to be provided with an executive summary of the findings from the research.

We wish you well with the project.

Yours sincerely

Govender

Dr S Govender
Chairperson: Research Ethics Committee (Human)

cc: Department of Research Capacity Development

UNIVERSITY of the WESTERN CAPE

DEPUTY REGISTRAR
Academic Administration

Administration Building, 1st Floor
ashaikjee@uwc.ac.za, nschoeman@uwc.ac.za
021 959 2110

10 December 2019

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT THE UNIVERSITY OF THE WESTERN CAPE

Name of Researcher	:	Derek Seely
Research Topic	:	The role of social networks in the creation of university spin-offs: A focus on academic entrepreneurship in the South African university context
Date of issue	:	10/12/2019
Reference number	:	UWCRP101219DS

This serves as acknowledgement that you have obtained and presented the necessary ethical clearance and your institutional permission required to proceed with the above referenced project.

Approval is granted for you to conduct research at the University of the Western Cape for the period **10 December 2019** to **21 October 2022** (or as determined by the validity of your ethics approval). You are required to engage this office in advance if there is a need to continue with research outside of the stipulated period. The manner in which you conduct your research must be guided by the conditions set out in the annexed agreement: *Conditions to guide research conducted at the University of the Western Cape.*

The University of the Western Cape promotes the generation of new knowledge and supports new research. It also has a responsibility to be sensitive to the rights of the students and staff on campus. This office will require of you to respect the rights of students and staff who do not wish to participate in interviews and/or surveys.

It is also incumbent on you to first furnish this office with a copy of the proposed publication should you wish to reference the University's name, spaces, identity, etc. prior to public dissemination.

Please be at liberty to contact this office should you require any assistance to conduct your research or specifically require access to either staff or student contact information.

Yours sincerely

DR AHMED SHAIKJEE
DEPUTY REGISTRAR
OFFICE OF THE REGISTRAR

UWC
UNIVERSITY OF THE WESTERN CAPE
PRIVATE BAG X17, BELLVILLE
STUDENT ADMINISTRATION
10 DEC 2019
This document contains a qualified electronic signature and date stamp. To verify this document contact the University of the Western Cape at researchperm@uwc.ac.za.