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THE INTERRELATIONSHIPS BETWEEN ENTREPRENEURIAL COMPETENCIES, ABSORPTIVE CAPACITY AND INNOVATION CAPACITY

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DECLARATION

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I declare that the above thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

	23 September 2020
Ms A Taljaard	**Date**

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Being a doctoral student is akin to being a novice mountain climber who, on his first climb, decides to summit Mt. Everest. From the base of the mountain, he cannot see the peak. His experienced friends assure him that, if he persists, it will all be worth it. He expects a long, slow, sometimes painful journey ahead – and that is exactly what he gets.

- *The Doctoral Support Team* -

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ABSTRACT

THE INTERRELATIONSHIP BETWEEN ENTREPRENEURIAL COMPETENCIES, ABSORPTIVE CAPACITY AND INNOVATION CAPACITY

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Speed and measure of the fourth industrial revolution (Industry 4.0) is bringing about shifts in power, wealth and knowledge. For entrepreneurs, who are known to drive innovation, Industry 4.0 offers a wide scope of opportunities in the future. As a middle-income country, South Africa needs to use its knowledge and innovations to sharpen its innovative edge in order to compete globally and stimulate innovation.

Hence, this research attempts to determine the relationships between entrepreneurial competencies, entrepreneurial absorptive capacity and innovation capacity. Three conceptual frameworks of the interrelationships between these constructs were synthesised from the literature. As ample research on entrepreneurial competencies is widely available, a Delphi study was employed, together with a concept matrix to determine which entrepreneurial competencies should be included specifically significant for innovation within the 4IR context in South Africa. Four entrepreneurial competency categories emerged: cognitive (knowledge), functional (skills), social (attitudes and behaviours) and meta (facilitating learning) categories. Using a survey method, the analysis on a sample of 452 innovative entrepreneurs in South Africa was mainly done by empirically testing the causal linear relationship through structural equation modelling (SEM). Furthermore, an Artificial Neural Networking (ANN) technique which tests non-linear relationships and develop pattern recognition as well as modelling was conducted to compare the results of a non-linear relationship with those of a linear relationship. However, explorative comparisons of the performance of linear SEM models with non-linear NN indicated that the SEM models in this case performed better in explaining the variance in the dependent variables than did the ANN.

Through the theories of innovative performance, person-entrepreneurial fit and knowledge spillover, the findings of the study indicate the importance of incorporating a unified entrepreneurial competency typology perspective on innovation. The cognitive, functional, social and meta competencies as well as entrepreneurial absorptive capacity are significant predictors of innovation capacity. The implications of this extend to transmitting knowledge through absorptive capacity, which allows entrepreneurs to identify and exploit opportunities, identified from new knowledge sources and incorporated into new innovations. Additionally, entrepreneurial absorptive capacity mediates the relationship between social, meta, and functional competencies and innovation capacity. Entrepreneurial absorptive capacity was also found to be a moderator between cognitive competencies and innovation capacity.

Therefore, the development of certain entrepreneurial competencies, significant for innovation, is crucial for improving the strength of the relationship between entrepreneurial absorptive capacity and innovation capacity of entrepreneurs. These results have important implications for Industry 4.0 entrepreneurs, educators, policy makers as well as entrepreneurship models.

Keywords: entrepreneurial competencies, entrepreneurial absorptive capacity, innovation capacity, innovative entrepreneurs, Delphi study, structural equation modelling, artificial neural networking.

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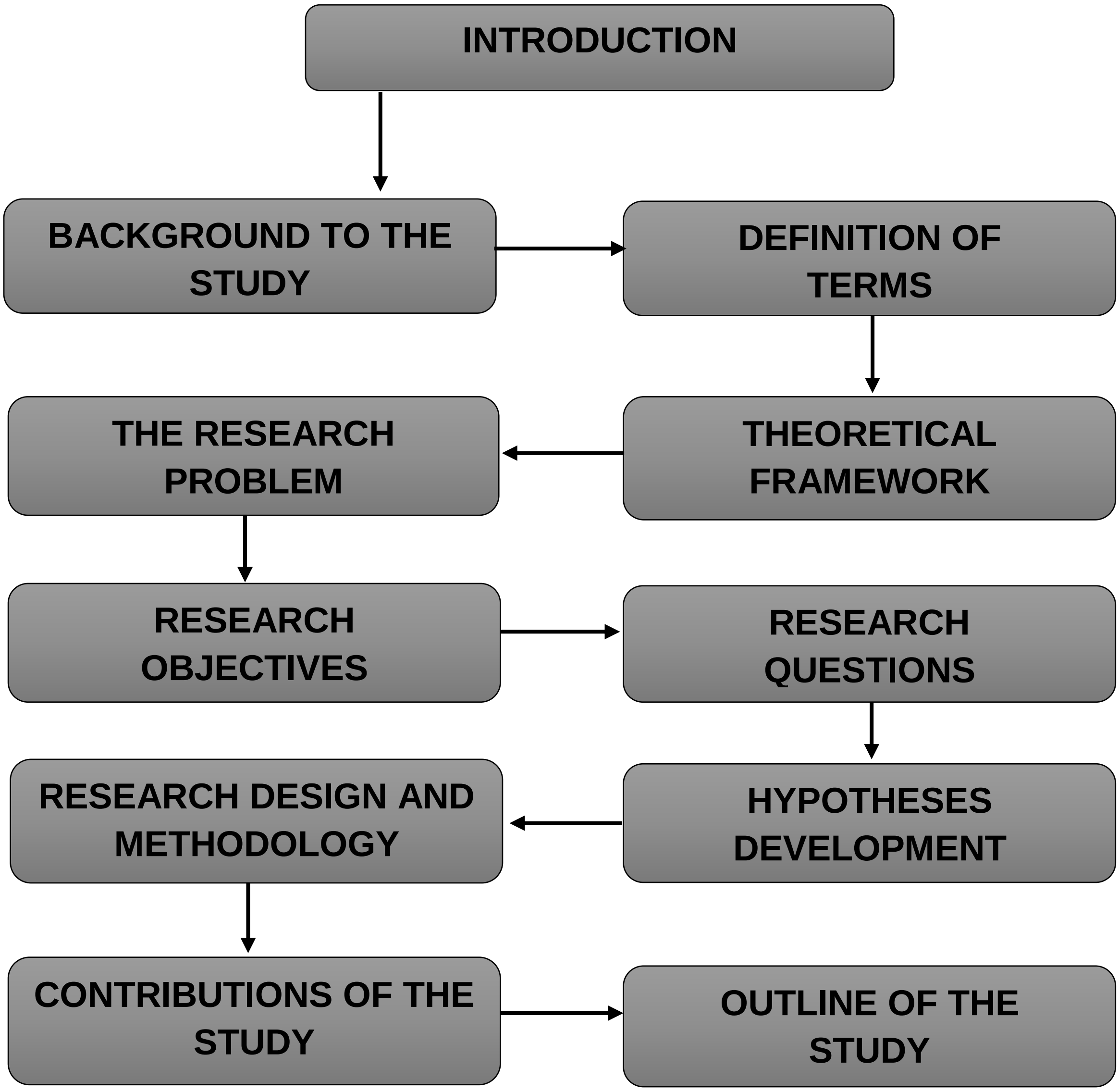
ABBREVIATIONS, ACRONYMS AND GLOSSARY

ACAP	Absorptive Capacity
ANN	Artificial Neural Networking
AVE	Average Variance Extracted
CIPC	Companies and Intellectual Property Commission
CFA	Confirmatory Factor Analysis
CEC	Cognitive Entrepreneurial Competencies
CFI	Comparative Fit Index
CMIN	Chi-square value
DA	Democratic Alliance
EC	Entrepreneurial Competencies
EACAP	Entrepreneurial Absorptive Capacity
EEA	Entrepreneurial Activity
EFA	Exploratory Factor Analysis
EGT	Endogenous Growth Theory
EO	Entrepreneurial Orientation
FEC	Functional Entrepreneurial Competencies
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEM	Global Entrepreneurship Monitor
HCT	Human Capital Theory
HTMT	Heterotrait-monotrait ratio
IC	Innovation Capacity
IFI	Incremental Fit Index
I4.0	Industry 4.0
4IR	Fourth Industrial Revolution
KMO	Kaiser-Olkin
KST	Knowledge Spillover Theory
KSA	Knowledge Skills and Abilities
KSC	Knowledge Skills Competences
MEC	Meta Entrepreneurial Competencies
NIS	National Innovation System
NN	Neural Networking
PAF	Principal Axis Factoring
PEF	Person Entrepreneurial Fit Theory

R&D	Research and Development
RMSEA	Root Mean Square Error of Approximation
TEA	Total Entrepreneurial Activity
TLI	Trucker-Lewis Index
SEC	Social Entrepreneurial Competencies
SEDA	Small Enterprise Development Agency
SEM	Structural Equation Modelling
SME	Small and Medium Enterprise
SMCs	Squared Multiple Correlations
SRMR	Standardised Root Mean Residual
UCF	Universal Competency Framework
VINT	Vision, Inspiration, Navigation and Trends
WEF	World Economic Forum

CHAPTER 1:
INTRODUCTION AND BACKGROUND TO THE STUDY

DIAGRAMMATIC SYNOPSIS



1.1 INTRODUCTION

By the year 2025, over one-third of skills (35%) that are considered important in today's workforce will have changed (Gray, 2016:1) to critical thinking, problem-solving, self-management, working with people, management and communication of activities, technology use and development, core literacies and physical abilities (Brown, Hingel, Ratcheva & Zahidi, 2020:36). In 2020, the Fourth Industrial Revolution (4IR) brought into play advanced robotics, artificial intelligence, autonomous transport and machine learning, advanced materials, biotechnology and genomics. Not only will these developments change the way we live, but also the way we work. As a result, some jobs will disappear, others will grow, while jobs that do not exist today will become commonplace. The future workforce will therefore need to align its skillset to keep pace (Brown *et al.*, 2020; Gray, 2016:1). However, this does not apply only to the workforce but also to the job creators. Entrepreneurs will continue to experiment with the avalanche of new technologies, new products and new ways of working.

An entrepreneur is defined as someone who brings value added resources in the form of labour, material and other assets and is also attached to the people who bring about change, innovation and new rules (Harahap, 2017). They are also known as individuals responsible for the process of creating new value or new ventures through value creating activities (Kruger & Steyn, 2020:6). Fortunately, by acting proactively, entrepreneurs as such, have an opportunity to help steer this emerging industrial revolution towards a far more positive future, where its very real promise leads to widespread social, environmental, economic and political progress (Maynard, 2015:1006). However, a key feature of technological discontinuities is that they require new skills, new abilities and new knowledge, and as a result, such innovations can be 'competence destroying' (Smith, 2015:59). These new skills, abilities and knowledge are seen as entrepreneurial competencies (EC), which include attitudes, values, beliefs, skills, abilities, personality, wisdom, expertise, mind-set, and behavioural tendencies (Dixon, Meier, Brown & Custer, 2005:26; Moolman, 2017). Entrepreneurial competencies are also defined as underlying characteristics such as generic specific knowledge, traits, self-image, motives, social roles, and skills which result in venture birth, survival and growth (Bird, 1995:51). According to Kruger and Steyn (2020:1), in order to respond and navigate the layers of I4.0 technologies and enable new possibilities, entrepreneurs require certain competencies in this globally connected and technology-fuelled world.

Entrepreneurship is of critical importance to the modern economy, which is based on a specific trait to collect, process and use various forms of knowledge to solve problems (Stošić-Mihajlović & Trajković, 2016:24) where significant relationships between EC and firm performance have been reported in empirical studies (Kaur & Bains, 2013:31; Li, 2009:131). In essence, the success and stability of modern companies predominantly depend on the continuity of innovation. This is based on continuous learning such as specialisation of existing and new knowledge, which is a function of the application and/or the creation of new technologies (Draskovic, Jovovic, Draskovic & Jereb, 2013:i, 1). Rasmussen, Mosey and Wright (2011) argue that there is a gap in the literature relating to which competencies are necessary, how they are developed and who provides them. Several authors (Darroch & Clover, 2005b; Erikson, 2002; Glancey, 1998; Mamabolo, Kerrin & Kele, 2017; Man, Lau & Chan, 2002a; Moolman, 2017; Perks & Strüwig, 2005; Ucbasaran, Westhead & Wright, 2002; Van Vuuren & Nieman, 1999; Veliu & Manxhari, 2017; Westhead, Ucbasaran & Wright, 2005; Wickham, 2001) have investigated and identified the integrated model of entrepreneurial performance, which shows that the absence of any one skill will lead to zero performance. Individual competence has become known as an important means of survival and the only real employment security for the individual (Moolman, 2017; Sydänmaanlakka, 2002:127). Entrepreneurs and managers often share similar roles and tasks in many aspects, such as organising and personnel management. It is therefore natural that researchers in the entrepreneurship field adopt the competency approach to study entrepreneurs (Li, 2009:1). Scholars (Bharwani & Talib, 2017; Cheetham & Chivers, 1996; Le Deist & Winterton, 2005; Moolman, 2017; Winterton, Delamare-Le Deist & Stringfellow, 2006) have also used the clustering approach, where competencies are clustered in categories such as cognitive competence (knowledge), meta-competence (facilitating learning), functional competence (skills) and social competence (attitudes and behaviours).

Since innovation drives evolution, the theory of knowledge teaches us that a statement, if it conveys knowledge, predicts future outcome (Miller & Morris, 2008:29). Rational prediction therefore requires theory and builds knowledge through systematic revision and extension. Although much research has been done on what drives innovation, Baporikar (2015:257) indicates that in essence the biggest obstacle and yet the most significant driver of innovation is people. Conceptualising the internal and external determinants of Innovation Capacity (IC), which is defined as measuring the level of invention and potential for innovation (Suarez-Villa, 1990), Lukjanska (2010:43) links absorptive capacity (ACAP) with IC that could be transformed into successful innovation, the determinants of which are identified as knowledge and competence. According to South-Africa's National Development Plan 2030 (Commission, 2013:262), expanding the production of highly skilled professionals will enhance the IC of the nation. Yet, even though opportunities for entrepreneurs in South Africa appear bright, African countries still have a limited capacity to absorb and benefit from opportunities offered by the 4IR. Revamping education and training systems to impart relevant skills to entrepreneurs are therefore a critical imperative (Bowmaker-Falconer & Herrington, 2020:37). Recent studies indicate that newly hired college graduates are not as adept in these higher-level knowledge- and information-based skills as employers expect and need. Entrepreneurs have also indicated that the shortage of highly skilled workers inhibits the growth of their own companies as well as the development of new entrepreneurial firms (Boyles, 2012:41-42). Although studies have found links between EC and organisational performance, new evidence is required based on EC necessary for entrepreneurs of the fourth industrial revolution (4IR). Which supports the inconclusive evidence that remains as to why a gap still exists in the National Innovation System (NIS) where research outputs are not being turned into commercially viable products and services.

The research question therefore lies in whether there are certain factors such as ECs and EACAP that can enhance an entrepreneur's capacity to innovate?

The overall purpose of this study is twofold: firstly to provide evidence as to which ECs are significant for innovation within the 4IR, in order to guide educators and entrepreneurs as to which competencies need to be developed to increase an entrepreneur's capacity to innovate. Secondly, to investigate the relationship between ECs and IC, which simultaneously integrates EACAP by constructing a moderated moderation model and mediated mediation model. The empirical results will provide a reasonable reference for improving entrepreneurial innovation capacity.

To achieve this overall purpose, the study aims to investigate the relationships between individual ECs, EACAP and IC of innovative entrepreneurs in South Africa, by drawing on existing theories. The study will further develop four models which predicts the IC of innovative entrepreneurs, incorporating ECs and EACAP. The models will consider how the interrelationships predict IC between four categories of ECs and EACAP.

For the purpose of this study, innovativeness is defined as: "the act of bringing something new and original into existence" (Boyles, 2012:46), shaped by absorptive capacity (ACAP) Meaning, that one has the capacity to identify, assimilate, and apply external knowledge for innovation (Cohen & Levinthal, 1990). An innovative entrepreneur is therefore someone who has taken the action of developing or inventing something new and original. Chandler and Hanks (1994:77) present a parsimonious model of venture performance, which specifically examines the moderating effect of founder competencies on venture performance. Based on the Persaud, Kumar and Kumar (2001) model for IC using knowledge, the framework indicates that IC can occur at individual or organisational level. Established entrepreneurs have been in business for more than three and a half years (Herrington, Kew & Kew, 2016:15). This study focuses on highly innovative entrepreneurs and how their IC and EACAP can shed light on their set of competencies, reasoning behind how and who create disruptive and radical innovations. Radical innovations tend to be disruptive, and create new-to-the-world products. They are also disruptive to producers because the markets they create undermine the competences and complementary assets on which existing competitors have built their success (Markides, 2006:22).

Previous research has addressed future performance impacts – performance differences that are predicted by differences in competencies (Kruger & Steyn, 2020:1; Levenson, 2005:5; Tisch, Abele & Metternich, 2019). Bennour and Crestani

(2007:151) and Kruger and Steyn (2020:1) presented a panorama of studies correlating competence with process performance. It has also been found that certain competencies can predict performance: for instance, Spreitzer, McCall and Mahoney (1997) found that certain competencies predicted subsequent performance ratings by supervisors and career advancement (Bray, Campbell & Grant, 1974; Dulewicz & Herbert, 1996). From an emerging economies perspective, findings suggest that enforcing ECs have a significant effect on firm performance (Ahmad, Suseno, Seet, Susomrith & Rashid, 2018:5). Even the possession of certain managerial competencies have been found to be associated with the performance of SMEs (Veliu & Manxhari, 2017:59). Empirical evidence in particular suggest that in order to respond and navigate the layers of I4.0 technologies and enable new possibilities, entrepreneurs require certain competencies in this globally connected and technology-fuelled world (Kruger & Steyn, 2020:1). Therefore, if competencies are not sufficiently forward-looking, since competency requirements change over time (Hollenbeck & McCall, 1999), then they will not be tied closely enough to strategy, and thus will be imperfect predictors of future performance (Levenson, 2005:7). Furthermore, entrepreneurial firms with better learning abilities tend to more actively gain knowledge and could be important to support a firm's outcomes. Hence findings suggest that the better the ACAP is the better the management performance is, thus creating profits (Bui, Liao, Nguyen & Chang, 2019:16). In this study, the purpose of testing the relationships is to determine whether there is a relationship between EC and EACAP that can lead to IC of innovative entrepreneurs.

This chapter provides an introduction by way of providing a background to the study, a brief literature review and a description of the research problem. This is followed by an explanation of how the purpose and objectives of the study will address the research problem. To ensure that the purpose and objectives are achieved, the study will answer a set of research questions and test the presented hypotheses presented in the four hypothesised models. The chapter further provides definitions of the constructs to be used and a brief discussion of the research design and methods applied in the study. Justification for conducting the study is provided by highlighting the contributions. This is followed by a delineation of the study and a discussion of the ethical considerations. In conclusion, it provides an outline of chapters one to eight of this research study.

1.2 BACKGROUND TO THE STUDY

Expand the production of highly skilled professionals and enhance the innovative capacity of the nation (Commission, 2013:262)

The decreasing trend in innovation in South Africa is a concern as it indicates that the country is losing its footing in innovativeness. This information is supported by the CIPC (2016-2017) and the GEM report (Herrington *et al.*, 2016); there is a decrease in patent registration and with regards to low innovation levels of total entrepreneurial activities in South Africa. Therefore, South-African SMEs need to embrace innovation to stay relevant in today's global economy since their survival depends highly on their innovativeness, creativity and entrepreneurship. Undeniably, the potential of the 4IR is unmistakable, with the expanding digital economy widening options for entrepreneurship and innovative businesses in South Africa (Bowmaker-Falconer & Herrington, 2020:37).

Looking to the future (2030), one of the strategic goals in the Companies and Intellectual Property Commission's (CIPC) Annual Report (CIPC, 2016-2017:35) is to contribute to a knowledge-based economy and competitive local industries by promoting innovation, creativity and indigenous cultural expression and knowledge. As a result of knowledge, new developments and technological progress is stimulated (Draskovic *et al.*, 2013:2). However, the capacity to identify, assimilate, and apply external knowledge for innovation, called absorptive capacity, is known to be essential for innovation in organisations (Cohen & Levinthal, 1990). According to the World Economic Forum, the future of jobs in our economy involves the employment, skills and workforce strategy for the future (Brown *et al.*, 2020). For Africa on the other hand, the most binding constraint to industrialise is not the energy or the materials, but the ideas. It is here where entrepreneurship and skills are critical (Naudé, 2017:11). Even though SMEs in South Africa are still driving job growth and economic development, a greater need lies in the investment in skills, innovation and technology to boost wages and productivity (Bowmaker-Falconer & Herrington, 2020:vi).

South Africa is classified as an efficiency-driven economy with the contribution of Small and Medium Enterprises (SMEs) to the Gross Domestic Product (GDP) at 45% in 2014. The country has an EEA of 0,3% with a ranking of 57T/60, innovation impact with a value of 2,8%, ranking 32T/60. Compared with Africa alone, South Africa is ranked 21/60 with a value of 30.15 with regard to innovation levels of % TEA or total entrepreneurship activity (the product is new to all or some customers and few/no businesses offer the same product) (Herrington *et al.*, 2016:138). In efficiency-driven groups, factors constraining entrepreneurship the most are entrepreneurship education at school age, government policies on taxes and regulation, R&D transfer, government policies and government entrepreneurship programmes (Herrington, Kew & Kew, 2018:17).

IC measures the level of invention and the potential for innovation. Suarez-Villa (1990) used innovation patent data in developing a model that provided insights on the evolution of patenting when IC was introduced. South Africa has a strong culture of innovation; however, there is still a gap in the National Innovation System (NIS), as most of the research outputs have not translated to commercially-viable products and services. The filing of patents has decreased from 2016 to 2017 by approximately 3.3%, to 9017 patents, with a downward trend over the last four years (CIPC, 2016-2017:30). According to the report, should the negative trend continue, further research should be conducted in order to understand the decrease in filings.

Several scholars have highlighted the importance of the role of the entrepreneur, specifically competencies and skills, in determining the firm's performance or success (Alipour & Taleghani, 2016; Chandler & Jansen, 1992; Darroch & Clover, 2005a; Man *et al.*, 2002a; Mohsin, Halim & Farhana, 2017) or in some cases the manager (Levenson, Van der Stede & Cohen, 2006). ECs have also been tested as a moderator in venture performance (Chandler & Hanks, 1994:77; Lawal, Iyiola, Adegbuyi, Ogunnaike & Taiwo, 2018; Man *et al.*, 2002a), determinants of successful innovations (Acs, Audretsch & Lehmann, 2013:193; Lukjanska, 2010:43), influential role and contributing factor needed for successful and sustaining entrepreneurship (Hazlina Ahmad, Ramayah, Wilson & Kummerow, 2010:184). Man *et al.* (2002a) used the concept of competitiveness in a conceptual model that links different competency areas with other constructs such as entrepreneurial competencies, competitive scope, organisational capabilities and firm performance. Competencies as a means to measure effectiveness have also been investigated (Alipour & Taleghani, 2016; Chandler & Jansen, 1992:223). Several scholars have been involved in exploring work on the development of EC (Rasmussen *et al.*, 2011) to create new ventures (Kaur & Bains, 2013; Rasmussen *et al.*, 2011) and in developing a framework of managerial/entrepreneurial competencies (Cheetham & Chivers, 1996; Man *et al.*, 2002a; Morris, Webb, Fu & Singhal, 2013; Winterton *et al.*, 2006). However, the relationship between the specific ECs significant for innovation within the 4IR is relatively limiting in existing literature (Grzybowska & Łupicka, 2017; Kruger & Steyn, 2020; Łupicka & Grzybowska, 2018).

In subsequent studies, scholars argued that demographic factors such as age and education (Pawitan, Widyarini & Nawangpalupi, 2018) and entrepreneurial orientation (Ibidunni, Atolagbe, OBI, Olokundun, Oke, Amaihian, Borishade & Obaoye, 2018) plays an important role in the process of EC's impact on innovation and performance. This means that the relationship between EC's and IC is affected by other variables, which will provide a more persuasive explanation of their relationship.

1.2.1 Background to the Fourth Industrial Revolution (4IR)

The Fourth Industrial Revolution or 4IR has become a global buzz-word since the issue was raised by the WEF in 2016. At present, we find ourselves at the beginning of the 4IR, which is characterised by so-called "Cyber-Physical Systems" as indicated in Figure 1.1. These systems are a consequence of the integration of production, sustainability and customer-satisfaction, forming the basis of intelligent network systems and processes (Bloem, Van Doorn, Duivestein, Excoffier, Maas & Van Ommeren, 2014:10). It further involves the connectivity of all human and mechanical actors over the complete value chain, as well as the digitalisation and real-time analysis of all relevant information. The term Industry 4.0 (I4.0) was established in 2013 by the German government as an initiative to ensure future competitiveness as a production location for high-tech products (Eberhard, Podio, Alonso, Radovica, Avotina, Peiseniece, Caamaño Sendon, Gonzales Lozano & Solé-Pla, 2017:49).

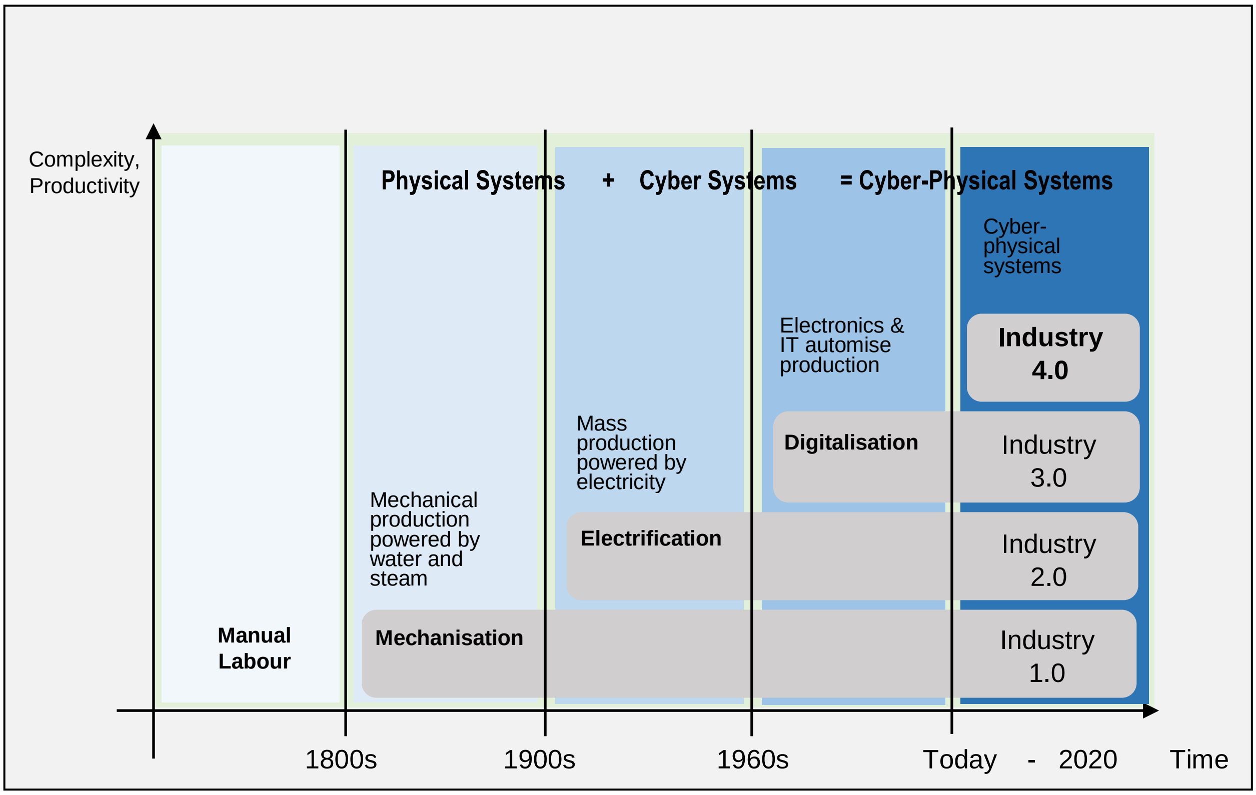


Figure 1.1: An overview of the four industrial revolutions

Source: Adapted from Bloem *et al.* (2014:11) and (Drath & Horch, 2014:56)

Within this emerging landscape, cyber security is becoming an increasingly important challenge, as global digital networks open up access to connected products and manufacturing processes across the world. A powerful fusion between online resources, modular and open-source technology, and point-of-source production devices, such as 3D printers, will increasingly enable entrepreneurs to set up shop almost anywhere. Furthermore, it is a revolution that one cannot turn the clock back on. There are many converging technologies that are increasing the gap between what we can do and our understanding of how to do it, such as the convergence between robotics, nanotechnology and cognitive augmentation, and between artificial intelligence, gene editing and maker communities (Maynard, 2015:1006). Intelligence is defined as "the ability to exploit knowledge in such a way as to be able to make the right solutions, choices and decisions", and creative intelligence as a combination of intellectual, emotional and intuitive intelligence (Sydänmaanlakka, 2002:199). Even if the evolution might happen more slowly than expected, the picture that emerges is one of a technology revolution that we cannot turn the clock back on. Entrepreneurs will continue to experiment with the avalanche of new technologies, new products and new ways of working (Maynard, 2015:1006).

The accelerating pace of technological, demographic and socio-economic disruption is transforming industries and business models. This is changing the skills that employers need and shortening the shelf-life of employees' existing skills sets in the process. For example, technological disruptions such as robotics and machine learning – rather than completely replacing existing job categories and occupations – are likely to substitute specific tasks previously carried out as part of these jobs, freeing workers up to focus on new tasks and leading to rapidly changing core skills sets in these occupations. Even those job positions that are less directly affected by technological change and have a largely stable employment outlook, for example marketing or supply-chain professionals targeting a new demographic in an emerging market, may require very different skills sets just a few years from now as the ecosystems within which they operate change (Gray, 2016:19). As with technological change, it is known to be a bit-by-bit cumulative process until it is punctuated by a major advance (Tushman & Anderson, 1986:441).

Often, incremental change for an existing technology will continue to render it as competitive; however, on the other hand, technological discontinuities take place. Therefore, a key feature of technological discontinuities is that they require new skills, new abilities and new knowledge, and as a result, such innovations can be "competence destroying". This means that existing organisations are unable to use the knowledge and experience they have accumulated during the period of equilibrium. Considering that the existing knowledge represents a big investment made over a long period of time, organisations are likely to want to make use of this knowledge (Smith, 2015:59).

According to (Schwab, 2016), the exponential changes in new technology are characterised by a fusion of technologies across the digital, physical and biological worlds that are leading to profound shifts across all industries. Technological innovations have heralded a 4IR that has marked the emergence of new business models which affect every aspect of society (Naudé, 2017:3). Earlier industrial revolutions were different from the new emerging 4IR. The earlier “revolutions” saw technology replacing skilled workers (e.g. artisans in textile factories replaced by power looms) and demanding low-skilled workers (e.g. the steam engine). The 4IR tends to replace lower-skilled workers while demanding higher-skilled workers. A binding constraint is therefore whether an economy can participate in manufacturing in the 4IR; the question then becomes whether it has enough relevant skills available (Brynjolfsson & McAfee, 2012).

According to Brynjolfsson and McAfee (2012) and David and Dorn (2013), skills that may become more relevant in the 4IR include creative and social intelligence, top management and leadership skills, as well as skills required for arts and entertainment. It is estimated that up to 66 per cent of jobs in developing countries are at risk (Frey, Osborne, Holmes, Rahbari, Garlick, Friedlander, McDonald, Curmi, Chua & Chalif, 2016) and by the year 2033, 47 per cent of the jobs in the advanced economies are at risk of being automated (Frey & Osborne, 2013). African countries are therefore at risk in terms of job-losses of existing low-skilled routine jobs in manufacturing, the re-shoring of manufacturing to advanced economies and the redundancy of the model of industrialisation through attracting Foreign Direct Investment (FDI), based on low-cost labour in assembly-type manufacturing (Naudé, 2017:4). These “new forms of manufacturing”, that refer to new business models that bring goods and services to the consumer, include tools that will enable African entrepreneurs to provide products-as-services, to establish and grow the sharing (collaborative) economy (Frey *et al.*, 2016).

Furthermore, I4.0 intends to improve the efficiency and productivity over the overall value chain. I4.0 is not projected to only reduce manual workplaces, but to create new jobs that are less physically exhausting and more flexible (Eberhard *et al.*, 2017:49). The competence profiles of employees that will work in so called “smart factories” will change strongly (Kagermann, Helbig, Hellinger & Wahlster, 2013). Changes in the education methods during previous industrial revolutions have often taken decades in order to provide workers and students with new major skill sets. However, the 4IR requires a fast adaption and involves disruptive changes. According to the WEF (Leopold, Ratcheva & Zahidi, 2016) it is expected that by 2020, on average a third of the currently desired core skills sets of most occupations will comprise skills not yet considered crucial to the job today. It further indicates that the highest level of skills stability over 2015-2020 is found in the media, entertainment and information sector, whereas a large amount of skills disruption is expected to happen in the banking sector, industry, infrastructure and mobility. It is therefore assumed that low-skilled workers in these industries have to retain and relocate to tasks that are non-susceptible to computerisation. Frey and Osborne (2013) argue that with the declining prices in computing, problem-solving skills are becoming more important, which indicates that a future workforce must deal with more cognitive tasks.

Frey and Osborne (2013) investigated 702 detailed occupations and their probability to be substituted by computerisation. Further results highlight the main jobs that are of high risk of substitution, as well as future jobs that offer great opportunities, such as entrepreneurship and green jobs. Digitalisation, for example, offers great opportunities for entrepreneurship, and new technologies offer great opportunities for innovations and ideas (Eberhard *et al.*, 2017:50-52). Prifti, Knigge, Kienegger and Krcmar (2017:48) focused on the individual as a key factor in 4IR and analysed the broad spectrum of competencies for individuals, not only on functional, but also on behavioural level. They offered an overview of competencies that should be taught to individuals for successfully working in 4IR. A behavioural approach was applied.

1.3 DEFINITION OF TERMS

1.3.1 Entrepreneurial business/venture

According to Nieman (2006:7) "entrepreneurial ventures" are defined as "businesses where the principal objectives are profitability and growth" which usually create employment. His latest definition of an "entrepreneurial venture" can be expressed as "one that constantly seeks growth, innovation and has strategic objectives" (Nieman, 2013:8). Morris, Pitt and Berthon (1996:61) define an "entrepreneurial business" as "one that proactively seeks to grow and is not limited to resources currently under its control". Three factors are identified in distinguishing entrepreneurial ventures from small businesses – namely, innovation, growth potential and a broad vision (Nieman & Nieuwenhuizen, 2009:10; Rwigema, 2004:7).

1.3.2 Innovative entrepreneurs

Inventive thinking by definition involves the act of bringing something new and original into existence (Boyles, 2012:46). It is a combination of intelligence and creativity that leads to the ability of entrepreneurs to evaluate multiple ideas to determine the true opportunities (Hills & Shrader, 1998:125; Keh, Der Foo & Lim, 2002). Scholars who study either macro or micro problems reserve a substantial place for innovative entrepreneurship within their analysis. In fact, innovative entrepreneurs are among the most elusive and intriguing characters that constitute economic growth (Baumol, 2010:10). The term "entrepreneur" refers to someone who undertakes and even, referring to earlier literature, anyone who organises a new business firm of any variety. Innovative entrepreneurs have a different function, as it is their job to locate new ideas and to put them into effect and practise leadership (Baumol, 2010:18). The innovative entrepreneur is also able to take the steps from invention to final marketing being carried out (Baumol, 2010:26). In Dahlstrand and Stevenson (2010:8), an innovative entrepreneurship policy is aimed at fostering the start-up of innovative, technology-based and rapidly growing knowledge-based enterprises.

1.3.3 Absorptive capacity

Absorptive capacity or ACAP is primarily associated with technological innovation and integrates both the external dimension, which is concerned with learning, and the knowledge transfer process within the innovating organisation (Hazlina Ahmad *et al.*, 2010:64). Cohen and Levinthal (1990:128) identified ACAP as being concerned with: "the ability of a firm to recognise the value of new, external information, assimilate it and apply it to commercial ends". The concept of ACAP further evolved from prior research on organisational learning, which is defined as the growing insights into and successful restructuring of organisational problems (Simon, 1969). It also involves the process of improving actions through better understanding (Fiol & Lyles, 1985:803), and the ability of the firm to assess and act upon internal and external stimuli in a cumulative, interactive and purposeful manner (Meyers, 1990:102). Research therefore shows that there are similarities between these definitions and the definition of ACAP, with the distinguishing factor of ACAP of an organisation being that it is a function of the level of a firm's prior related knowledge (Deeds, 2001:33).

1.3.4 Entrepreneurial absorptive capacity

Entrepreneurial absorptive capacity or EACAP on the other hand differs from ACAP, in the notion of Cohen and Levinthal (1990), about the way in which EACAP refers to the ability of individuals. Qian and Acs (2013) argue that entrepreneurs who start a new business need market and business knowledge to create and operate a firm, not only scientific knowledge. The notion of EACAP encompasses several kinds of knowledge, which emphasises the heterogeneity of knowledge. EACAP also involves knowledge and skills of entrepreneurs to understand a new technology, recognise its market value, and bring it into commercialisation (Qian & Acs, 2013:193). Fort the purpose of this study, EACAP is therefore defined as the ability of an entrepreneur to recognise the value of new, external information, assimilate it, and apply it to commercial ends. For the purpose of this study, EACAP is defined as: the ability of an entrepreneur to recognise the value of new, external information, assimilate it and apply it to commercial ends.

1.3.5 Individual absorptive capacity

Cohen and Levinthal (1990:131) state that "an organisation's absorptive capacity depends on the absorptive capacity of its individual members", of which they are a key building block and function of organisational ACAP (Löwik, 2013:105). In existing ACAP literature an individual's ACAP is conceptualised and operationalised as a set of competences consisting of individuals' prior knowledge and experience (Hayton & Zahra, 2005; Jane Zhao & Anand, 2009), values and beliefs, technical skills (Matusik & Heeley, 2005), and motivation (Minbaeva, Petersen, Bjorkman, Fey & Park, 2003). However, these competences mainly relate to the knowledge-processing function of individuals for organisational ACAP (Löwik, 2013:106).

1.3.6 Entrepreneurial competencies

Competency is a term defined as "an underlying characteristic of an individual that is causally related to criterion-referenced effective and/or superior performance in a job or situation". It is also "a characteristic and measurable pattern of knowledge, skills and behaviours that contributes to superior job performance" (Mills, 2004:10). Baum, Locke and Smith (2001:293) define the concept as individual characteristics such as knowledge, skills and/or abilities required to perform a specific job. Bird (1995:51) defines EC as underlying characteristics such as generic-specific knowledge, traits, self-image, motives, social roles, and skills which result in venture birth, survival and/growth. It is further conceptualised as the total sum of an entrepreneur's attributes, knowledge, beliefs, skills and abilities.

1.3.7 Four categories of ECs

Le Deist and Winterton (2005) proposed a multidimensional view on competence as a construct that holds both the individual and the personal parts of a person and cannot be separated. The model is based on the original model developed by (Cheetham & Chivers, 1996). It includes functional competence, cognitive competence, social competence and meta-competence, where meta-competence appears as a comprehensive element that facilitates the acquisition of the other competencies. Le Deist and Winterton (2005) adapted the model by blending the personal and occupational competences and created a four-dimensional view on competence. The framework proposed by the two authors is the most recent development in terms of defining competence, which is further discussed and illustrated in Chapter 2. Therefore, this researcher considers this to be the most adequate model for defining such a recent concept in entrepreneurship. The model has the following categories/dimensions:

- *Cognitive competence*: this refers to underpinning theory and concepts as well as informal tacit knowledge gained experientially; knowledge, the "know that" is underpinned by understanding, the "know why".
- *Functional competence*: this refers to skills or know-how and things that a person should be able to do and to demonstrate.
- *Social/Personal competence*: this refers to behavioural competencies or knowing how to behave; some behaviours and attitudes related to entrepreneurial competence are having a positive attitude towards change and showing initiative.
- *Meta-competence*: this is referred to as a comprehensive concept of the multidimensional construction of competence; it further refers to the element that facilitates the acquisition of other competencies.

1.3.8 Innovation capacity

The concept innovation capacity or IC was originally introduced by Suarez-Villa (1990) as a concept, framework or method that measures the level of invention and the potential for innovation. The term innovative capacity might also be used to refer to an individual's aptitude to an educational quality, or to an entity's condition, and therefore, merely denotes a characteristic. Invention refers to ideas that are patented and when these ideas are used for economic or social purposes, they become innovations (Suarez-Villa, 2017:1). He defines a society's IC as "the successful outcomes of all corporate and individual invention". Multiple definitions for innovation types have resulted in an ambiguity in the way the terms "innovation" and "innovativeness" are operationalised and utilised in the new product development literature (Garcia & Calantone, 2002:110; Smith, 2015:25).

Key aspects of innovation have been identified as newness and novelty, which is derived from the Latin word *Novus,* meaning new or novel. However, the term "newness" can take many different forms such as: new producer, new use, new customer, new technology or completely new product (Smith, 2015:4). The terms really-new, radical, incremental and discontinuous are used ubiquitously to identify innovations (Garcia & Calantone, 2002:110). Rogers (2003:12) captures the definition of innovation, which refers to differences in "newness" as, "an idea, practice or object that is perceived as new by an individual or other unit of adoption". However, novelty and newness are limiting, because innovation, as well as being novel and new, needs to be a "viable business concept". It is therefore about the development of something new and its implementation into a viable product one can purchase (Atkinson & Ezell, 2009:129). Innovation is also defined as "the implementation of a new or significantly improved product, or process, new marketing, or a new organisational method in business practices, workplace organisation or external relations". Innovativeness, on the other hand, is most frequently used as a measure of the degree of "newness" of an innovation, although a single consistency does not exist due to varying perspectives for innovativeness (Garcia & Calantone, 2002:112). For the purpose of this study, IC is defined as a concept that measures the individual level of invention and the potential for innovation.

1.3.9 Open innovation

According to Chesbrough (2012:20), the open innovation paradigm can be understood as the antithesis of the traditional vertical integration model, where internal innovation activities led to internally developed products and services that were then distributed by the organisation. Open innovation also entails the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand markets for external use of innovation (Chesbrough, 2006:1). Chesbrough (2006) further describes "open innovation" as where innovating companies increasingly utilise external sources in order to carry out innovation. Organisations utilise external resources for innovation by either taking internally generated ideas/discoveries and using an external route to market via a third-party organisation so that the latter develops ideas/discoveries into marketable products or services which it then markets. Organisations also do ideas/discoveries themselves from external organisations, with subsequent development taking place internally using the organisation's own resources/facilities (Smith, 2015:106). The rise of network-based models, which is effectively a form of open innovation, has challenged the closed innovation model. The reason for this is changes in the external environment. Open innovation is based on vertical disintegration, where innovation becomes much more flexible in terms of sourcing new ideas/discoveries. Businesses taking the open-innovation route become much more fluid and flexible, with ideas, discoveries and inventions increasingly flowing both in and out of the organisation (Dodgson & Gann, 2010).

1.4 THEORETICAL FRAMEWORK

In this section, extant literature on the key terms of the study is discussed briefly in an attempt to establish the state of the current discourse linked to the study's focus.

In recent years several scholars have investigated drivers of innovation linking several variables like R&D, exportation, partnerships and technology transfer to innovation (Hadhri, Arvanitis & M'Henni, 2016) as well as structural, performance and behavioural factors (De Fuentes, Dutrenit, Santiago & Gras, 2015). Other determinants have empirically proved to play a role such as social networking (Scuotto, Del Giudice & Carayannis, 2017a) transformation leadership, knowledge sharing, perceived organisational support (Le & Lei, 2019), collaboration, human capital, information technology and funding as innovation inputs, as well as institutional factors such as foreign ownership, market competition, firm size, and environment (Divisekera & Nguyen, 2018). Recent studies have also focused their attention on absorptive capacity (Lau & Lo, 2015; Scuotto *et al.*, 2017a; Smit, Abreu & de Groot, 2015). Determinants of innovation capability within patent features have also been investigated (Ponta, Puliga, Oneto & Manzini, 2020). These studies have used a variety of qualitative and quantitative research methods and provided valuable insights into the possible factors that may affect this relationship. Yet, these investigations were conducted in the general business sector in Lebanon, the service sector in Mexico, the tourism sector in Australia, the exporting sector on SMEs in Brazil as well as firms in the Netherlands, Korea and China. Furthermore, there is holistic understanding of the interrelationship between these different factors and how they contribute to improving the IC of the individual entrepreneur. With entrepreneurship being a source of economic growth and job creation, human capital – the set of knowledge, skills, and abilities that are possessed by employees – plays a pivotal role in innovation and is a conducive factor for the innovation performance of entrepreneurial firms (Martin, McNally & Kay, 2013; Qian & Acs, 2013; Suarez-Villa & Hasnath, 1993). This still remains an under researched area in the field of entrepreneurship. Entrepreneurial competencies and entrepreneurial absorptive capacity are the two variables considered in this study as drivers of innovation capacity.

This study aims to address this gap by investigating how the following factors affect the IC of innovative entrepreneurs in South Africa, in order to get a better understanding of how and why they invent the way they do.

- Four categories of competencies (cognitive, functional, social, meta), specifically competencies significant for innovation within 4IR.
- Entrepreneurial absorptive capacity as a significant factor in the facilitation of innovation effectiveness.

The next section provides the theoretical underpinning surrounding the broad concepts of EC, EACAP and IC. It streamlines various relationships between the constructs and how different theories fit together. A number of theories have been advanced in the entrepreneurship literature based on various disciplines such as education and training, interested in the phenomenon. The study is therefore based on three theories relating to both the organisation and individual factors affecting entrepreneurship of an organisation, namely: the person-entrepreneurial fit theory, absorptive capacity theory and the knowledge-spillover theory.

1.4.1 Theoretical foundation for the research

The following theories formed the foundation of the literature review in studying the relationship of the three constructs: Knowledge Spillover Theory (KST) (Marshall, 1920), which is an advancement of the microeconomic foundations of the Endogenous Growth Theory (EGT) (Romer, 1990); Absorptive Capacity Theory (ACAP) (Acs, Braunerhjelm, Audretsch & Carlsson, 2009), which evolved from prior research on organisational learning; Human Capital Theory (HCT); and Person-Entrepreneurial Fit (PEF) Theory, which is based on Kirton's (1976) Adaption-Innovation Theory.
The major contributions made by the person-entrepreneurial fit theory, absorptive capacity theory and knowledge-spillover theory towards this study are summarised in the following section. It is discussed in more detail in chapter 2 and chapter 3.

1.4.1.1 The person-entrepreneurial fit theory underpinning the EC-IC relationship

The person-entrepreneurial fit theory serves as a theoretical anchor in terms of which to explore ECs that will be instrumental to entrepreneur's IC. Person-job fit and person-organisation fit are among concepts commonly discussed in the long-standing organisations, while in small and entrepreneurial businesses they are replaced with person-entrepreneurship fit (Kakapour, Hemmati & Khanifar, 2014:243). Empirical evidence derived from this theory suggest that the closer the match between individuals' attitudes, values, knowledge, skills, abilities and personality, the better their job satisfaction as entrepreneur and their performance. The theory further suggests that the closer the match between entrepreneurs' personal characteristics and the requirements of being an entrepreneur (e.g., creating new ventures by transforming discoveries into marketable products), the more successful they will be (Markman & Baron, 2003:281). Hsu, Burmeister-Lamp, Simmons, Foo, Hong and Pipes (2019:2) introduced perceived person-entrepreneurship fit as a moderator between entrepreneurial self-efficacy and entrepreneurial intention. The findings indicated that when a strong perception of fit with entrepreneurship is achieved, entrepreneurial intention is strongly predicted by entrepreneurial self-efficacy. Person-entrepreneurship fit among entrepreneurs of knowledge based firms in Tehran indicated that social capital, social skills and self-efficacy factors have a major role in explaining this construct (Kakapour *et al.*, 2014). Contrastingly, the relationship between personality traits and cognitive adaptability did not provide a better person-entrepreneurship fit of established entrepreneurs. Nonetheless, it is still possible to confirm that a person-entrepreneurship fit could be present if an entrepreneur has a positive relationship between cognitive adaptability dimensions and aesthetic interest (Botha & Morallane, 2019:8).

This study specifically argues that the extent to which entrepreneurs are high on a number of distinct individual competencies, or as Markman and Baron (2003) calls it, individual-difference dimensions (e.g., self-efficacy, ability to recognise opportunities, personal perseverance, human and social capital, superior social skills) the closer will be the person-entrepreneurship fit. Consequently, the greater the likelihood or magnitude of IC of the innovative entrepreneurs investigated in this study.

1.4.1.1.1 Entrepreneurial competencies and innovation capacity

Research on ECs have been viewed as essential for entrepreneurs to perform successfully and transform businesses, however, research on ECs and their impact on innovative performance is still lacking (Mohsin *et al.*, 2017:88). Several developments have since occurred that have opened up the conversation surrounding the importance of competencies significant for I4.0. While it is true that entrepreneurs with highly developed ECs are more likely to introduce innovation to their businesses (Mitchelmore & Rowley, 2010), it is postulated that some of the competencies have more influence on innovative outcomes among entrepreneurs. The literature provides emerging evidence of a positive relationship between ECs and innovative outputs, where empirical evidence suggests that entrepreneurs must have the right competencies to undertake innovative projects (Mohsin *et al.*, 2017:88, 97). Moreover, the importance of entrepreneurial key competencies has been evident in recent studies, in particular in the offering of entrepreneurship academic programmes (Arafeh, 2016; Fernando, 2020; Kruger & Steyn, 2020; Lilleväli & Täks, 2017; Tittel &

Terzidis, 2020) and key competencies for I4.0 (Grzybowska & Łupicka, 2017; Prifti *et al.*, 2017). In some cases, ECs are found to have a moderating impact on venture performance (Lawal *et al.*, 2018:1).

Upon exploring the dominant conceptual approaches to competence and competency, one is stuck by the limited progress that has been made towards the development of a commonly accepted understanding of employability, competence and competency. Moolman (2017:39) argue for a holistic conception of competence, as it incorporates both the behavioural and functional approaches to competence and competency. ECs have been identified in the literature as a specific group of competencies that are necessary to be implemented for successful entrepreneurship (Mitchelmore & Rowley, 2010). Since this study is focused on innovative entrepreneurs, ECs are explored in detail in chapter 2 to distinguish between cognitive, functional, social and meta competencies. Le Deist and Winterton's (2005:4) multi-dimensional holistic competence approach is becoming more widespread in order to better align educational and work-based provision. Scholars such as Moolman (2017); Orhei (2011) and Orhei, Nandram and Vinke (2015) exploit this approach to create synergy between formal education and experiential learning to develop professional competence (such as being an entrepreneur), which will ultimately yield benefits for graduates, the workforce, society and the economy (Moolman, 2017:39). The approach use four broad routes: Cognitive; Functional; Social; and Meta competence; enabling the categorising of competencies and furthermore distinguishing the mechanisms through which knowledge, skills and competence are required and recognised (Cheetham & Chivers, 1996:22). This study not only identifies the collective competencies (the synergetic combination of individual competencies), but also adopts these four domains of competence in classifying ECs. Competence is ultimately known as the ability to accomplish a work task up to a recognised standard for a particular profession (Matthews & Brueggemann, 2015:11); in this case, the profession of entrepreneur of the 4IR. Man, Lau and Chan (2002b) clarify that ECs are viewed as the total ability package of an entrepreneur to perform the job role successfully and to also transform the business. The main strength of their argument lies in that ECs are exercised by individuals who start and transform their businesses. The relationship between these four competence categories and IC have not been tested empirically in the field of entrepreneurship. Consequently, the full extent to which ECs affects IC are not yet known.

1.4.1.2 Absorptive capacity theory underpinning the EACAP-IC relationship

The theory of absorptive capacity contributes to this study by providing an advanced conception of the importance of external knowledge as a critical component of innovation (Smith, 2015). Since its conception (Cohen & Levinthal, 1989), studies have considered its application not only in innovation, but also to areas such as inter-organisational collaboration and learning, marketing, supply chain management, international business and entrepreneurship. In addition, prior studies have examined the relationship between ACAP and performance outcomes including innovation, financial performance and knowledge transfer (Zou, Ertug & George, 2018:87). The notion of ACAP as a multi-dimensional construct consists of four capabilities namely acquisition, assimilation, transformation and exploitation (Zahra & George, 2002). The more specific focus by the four dimensions identified in recent literature opens up some promising avenues for operationalising the concept (Noblet, Simon & Parent, 2015:367). Absorptive capacity theory is a concept that has been primarily associated with technological innovation, and is concerned with learning and the knowledge transfer process within an innovating organisation (Smith, 2015:64). It also helps to explain why some organisations, even when exposed to external knowledge, are poor innovators because they cannot absorb and make use of knowledge (Smith, 2015:65). The concept of ACAP has mostly been studied in the case of large and R&D companies (Zahra & George, 2002). Part of the debate revolved around the role age and size play on a firm's capacity to innovate (Zou *et al.*, 2018:88). Discussions on open innovation suggest that the ability to absorb external knowledge has become a major driver for competition. It is often a precondition that businesses dispose of "absorptive capacity" to internalise external knowledge. However, for small businesses, implementing the concept of ACAP is less known. They will have to look for assistance to build their ACAP or even to “outsource” a significant part of this function (Spithoven, Clarysse & Knockaert, 2011:2).

1.4.1.2.1 Entrepreneurial absorptive capacity and innovation capacity

Since the construct’s introduction (Cohen & Levinthal, 1989) ACAP has played and continues to play a major role in the innovation literature (Zou *et al.*, 2018). It can contribute to a firm’s innovative outcomes and performance in at least two ways. First, by enabling a firm to assess the value of external knowledge, acquire external knowledge that is useful, and then combining such knowledge with its existing knowledge in order to generate innovative outcomes (Cohen & Levinthal, 1990:141). Second, information or ideas across an organisation can provide various inputs, which can yield innovative outcomes if exchanges are made between departments (Cohen & Levinthal, 1990:131-132). In general, literature on the relationship between ACAP and innovation proposes that both variables are positively related (Zou *et al.*, 2018:89). A meta-analysis conducted on 241 studies by Zou *et al.* (2018) further reveal that ACAP is a strong predictor of innovation and knowledge transfer. Nonetheless, the impact that individual EACAP has on ones capacity to innovate remains unclear, as little research has been done on the individual level of ACAP. Several scholars have argued that there should be more individual level foundation for ACAP (Lane, Koka & Pathak, 2006; Schweisfurth & Raasch, 2018:689; Volberda, Foss & Lyles, 2010). The individual is in fact the person who has to possess the ability to absorb knowledge from outside the organisation and is relied on to search for and learn from external knowledge sources (Schweisfurth & Raasch, 2018).

In our advancement of ACAP from an individual-level perspective, individual ACAP has been shown to be predicated on prior knowledge, cognition, and the diversity of external networks (Jiménez-Castillo & Sánchez-Pérez, 2013; Löwik, Kraaijenbrink & Groen, 2012), and to be related to innovativeness (Löwik *et al.*, 2012; Ter Wal, Criscuolo & Salter, 2017). In the past few years, EACAP has drawn much academic and business interest on entrepreneurial orientation (EO) (Hernandez-Perlines, 2018), which empirically support the notion that ACAP is also a moderator in its relationship between EO and the international performance of family businesses (Hernandez-Perlines, 2018:58) as well as EO and innovation performance of SMEs in China (Zhai, Sun, Tsai, Wang, Zhao & Chen, 2018:1). Seemingly, these relationships forms the basis on which a relationship could be supposed between EACAP and IC. This study perceived ACAP in the context of entrepreneurship as a capability to transform new knowledge into IC on the part of an individual. Particularly viewing EACAP as a fundamental determinant of IC.

1.4.1.3 Absorptive capacity theory of knowledge-spillover entrepreneurship underpinning the EACAP-EC relationship

Knowledge-spillover theory is an advancement of the microeconomic foundations of the endogenous growth theory developed by Romer (1990). Advanced by Qian and Acts (2013), the new *absorptive capacity theory of knowledge spillover entrepreneurship* provides insight into the relationships between new knowledge and knowledge embodied in people and entrepreneurship. This theory has a long and well-documented history (Cohen & Levinthal, 1990; Zahra & George, 2002), and argues that knowledge spillover entrepreneurship not only depends on new knowledge but more importantly on absorptive capacity that allows entrepreneurs to understand new knowledge, recognise its value and commercialise it by creating a firm (Marks, Dawa & Kanyemba, 2020:117). Qian and Act's model identifies two conduits through which human capital or knowledge embodied in people influences entrepreneurship (Qian & Acs, 2013). Knowledge spill-over theory of entrepreneurship has attracted attention from researchers for a number of reasons. Primarily, emphasising the importance of small entrepreneurial firms in creating innovations and fostering growth and wealth (Ghio, Guerini, Lehmann & Rossi-Lamastra, 2015:1). Acs and Audretsch (1988) argue that the creation of a new venture is a response to opportunities stemming from knowledge generated and not commercially exploited by incumbent firms or academic research institutions. Shane and Venkataraman (2000:217) claims that what distinguishes knowledge spillover theory of entrepreneurship is that the source of the entrepreneurial opportunities involves knowledge spillovers. While Schumpeter (1934) recognized the role of the innovator in taking opportunities for starting the process of creative destruction in developing new products, the question remains in where these opportunities come from and how they are turned into innovations.

1.4.1.3.1 Entrepreneurial absorptive capacity and entrepreneurial competencies that leads to innovation capacity

According to Caiazza, Belitski and Audretsch (2020:694) the process that turns knowledge into innovation is highly ambiguous and complex. They argue that innovators are economic agents able to recognise opportunities, overcome the knowledge filter and take the necessary risks needed to turn new knowledge into innovations (Namatovu & Dawa, 2017:696). Recently, several studies have concluded that previous research on the absorptive capacity theory of knowledge spillover entrepreneurship has focused on the scope and boundaries of this phenomenon at a firm, institutional or regional level (Caragliu & Nijkamp, 2012; Proeger, 2020; Zhao, Jiang & Wang, 2019), but not at the level of the individual entrepreneur (Marks *et al.*, 2020). It is therefore expected that with a certain level of knowledge, skills and experiences coupled with exposure to a new environment leads to an increase in new knowledge (Marks *et al.*, 2020:118). Therefore, entrepreneurs with higher levels of human capital are better at identifying and exploiting opportunities (Namatovu & Dawa, 2017:410). According to Mason, Rincon-Aznar and Venturini (2020:238), the resources and capabilities which underpin ACAP derive in large part from prior investments in R&D and innovation, in knowledge search activities and in skills acquisition and development.

With respect to the ECs – ACAP relationship, empirical studies conducted by Dzhengiz and Niesten (2020:881) demonstrate that managers who are able to recognise and acquire external knowledge develop environmental competencies and capabilities. It further showed that environmental competencies have a positive direct effect on environmental performance, and an indirect effect as mediator between environmental capabilities and performance. Dai and Yu (2013:1143) concur that a positive and significant relationship between skills related to identifying and using export market knowledge and export performance was found. In their hypotheses Mason *et al.* (2020:238) found that specific workforce skills such as high-level skills and upper intermediate-level skills contribute to the development of ACAP resulting in innovative output.

This study explains the role of entrepreneurial competencies as a mechanism that needs to be incorporated and developed in acquiring knowledge resources and the entrepreneur’s subsequent ability in transforming it into innovative output. It further identifies which ECs contribute most to EACAP.

1.5 THE RESEARCH PROBLEM

The background of the study has made it clear that despite the importance of the entrepreneur to the modern economy, survival depends highly on their innovativeness, creativity and entrepreneurship (Bowmaker-Falconer & Herrington, 2020). Although research on the drivers of innovation have been investigated and tested to an extent (De Fuentes *et al.*, 2015; Divisekera & Nguyen, 2018; Hadhri *et al.*, 2016; Le & Lei, 2019; Ponta *et al.*, 2020; Scuotto *et al.*, 2017a) very little is known about the ECs and EACAP required for entrepreneurs and entrepreneurial organisations to be able to invent “disruptive innovations” to keep pace with the fourth industrial revolution has been limited. Therefore, this study provides further insights into the importance of specific ECs that predicts high levels of invention and potential for innovation. Specifically, the extent to which the interrelationship exists between ECs, EACAP and IC in understanding why entrepreneurs invent the way they do. Danneels (2004) raised a key question in the context of predicting whether a technology will be disruptive. Disruptiveness of innovations refers to the extent at which an emerging customer segment sees value in the innovation at the time of introduction, which disrupts the products mainstream customers use. Therefore, can the disruptive technology framework make certain predictions about the type of organisations or entrepreneurs likely to develop disruptive innovations? Are entrepreneurial organisations likely to be the best solution to produce high levels of innovation capacity?

Critical to aiding the innovative performance of entrepreneurial organisations is the understanding of the individual as a driver of innovation and specifically its ECs. Keeping in mind that South Africa only has an innovation impact with a value of 2,8% with regard to innovation levels of TEA (Herrington *et al.*, 2016:138), it is therefore critical to establish whether certain ECs or a set of ECs can increase the IC of entrepreneurial businesses. Therefore, a Delphi study is conducted to determine which ECs are necessary and should be included to drive innovation for the 4IR entrepreneurs in South Africa.

Empirical evidence exists on the performance impact that competencies have at the individual, unit or organisational level (Levenson, 2005:4). Boyles (2012:41) compared 21st century knowledge, skills and abilities with entrepreneurial competencies and found a meaningful overlap between the two. Gray (2016:19) identified ten skills the workforce needs to thrive in the 4IR. A comparison was made between the skills that were required in 2015, compared with the skills required for the workforce of 2020, of which emotional intelligence and cognitive flexibility were identified as some of the new skills needed. However, Stowe Boyed commented on the report, indicating that the World Economic Forum's (WEF) skills list was out of date. Leopold *et al.* (2016) came up with a new list of 10 work skills for the postnormal era, which includes: Boundless curiosity, Freestyling, Emergent Leadership, Constructive Uncertainty, Complex ethics, Deep generalists, Design logic, Postnormal creativity, Posterity and Sensemaking. Although many research studies have been done on the drivers of innovation, little in- depth research has been conducted on how big an influence the individual plays in an organisation's IC, in particular its EC and EACAP. Despite the acknowledgement that individuals are central to ACAP, researchers tend to overlook the roles the individual plays in exploring, assimilating and exploiting external knowledge. This would seek to contribute to existing research on how the entrepreneur contributes to his/her organisation's IC (Ter Wal, Criscuolo & Salter, 2011:1).

SMEs contributed approximately 45% to the GDP in 2014. From the background of the study, it is clear that the filing of patents in South Africa has decreased from 2016 to 2017 by approximately 3.3%. We have an innovation impact with a low value of 2,8%, ranking 32T/60 and 21/60 compared with Africa alone, with a value of 30.15 with regard to innovation levels of TEA (the product is new to all or some customers and few/no businesses offer the same product) (Herrington *et al.*, 2016:138). There is a need to understand some of the reasons why some entrepreneurial organisations' IC is low and some high.

The research problem thus deals with the overall lack of evidence that certain ECs, particularly those significant for innovation within 4IR and one's EACAP increases an entrepreneur's capacity to innovate. Specifically, the extent to which these interrelationships exists.

As outlined in the research problem, this study sought to develop and test a predictive model, which will:

- Provide evidence as to which ECs are significant for innovation within the 4IR, in order to guide educators and entrepreneurs as to which competencies need to be developed to increase an entrepreneur's capacity to innovate; and
- Indicate whether significant relationships exist between ECs and IC, which is simultaneously integrated by EACAP, constructing a moderated moderation model and mediation mediated model, providing a reasonable reference for improving IC.

1.6 RESEARCH OBJECTIVES

To realise the overall purpose, primary and secondary objectives will be set. These objectives will be achieved by means of answering specific research questions.

1.6.1 Primary objectives

The primary objective of this study is:

To determine whether there is a significant positive relationship between entrepreneurial competencies (within the four categories), entrepreneurial absorptive capacity and innovation capacity of innovative entrepreneurs in South Africa.

1.6.2 Secondary objectives

To achieve this overall purpose and primary objective, the study will be conducted in two parts: a literature review and empirical study. Each of these parts will contribute to achieving its own set of secondary objectives which will also be used to provide a logical structure for the remainder of the study.

1. To determine the specific Entrepreneurial Competencies significant for innovation within the 4IR context in South Africa.
2. To determine whether these specific Entrepreneurial Competencies enhances an entrepreneur’s Innovation Capacity.
3. To determine whether Entrepreneurial Absorptive capacity enhances an entrepreneur’s Innovation Capacity.
4. To determine whether specific cognitive, functional, social and meta competencies enhances ones Entrepreneurial Absorptive Capacity.
5. To determine whether Entrepreneurial Absorptive Capacity has a mediating effect on the relationship between the four categories of Entrepreneurial Competencies and Innovation Capacity.
6. To determine whether Entrepreneurial Absorptive Capacity has a moderating effect on the relationship between the four categories of Entrepreneurial Competencies and Innovation Capacity.
7. To determine whether the four categories of Entrepreneurial Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity.

8. To determine whether Neural Networking (through testing non-linear relationships) provides a better model fit to that provided by Structural Equation Modelling through linear relationships.

1.7 RESEARCH QUESTIONS

The primary research question:

Is there a significant positive relationship between entrepreneurial competencies (within the four categories), entrepreneurial absorptive capacity and innovation capacity of innovative entrepreneurial businesses in South Africa?

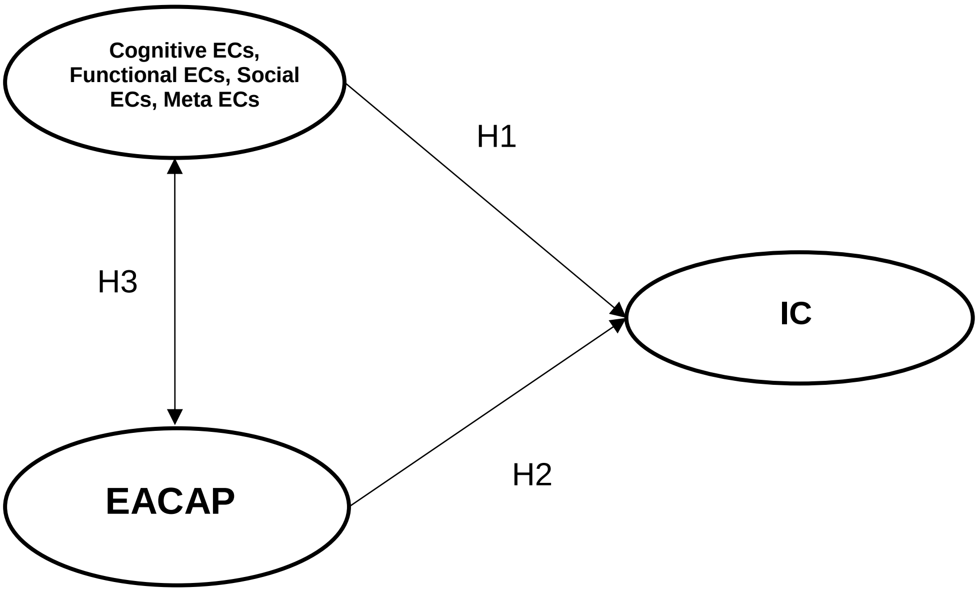
The secondary research questions:

1. What specific Entrepreneurial Competencies are significant for innovation within the 4IR context in South Africa?
2. Is there a significant positive relationship between these Entrepreneurial Competencies and Innovation Capacity?
3. Is there a significant positive relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity?
4. Is there a significant positive relationship between the four categories of Entrepreneurial Competencies and Absorptive Capacity that can lead to Innovation Capacity?
5. Does Entrepreneurial Absorptive Capacity mediate the relationship between the four categories of Entrepreneurial Competencies and Innovation Capacity?
6. Does Entrepreneurial Absorptive Capacity moderate the relationship between the four categories of Entrepreneurial Competencies and Innovation Capacity?
7. Do the four categories of Entrepreneurial Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity?

8. Does Neural Networking (through testing non-linear relationships) provide a better model fit to that provided by Structural Equation Modelling (SEM) through linear relationships?

1.8 HYPOTHESES DEVELOPMENT

1.8.1 Hypothesis models

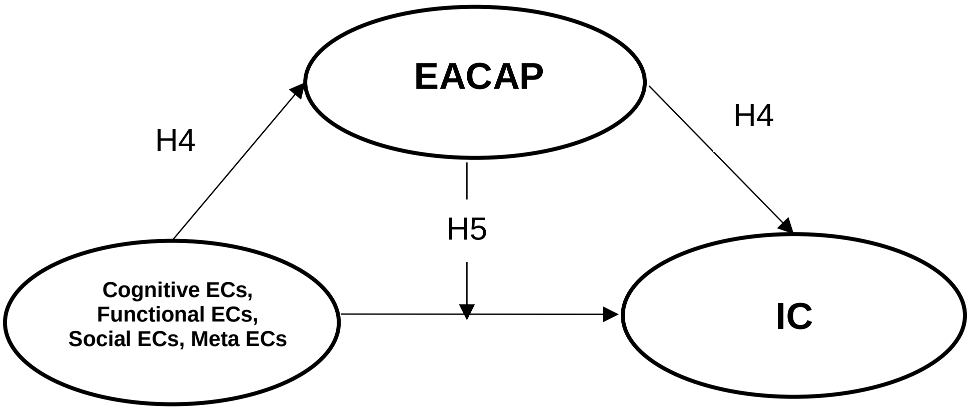


EACAP = Entrepreneurial Absorptive Capacity

EC = Entrepreneurial Competencies

IC = Innovation Capacity

Figure 1.2: Hypothesis model 1 [Based on Conceptual Framework 1: Relationships]

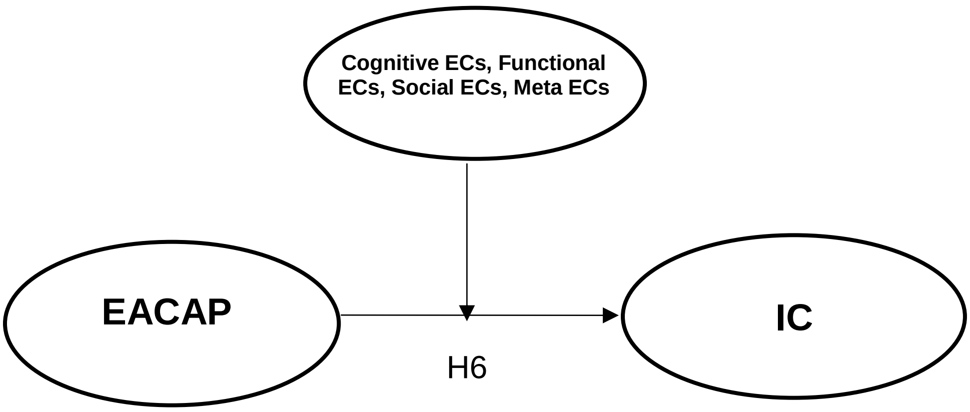


EACAP = Entrepreneurial Absorptive Capacity

EC = Entrepreneurial Competencies

IC = Innovation Capacity

Figure 1.3: Hypothesis model 2 [Based on Conceptual Framework 2: EACAP as moderator and mediator]



EACAP = Entrepreneurial Absorptive Capacity

EC = Entrepreneurial Competencies

IC = Innovation Capacity

Figure 1.4: Hypothesis model 3 [Based on Conceptual Framework 3: EC as moderator]

1.8.2 Hypotheses

H1: There is a significant positive relationship between Entrepreneurial Competencies and Innovation Capacity

H1a: There is a significant positive relationship between Cognitive Competencies and Innovation Capacity

H1b: There is a significant positive relationship between Functional Competencies and Innovation Capacity

H1c: There is a significant positive relationship between Social Competencies and Innovation Capacity

H1d: There is a significant positive relationship between Meta Competencies and Innovation Capacity

H2: There is a significant positive relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity

H3: There is a significant positive relationship between Entrepreneurial Competencies and Entrepreneurial Absorptive Capacity

H3a: There is a significant positive relationship between Cognitive Competencies and Entrepreneurial Absorptive Capacity

H3b: There is a significant positive relationship between Functional Competencies and Entrepreneurial Absorptive Capacity

H3c: There is a significant positive relationship between Social Competencies and Entrepreneurial Absorptive Capacity

H3d: There is a significant positive relationship between Meta Competencies and Entrepreneurial Absorptive Capacity

H4: Entrepreneurial Absorptive Capacity mediates the relationship between Entrepreneurial Competencies and Innovation Capacity

H4a: Entrepreneurial Absorptive Capacity mediates the relationship between Cognitive Competencies and Innovation Capacity

H4b: Entrepreneurial Absorptive Capacity mediates the relationship between Functional Competencies and Innovation Capacity

H4c: Entrepreneurial Absorptive Capacity mediates the relationship between Social Competencies and Innovation Capacity

H4d: Entrepreneurial Absorptive Capacity mediates the relationship between Meta Competencies and Innovation Capacity

H5: Entrepreneurial Absorptive Capacity moderates the relationship between Entrepreneurial Competencies and Innovation Capacity

H6: Entrepreneurial Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity

H6a: Cognitive Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity

H6b: Functional Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity

H6c: Social Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity

H6d: Meta Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity

H7: Neural Networking (through testing non-linear relationships) provides a better model fit to that provided by Structural Equation Modelling (SEM) through linear relationships.

1.9 RESEARCH DESIGN AND METHODOLOGY

The research design was based on this study's research problem, objectives and hypotheses. It is a master plan that specifies the methods and procedures for collecting and analysing the needed information and provides a framework or plan of action for the research (Zikmund, Babin, Carr & Griffin, 2013:64). A sequential exploratory mixed-method design was used to collect the data. The study consists of a literature review and an empirical study. Together with the literature review, a Delphi technique and concept matrix was conducted to compile a list of ECs that are necessary for innovation. The Delphi method is an effective and reliable data-collection method that is particularly useful when there is uncertainty or little knowledge surrounding the area being investigated (Crisp, Pelletier, Duffield, Adams & Nagy, 1997; Dalkey & Helmer, 1963; McKenna, 1994; Reid, Pease & Taylor, 1990).

The research design was cross-sectional, which involves the analysis of data that has been collected at a particular time and is sociological in nature, but not longitudinal or experimental. Using a cross-sectional design, taking the research objectives into consideration, enabled the researcher to study multiple actions; it did not differentiate between cause and effects or the sequences of events. The sample of entrepreneurs was drawn from various highly innovative entrepreneurs in South Africa, in order to provide a variety of components and industries. A classical Delphi method was used, where data were collected from the participants in a series of rounds and the results were fed back to the participants until stability in responses among the participants had been achieved. The results and consensus of the Delphi study (as discussed in chapter 2) were then incorporated in the survey for empirical testing. Measures were developed for a pilot study involving innovative entrepreneurs, of which SEM and NN were used for further statistical testing. This was done in order to determine the bidirectional relationships between constructs and to determine whether there was interrelationships between EC, EACAP and IC of innovative entrepreneurs.

1.9.1 Description of overall design

Due to the exploratory nature of the preliminary research questions outlined in this chapter, in *Phase 1, as illustrated in Figure 1.5,* a Delphi method was utilised and a concept matrix developed (discussed in chapter 2), which comprised of a critical comparative literature review that determined the ECs for measurement. This method was chosen to ensure that all the required competencies needed to be included for measurement had been considered. Based on the Delphi results, and those ECs identified and tested in previous research studies, which could not simply be ignored. The Delphi method (discussed in section 5.2.1 and illustrated in Figure 5.4) is an effective and reliable data collection method that is particularly useful when there is uncertainty or little knowledge surrounding the area being investigated. A concept-centric approach was used (Webster & Watson, 2002:16) to compile the organising framework of competencies into a concept matrix. The purpose of this part of the study was to develop consensus among expert principals regarding the EC considered most essential for the 4IR, which was discussed in chapter 2. The Delphi study facilitated a structured communication of participants including academics, industry experts and entrepreneurs. For this Delphi study, the targeted panel size was between 10 and 25 industry experts, academics and entrepreneurs. A questionnaire in the form of a survey was developed and distributed to the panel members in the various rounds to collect data over a period of three months, where consensus was reach after round two. The competencies derived from these results were then utilised into the final questionnaire for measurement (discussed in section 2.6).

The overall research design for the empirical study is described in the following section.

1.9.1.1 Research instrument

A survey was the most appropriate strategy, given the research study's problem and research objectives. The aim was to generate findings that were representative of a large population of innovative entrepreneurs that focus on new and novel innovations within South Africa.

1.9.1.2 Research descriptors

This was an empirical research study, due to research collected from new data from potential research participants. Basic (pure/fundamental research) was undertaken because the aim was not to directly solve an organisational problem but to improve understanding of the relationship between EC, EACAP and IC. The purpose was to find new knowledge regarding EACAP and the influence EC has on the IC of an entrepreneurial business, which would in turn identify the competencies required for the entrepreneurial workforce for 4IR. Therefore, research objectives were predetermined in line with the available time and resources at hand.

Primary data were collected for the specific purpose of the research study to add value to entrepreneurial businesses. Existing secondary data were also reviewed. This was a cross-sectional and not a longitudinal study because the particular phenomena of competencies and ACAP were examined at this particular time. The survey strategy tends to be used for descriptive research to describe characteristics of situations, individuals and answer questions such as “What?”, “Where?”, “How?”, “How much?” and “How many?”.

The method of data collection in this study was based on a communication approach in the form of a structured survey. A survey is defined as a method of collecting primary data which is based on a representative sample of individuals.

Research rarely has access to every member of a population. Data are therefore collected from a small subset of the population known as a “sample” (Field, 2009:34).

1.9.2 Sampling

Data were collected from a small subset of the population known as a “sample”. Researchers rarely have access to every member of a population (Field, 2009:34).

1.9.2.1 Target population

The target population is discussed according to the following questions:
"Who?", the "Doing what?", the "Located where?" and "When?" as outlined below.

Who?

The primary target population was innovative entrepreneurs in South Africa.

Doing what?

The study included entrepreneurs that had an innovative business of some sort, which could be technology-oriented, an incremental or radical invention or operating within the 4IR industry; therefore, bringing something new and original into existence.

Located where?

The entrepreneurial ventures were operating in South Africa, based in any of the nine provinces. The targeted businesses were not limited to branches located internationally.

When?

1 November 2018 until 30 November 2019.

1.9.2.2 Unit of analysis

In order to attain the goal of the study, potential respondent entrepreneurial businesses were identified through a search of the most innovative businesses and entrepreneurs in South Africa, specifically focusing on industries related to the 4IR. Innovative entrepreneurs were identified through innovation summits, conferences and innovation competitions, as well as technology accelerator programmes and incubators. These entrepreneurs possessed eligible businesses that were either controlled or headquartered in South Africa, and their management team was also based in the country.

1.9.2.3 Entities/sources from which data were collected

The research instrument was based on the findings of the secondary data sources, which included amongst others relevant literature, government documents, research reports and official Internet sites. Primary data were collected from questionnaires and distributed to innovative entrepreneurs.

1.9.2.4 Methods/techniques for selecting respondents, participants or data sources

This study used a combination of two sampling techniques – namely "purposive/judgemental" and "systematic" sampling. A "systematic" sampling technique is a probability sampling procedure and it is most commonly associated with survey-based research strategies. A systematic sampling technique works well because the population covers a large geographical area. Inferences can therefore be drawn from the sample about the larger population, to be able to meet the research objectives (Saunders, Lewis & Thornhill, 2016:208). A "purposive/judgemental" sampling technique is a non-probability sampling procedure, where the sample is arbitrary and subjectively selected (Cooper & Schindler, 2011:385). This is in order to fulfil the purpose of providing answers to the study's research questions and objectives. A census approach is followed when the population is small and necessary when the elements are quite different from each other. The size of a population suggests that a census is feasible (Cooper & Schindler, 2014:338). Therefore, as the potential total target population size in this study was not known to the researcher, it was decided to follow a census approach allowing all the potential respondents in the sampling frame to complete the survey.

1.9.3 Data collection

The method of data collection in this study was based on a communication approach in the form of a structured survey. Data collection involved gathering both secondary and primary data.

1.9.3.1 Nature of data to be collected

Secondary data were collected to identify the various components of ACAP, EC and IC. Primary data were collected to be able to evaluate the EACAP of the individual, measuring EC and IC, in order to determine the relationship between these constructs and how they influence one another.

According to Saunders *et al.* (2007:163), it is important to recognise the factors that hamper access to the required sources of data. These factors include physical access and the request for access, participation and cooperation. This was planned for in advance and appropriate measures and strategies developed in order to overcome any obstacles in order to still reach the set of research objectives.

1.9.3.2 Data collection methods

Secondary data were collected from a myriad of sources that included existing literature from academic journal articles, books, government documents, research reports, electronic journals and Internet sites.

Primary quantitative data were collected from entrepreneurial businesses through self-administered questionnaires that consisted of rating, ranking, open-ended and closed-ended questions. The questionnaire was designed and structured to ensure the collection of valid and reliable data.

1.9.3.3 Pre-/pilot-testing

A questionnaire was developed to accommodate innovative entrepreneurial businesses. The questionnaire was first pilot-tested on entrepreneurs that met the target population requirements. Thereafter, these businesses were excluded from the research study to avoid participant bias. A group of experts were requested to comment on the questionnaire design and structure. It was essential that the respondents should have no problems in understanding and answering the questions.

1.9.4 Data analysis

Data analysis is described as a process that involves reducing accumulated data to a manageable size, developing summaries, looking for patterns, and applying statistical techniques (Cooper & Schindler, 2011:90). Descriptive and inferential statistics were applied to investigate and summarise the research constructs. Both SEM and NN were used to empirically test the conceptual framework and hypothesised model to facilitate both a linear and pattern recognition view of the conceptual model.

In order to analytically test a conceptually grounded theory of ACAP, EC and IC, explaining how different measured items represent important measures of each phenomenon, and also test the postulated hypotheses, the study used SEM and NN. SEM was used to empirically examine the theoretical model to conduct one- and two-way path analysis. Squared multiple correlations were used to measure item reliability (Bagozzi & Yi, 2012). Confirmatory Factor Analysis (CFA) allows the evaluation of the hypotheses' construct validity by testing whether a theoretical model of what a test is supposed to measure is consistent with the observed covariances (Kline, 1998b:343). CFA is also used to determine whether the hypothesised structure provides a good fit for the data – that is, whether a relationship exists between the observed variables and the underlying latent or unobserved constructs.

Artificial Neural Networking (ANN) has been widely known as solving many forecasting and decision modelling poblems. It is able to model any type of parametric or non-parametric process and automatically and optimally transform the input data (Hill, Marquez, O'Connor & Remus, 1994:5). An artificial neural network is defined as a network composed of a large number of simple processor (neurons) that are massively interconnected, operate in parallel, and learn from experience (Specht, 1991:568). Using the survey data, a neural network-based approach was used to quantify the connectivity between these determinants (ACAP, CE and IC). The reliability of the resulting model was assessed via a 10-fold cross-validation. After being deemed reliable, the model parameters were used, which indicated the connection weights between input units, hidden units and output units for determining the relative importance of each input to the single output (Wong, Wong & Chin, 2011:13066). ANN is a mathematical model for predicting system performance (i.e., system output) (Bataineh, 2012:1).

1.9.5 Assessing and demonstrating the quality and rigour of the proposed research design

To assess and demonstrate the quality and rigour of the proposed research design, the sources of error or bias were considered along with the appropriate criteria and techniques.

1.9.5.1 Criteria and techniques for assessing the quality and rigour of the proposed study

Participant or subject error, participant bias, observer error and observer bias are four threats to reliability. Instrumentation, testing, history, mortality and maturation are threats to validity. As a researcher one has to keep these in mind as well as find ways to effectively deal with them so that they do not negatively influence the research results.

1.9.6 Research ethics

Research ethics refers to the “appropriateness of the research’s behaviour in relation to the rights of those who become the subject of his/her [work] or [are] affected by the work”. In this specific study the potential ethical issues were recognised and considered from the outset of the research during each stage of the project. The key ethical issues that were addressed related to the privacy of the participants. The participation was completely voluntary in nature and the individual had the right to withdraw partially or completely from the research process. Data that were provided by the participating individuals or identifiable individuals were treated as strictly confidential and anonymous and the findings of the research will be made freely available to all interested parties. The researcher remained objective at all times during the research process. There further was no falsification of data and the work is free of any form of plagiarism.

The questionnaire used in this study as well as gatekeepers letters were submitted to the University of Pretoria's ethics committee with approval awarded on 9 March 2017 [Protocol no: EMS075/18] (Refer to Appendix A for the ethical approval letter). The approval was subject to the researcher abiding to the principles and parameters set out in the actual execution of the research.

1.10 CONTRIBUTIONS OF THE STUDY

The person responsible for the successful performance of the business is called the entrepreneur and the knowledge, skills and abilities required to run and get fruitful results from the business successfully is called the competency

(Kaur & Bains, 2013:31).

This closely relates to critique that competencies are typically specified as "end state" characteristics, meaning that no further development can take place (McCall, 1998).

The study sets out to provide the following theoretical and practical contributions:

1.10.1 Theoretical contributions

The theoretical contribution of this study is grounded in conceptualising a model of entrepreneurs' competencies by taking into consideration the skills and abilities required to develop innovations for the 4IR and it's IC. Not only does it focus on individual competencies, but the domains under which they fall as a matter of importance. This is so especially in the context of training and development initiatives seeking to clarify the concept of entrepreneurial competence by incorporating knowledge, skills and competences within a holistic competence typology. Skills are captured by functional competence, knowledge captured by cognitive competence, attitudes and behaviours captured by social competence, while meta-competence is concerned with facilitating the acquisition of the other substantive competence, therefore facilitating learning (Winterton *et al.*, 2006:40).

The study further aims to contribute to the existing literature on entrepreneurship in a number of ways: firstly, this study proposes that the principal focus of entrepreneurial scholars interested in understanding the influence of IC on ECs should be to follow a competency-based approach. Secondly, the study strives to identify and understand the significant ECs necessary for high levels of IC to occur, particularly in the context of an individual's EACAP. Thirdly, this study seeks to determine the predictability of IC, using competencies and EACAP as constructs influencing an entrepreneur's innovativeness. Finally, the outcome of this research will be incorporated into a framework of recommended entrepreneurial competencies required for the 4IR for entrepreneurs and entrepreneurial businesses. The study further argues that researchers should revisit the contribution of the individual in understanding the critical ECs that play a role in the IC of an entrepreneurial business. This is because the ECs of the individual entrepreneur have proven performance outcomes (Bryant & Poustie, 2001:73; Covin & Miles, 1999; Morris *et al.*, 2013:353; Sánchez, 2012:257).

1.10.2 Practical contributions

Practically, noting the radical changes in today's business environment, entrepreneurs should be made aware of important competencies that may have causal connection to their business success and innovative performance.

The findings derived from this research may also be useful to entrepreneurs in alerting them to the kind of training necessary to improve the business's IC. They provide business owners with knowledge about the business's ability to integrate, build and reconfigure internal and external competencies to rapidly changing environments. This can be achieved through its entrepreneurial absorptive capacity in developing and extending the business's capacity to learn (Cohen & Levinthal, 1990:128). This study also provides some useful guidelines for policy makers and educators as to ways in which educational and training programmes can be improved to support the development and success of entrepreneurs and predict future outcomes.

This study should be beneficial to entrepreneurs by expanding on models for innovation and competence development and should help with implementing the right interventions to encourage IC. Measuring the IC of entrepreneurial businesses in South Africa can provide important insights on the dynamics of invention in any economic activity, nation or geographical area. According to Suarez-Villa (1990), IC is a concept that measures the level of invention and the potential for innovation. Therefore, measuring the level of invention also provides an important indicator of the capacity or potential for innovation and the introduction of new technologies. Insight gained may be used by policy-makers, industry analysts or academic researchers for understanding changes in technology and invention (Suarez-Villa, 2017), particularly when it comes to entrepreneurs. IC can also measure the level of invention for any economic activity or industry to determine actual or potential technological leadership. Often, declining levels of IC can serve as an early warning of future difficulties and decline (Suarez-Villa, 1990; Suarez-Villa, 2017).

1.11 OUTLINE OF THE STUDY

As illustrated in Figure 1.5, the following structure was followed as the outline of the study. The introduction and background of the study is discussed in chapter one, three literature review chapters (chapters 2, 3 and 4), methodology (chapter 5), research findings (part 1): descriptive statistics and factor analysis (chapter 6), research findings (part 2): structural equation modelling and neural networking (chapter 7), and conclusions and recommendations (chapter 8).

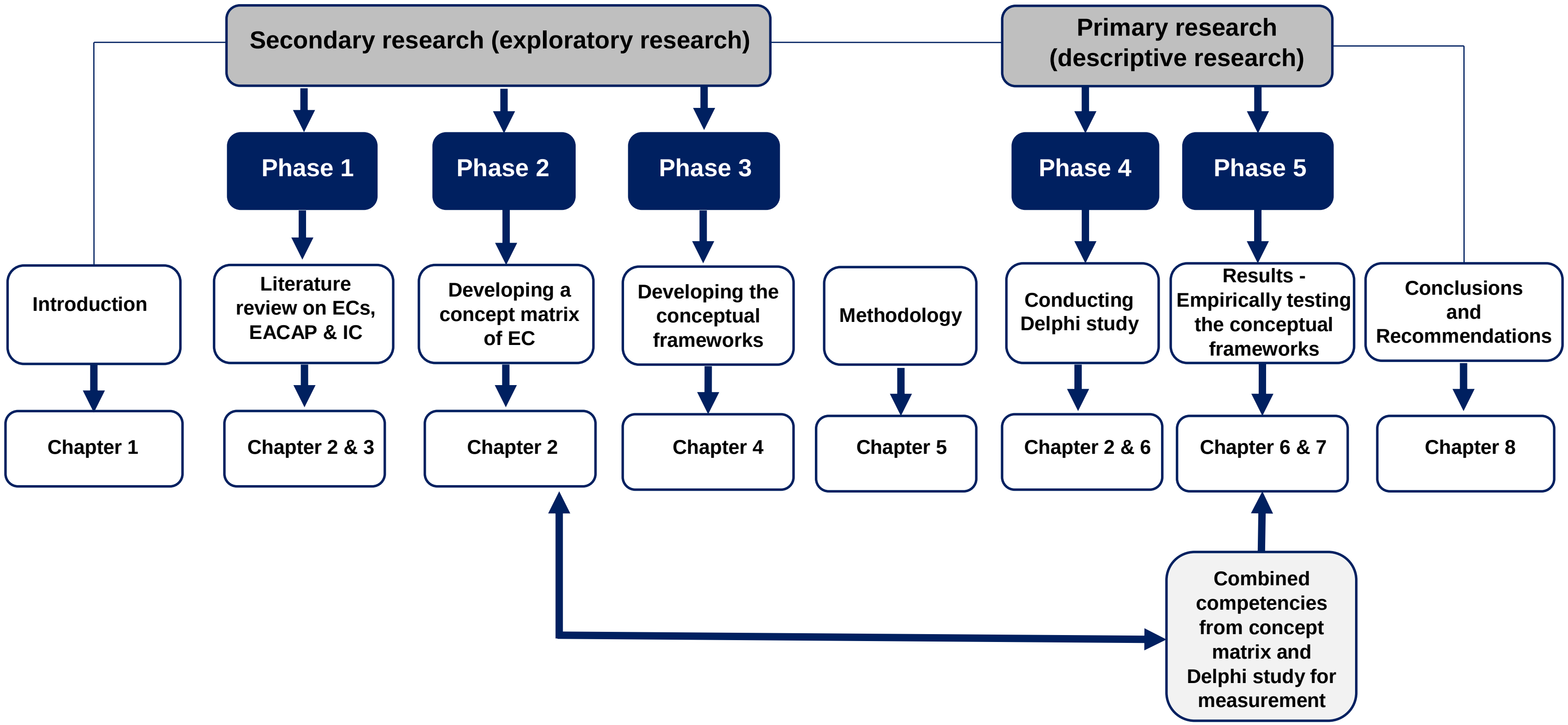


Figure 1.5 Chapter outline of this study (including methodological procedure)

The document consists of the following chapters:

Chapter 1: Introduction and background of the study

Chapter 1 focuses on the introduction and background to the study. It defines the research problem and clearly states the research objectives and hypotheses. The importance of the study is discussed and the key terms defined. Literature regarding ACAP, EC and IC was reviewed and discussed briefly. Finally, the chapter presents the delimitations and assumptions of the study and outlines the research design and methodology.

Chapter 2: Entrepreneurial competencies and categories for the fourth Industrial revolution

This chapter discusses the literature review on entrepreneurial competencies and their dimensions. It outlines the entrepreneurial competency framework and compares current entrepreneurial competence models and competence domains. The differences between competencies are compared by exploring their characteristics and overlapping features. A unified typology of knowledge, skills and competence is reviewed in terms of their content, antecedents and outcomes. In order to identify the competencies significant for innovation in entrepreneurial businesses or entrepreneurs, an overview of competencies found in competence literature is summarised and further investigated through a Delphi technique for further measurement.

Chapter 3: Absorptive capacity and innovation capacity

In Chapter 3 Absorptive Capacity theory is discussed as well as its process, dimensions and antecedents. The concept is further discussed by explaining the theory behind organisational capability and the difference between learning and knowledge. In order to explain the link between knowledge and entrepreneurship, the linking of Absorptive Capacity and Entrepreneurial Competencies, the Knowledge Spillover Theory is discussed. The innovation section in this chapter discusses Innovation Capacity from an organisational and individual level perspective. It further discusses Innovation Capacity as a construct, and existing literature on the internal and external determinants of innovation capacity. A brief overview is provided on technological change and the fourth industrial revolution and its relevance for the future of entrepreneurship. The section also discusses typology of knowledge on types of innovations, identification of innovations and measures of innovation capacity.

Chapter 4: Relationships and conceptual frameworks within this study

Based on the results found in Chapter 2 and 3, three conceptual frameworks of the interrelationships between the constructs EC, EACAP and IC were synthesised from the literature. The individual's capacity to innovate and how EACAP and ECs play a role in this relationship is of particular importance. The conceptual frameworks further illustrate how this study builds on the three main theories of this study, namely; absorptive capacity, person-entrepreneurial fit theory and knowledge spillover theory. This indicates the importance of incorporating a unified entrepreneurial competency typology perspective on innovation. Furthermore, ACAP and its process of recognition, assimilation, transformation and exploitation of knowledge is unfolded and is illustrated as a possible moderator and mediator between these relationships. ECs is also discussed as a possible moderator between this relationship.

Chapter 5: Research methodology

This chapter discusses the research design and methodology in detail. The research objectives and hypotheses are presented. The chapter explains the qualitative and quantitative research design and process followed, which included a Delphi study, followed by a concept matrix and empirical research based on a self-administered survey. The validity and reliability of the study, and the design of the questionnaire used to collect data are dealt with. In the final section, the data processing and analysis are explained by means of statistical techniques, such as SEM and Neural Networking that have been used.

Chapter 6: Research findings (part 1): descriptive statistics and factor analysis

In this chapter, all the research findings are presented based on the data analysis and the interpretation thereof. It includes the descriptive statistics of the study and the validity and reliability of the constructs. The chapter presents the research findings obtained by means of factor analysis and inferential statistics.

Chapter 7: Research findings (part 2): structural equation modelling and neural networking

The hypotheses are tested through SEM, based on the three conceptual frameworks presented. The refined SEM models are illustrated and a final Neural Network model is tested in order to determine whether the testing of non-linear relationships (NN) provides a better model fit to that provided by linear relationships (SEM).

Chapter 8: Conclusions and Recommendations

Chapter 8 highlights the conclusions and recommendations. It summarises the main findings of the study. The research objectives and hypotheses are revisited and the limitations of the study, its contribution and future research are described.

CHAPTER 2:
ENTREPRENEURIAL COMPETENCIES AND CATEGORIES FOR THE FOURTH INDUSTRIAL REVOLUTION

DIAGRAMMATIC SYNOPSIS

INTRODUCTION

↓

ENTREPRENEURIAL COMPETENCIES

↓

ENTREPRENEURIAL COMPETENCIES AND PERFORMANCE

↓

ENTREPRENEURIAL COMPETENCIES SIGNIFICANT FOR INNOVATION - RESULTS FROM LITERATURE

↓

PERSON-ENTREPRENEURIAL FIT THEORY

↓

THE PROCESS FOLLOWED TO IDENTIFY THE ECs FOR FURTHER TESTING: LITERATURE AND DELPHI STUDY

↓

CLUSTERING ENTREPRENEURIAL COMPETENCIES FOR THE 4TH INDUSTRIAL REVOLUTION INTO FOUR CATEGORIES

↓

CONCLUSION

2.1 INTRODUCTION

From the primary objective, the secondary objectives of the study were formulated, namely to determine the specific entrepreneurial competencies significant for innovation within the 4IR context in South Africa. This chapter presents a review of existing research on entrepreneurial competencies (ECs), with special reference to the competencies required for 4IR. The prominent rise of knowledge is attributable to the rapid information explosion that has occurred since the 1960s. This engendered the so-called Global Village, in which world economies have become more connected and interactions between states have become more open. Consequently, this led to the increase in economic competition which affects all nations around the world (Nakale, 2015:6). Forward-looking nations are therefore seeking ways to mitigate the effects of such forces, which have proved to be detrimental to many economies all over the world, including the industrial advanced economies (Nakale, 2015:6). According to the VINT (Vision, Inspiration, Navigation and Trends) research report, focusing on the 4IR, I4.0 is at the forefront of this development, which is generally regarded as the fourth stage of the Industrial Revolution (Bloem *et al.*, 2014:4). Based on the roadmap report of the European Union on the future of the industry, a new production paradigm is arising: an advent of cyber-physical internet-based systems that offer innovative capacities that can benefit industry and other economic sectors (Bloem *et al.*, 2014:5).

In this chapter, a thorough investigation will be done on the core set of ECs that impact on innovation. The chapter commences with the importance of ECs in the economy, and focuses in particular on the value of ECs that are required for the 4IR for innovation to take place. The entrepreneurial competency framework is investigated with a comparison between existing entrepreneurial competence models. The differences between competencies are compared by exploring their characteristics and overlapping features. A unified typology of knowledge, skills and competence is reviewed in terms of their antecedents, processes and outcomes. In order to identify the competencies significant for innovation, the chapter concludes by providing a framework of competencies found in the literature that could also be significant as competencies for the 4IR, categorised under four main domains of competence: cognitive, functional, social and meta competency categories/domains.

Furthermore, with the literature review in Chapter 2, the researcher aims to work towards the development of three conceptual frameworks illustrating the interrelationships between EC, EACAP and IC. Based on the categories and components identified in the literature review presented in this chapter, a conceptual literacy framework for the study is developed, focusing on ECs in Chapter 2 and ACAP and IC in Chapter 3. In Chapter 4, the researcher has a detailed discussion on the relationships and conceptual frameworks within this study.

2.2 ENTREPRENEURIAL COMPETENCIES

In this section, ECs are introduced as one of the three main constructs in this study. A conceptual underpinning is undertaken on the terms, knowledge, skills and competencies (section 2.2.1), followed by a framework of competency, competence and competencies.

2.2.1 Conceptual underpinning of knowledge, skills and competencies (KSC)

Many disciplines of research, such as Psychology, Organisational Management, Education, Human Resources or Information Systems, have studied the concept of competencies (Prifti *et al.*, 2017:48). In entrepreneurial literature, terms such as capabilities, resources, assets, competencies, and skills are often used interchangeably (Colombo & Grilli, 2005:795). Models of entrepreneurial competence are grounded in various approaches and notions.

Three approaches have mainly been followed in competencies research (Delamare Le Deist & Winterton, 2005). First, the *behavioural* approach argues that competencies are fundamentally behavioural, unlike intelligence or personality, and can be taught through learning and development. It focuses on attributes which go beyond the cognitive ability, like self-awareness, self-regulation and social skills (Boyatzis, 1982:26; McClelland, 1973:5). Secondly, the *functional* approach focuses on successfully completing a task by restricting the term of competencies to the skills and know-how required for conducting a task (Frank, 1991; Miller, 1991). Thirdly, the *multi-dimensional/holistic* approach describes competencies as a collection of individual competencies required from an individual and organisational competencies required to achieve the desired results (Straka, 2004:287). Although in a way a “fuzzy concept”, it is seen as a useful term, bridging the gap between education and job requirements (Van Klink & Boon, 2003:126).

2.2.2 A framework of competency, competence and competencies

2.2.2.1 Competency

The concept of entrepreneurial competency is grounded in competence, competency and entrepreneurship literature, in which earlier researchers attempted to understand entrepreneurs by seeking to identify their traits and characteristics. A *core competency* is seen as a collective competency that includes the learnable behaviours an entire organisation must practise in order to achieve competence in relation to the organisation’s purpose and its competitive environment (Matthews & Brueggemann, 2015:11). It is also defined as ‘the collective learning in the organisation, especially how to co-ordinate diverse production skills and integrate multiple streams of technologies’ (Hamel & Prahalad, 1994). In entrepreneurial research it is indicated that ECs are particularly related to the birth, survival or growth of a business (Baum *et al.*, 2001:293; Bird, 1995:51; Colombo & Grilli, 2005:813; Mitchelmore & Rowley, 2010:97). Danneels (2002:1102) defines competency as “an ability to accomplish something by using a set of material and immaterial resources”. In Le Deist and Winterton (2005:27), it is said that “competence” generally refers to functional areas and “competency” to behavioural areas. It dominated the management strategy literature of the 1990s, which emphasised “core competence” as a key organisational resource that could be exploited to gain competitive advantage. Bartram, Robertson and Callinan (2002) define competencies as: “sets of behaviours that are instrumental in the delivery of desired results or outcomes”. In this sense, a competency is the repertoire of capabilities, activities, processes and responses available that enable a range of work demands to be met more effectively by some people than by others, and not the behaviour or performance itself (Kurz & Bartram, 2002:227). Matthews and Brueggemann (2015:10) define a competency as the necessary criteria for competence, which is distinguished as individual and collective competencies.

Individual competencies are known as a combination of learnable behaviours that encompass attitudes (wanting to do), skills (how to do), knowledge, (what to do), practical experiences (proven learning), and natural talents of a person in order to effectively accomplish an explicit goal within a specific context (Matthews & Brueggemann, 2015:10). *Collective competencies* are known as the synergetic combination of the individual competencies of team members within organisations. High-functioning teams are those that apply collective competencies the most effectively. Essentially, you learn competencies (knowledge, skills and attitudes) in order to meet a certain level of competence (Matthews & Brueggemann, 2015:10).

Winterton *et al.* (2006:17), emphasise that intellectual capabilities are required to develop knowledge, and operationalising knowledge is part of developing skills. All are prerequisites for developing competence, along with other social and attitudinal factors. According to Weinert (2001b:29), a range of dimensions influences an individual’s degree of competency, which includes: ability, knowledge, understanding, skill, action, experience and motivation. Despite living in an era when we need more creativity to drive innovation, evidence shows that our creativity skills may be in decline. Creativity, innovation, imagination and entrepreneurship are vital to sustaining and improving an advanced standard of living. The innovation and entrepreneurship competency framework illustrated in Figure 2.1 is designed to facilitate the learning experience needed to improve creativity, innovation, and entrepreneurship capability (Matthews & Brueggemann, 2015:23). It incorporates the scholarship of experts into a 12-key competency structure that is designed to improve innovation and entrepreneurship capability and success rates. It further speaks towards the need for an innovation and entrepreneurship competency framework to help guide the innovation and entrepreneurship process from “unconscious incompetence to conscious incompetence to conscious competence and finally to unconscious competence (Matthews & Brueggemann, 2015).

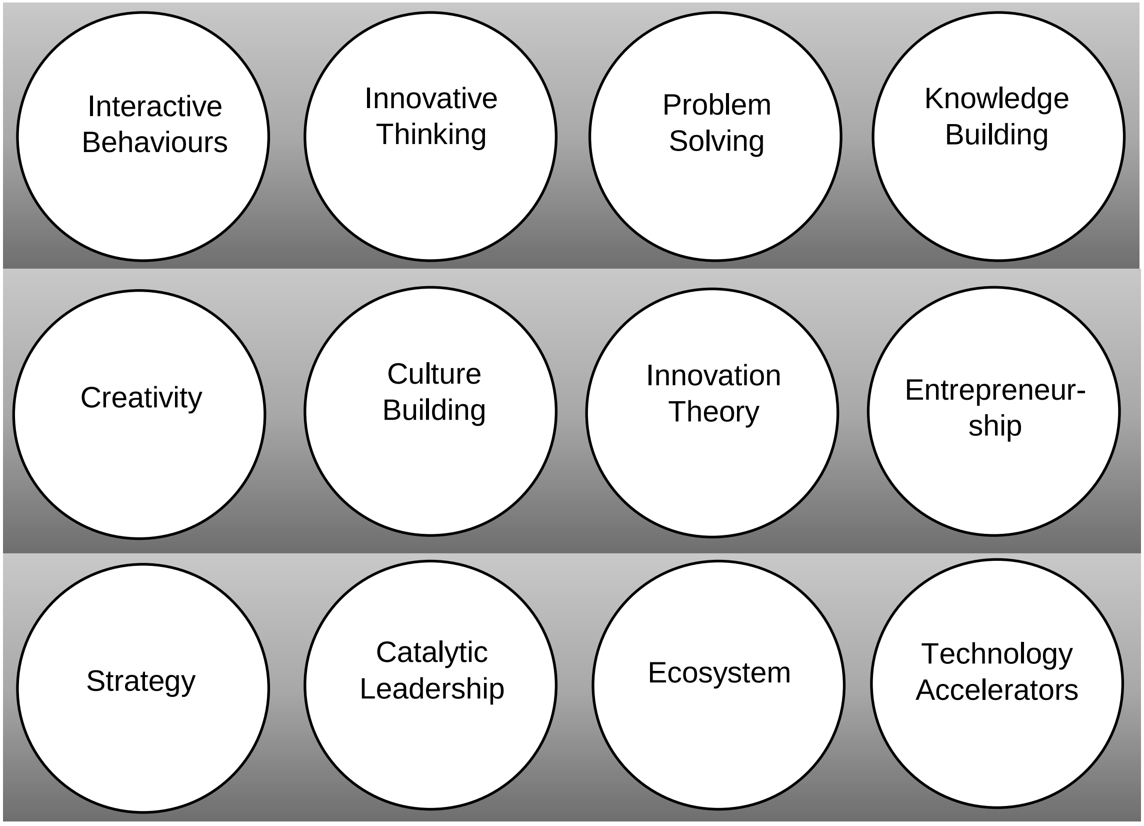


Figure 2.1: The innovation and entrepreneurship competency framework
Source: Matthews and Brueggemann (2015:4)

Matthews and Brueggemann (2015:4) further argue that the innovation and entrepreneurship framework is not linear, but rather that the competencies function as a holistic interactive set of dynamic back-and-forth flows. The flow chart illustrated in Figure 2.2 depicts the thinking processes of innovators and entrepreneurs. The central thrust of this dynamic interaction of competencies is the innovation pipeline, consisting of imagination, creation, innovation, and the ultimate outcome.

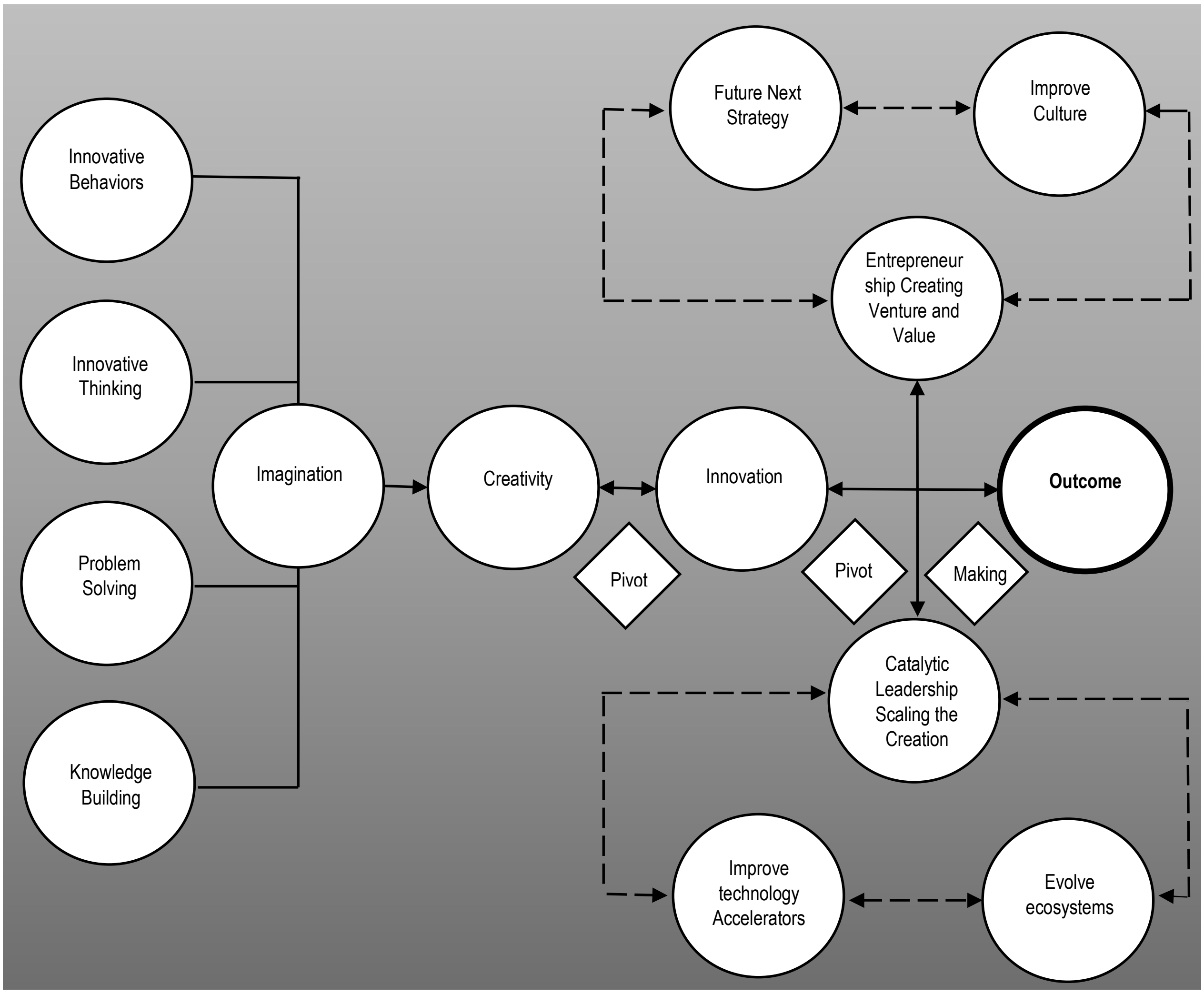


Figure 2.2: The interactive flow of the competency framework

Source: Matthews and Brueggemann (2015:5)

2.2.2.2 Competence

There is considerable diversity in how competence is defined, depending on who is being assessed, who is doing the assessing, and the context in which the competence is being applied (Morris *et al.*, 2013:354). *Competence* is known as the ability to accomplish a work task up to a recognised standard for a particular profession (Matthews & Brueggemann, 2015:11). Core competence is generally a concept that is only used on an organisational level and is made up of accumulated competence that an organisation can exploit in its present or future to give added value to the customer.

It is therefore a combination of competencies, technologies and information systems that make a business competitive (Miller & Morris, 2008).

According to Floyd and Lane (2000), organisational renewal involves the building and expansion of organisational competences over time. Therefore, a theory of strategic renewal must recognise that maintaining adaptiveness requires exploring both existing competencies and new ones (Floyd & Lane, 2000:155). As illustrated in Figure 2.3, the architecture of organisational competence is made up of core competence and other competences. Competence is defined in different ways and on different levels (Miller and Morris (2008:3). On a more general level, competence can be defined as an ability and willingness to perform well in a certain job. The complexity of tasks required by entrepreneurs dictates that they need to prepare themselves with relevant competencies that could be utilised in developing a successful venture (Ahmad, Halim & Zainal, 2010:73).

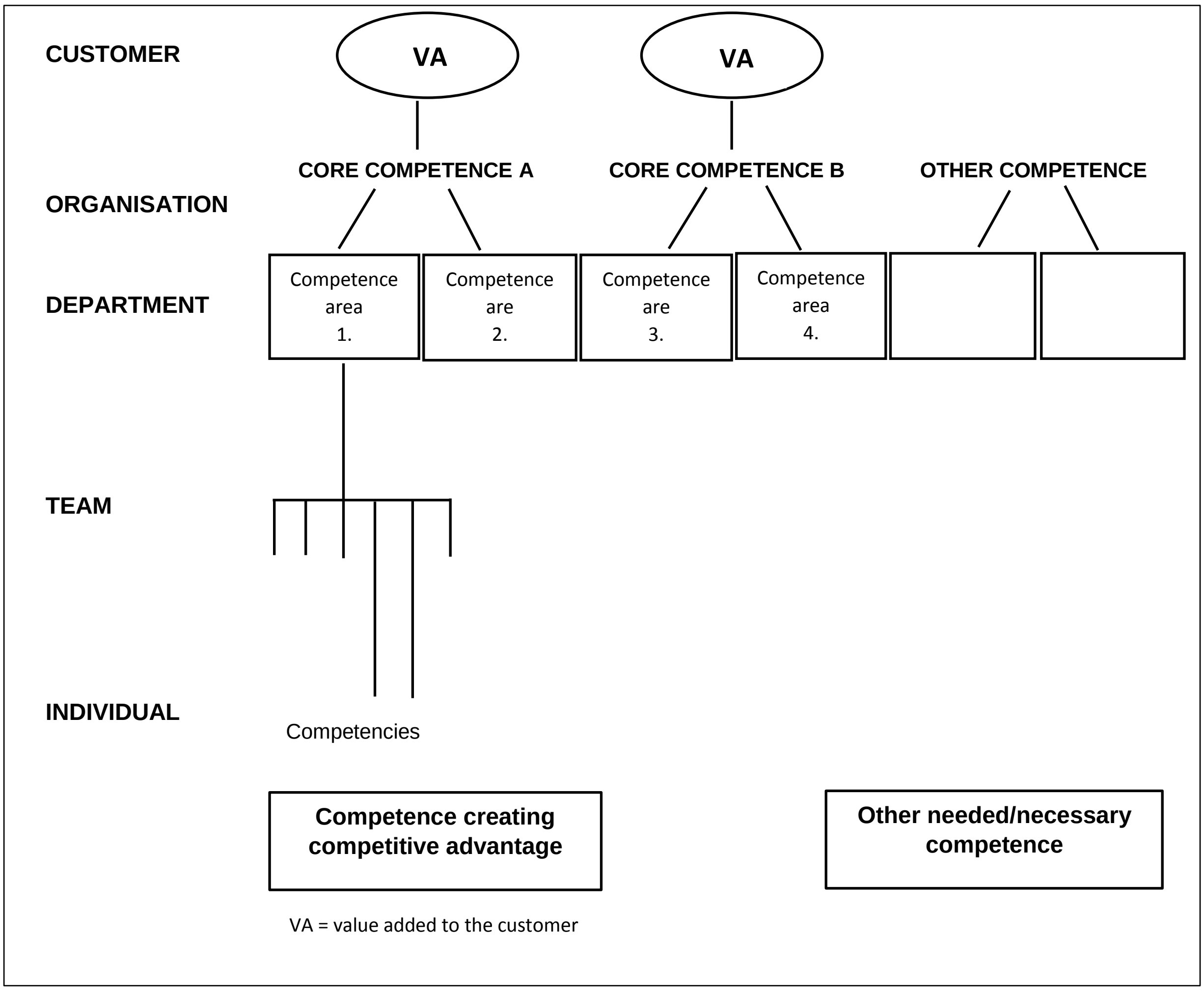


Figure 2.3: The competence architecture of an organisation

Source: Adapted from Miller and Morris (2008:3)

Research on competence is typically driven by aspirations to achieve superior performance and business success (Mitchelmore & Rowley, 2010:92). Markman and Baron (2003:281) suggest that the closer the match between entrepreneurs' personal characteristics and the requirements of being an entrepreneur (e.g., the creation of new companies by transforming discoveries into marketable items), the more successful they will be. The person-entrepreneurship fit theory suggests that to the extent to which entrepreneurs are high on a number of distinct individual-difference dimensions such as self-efficacy, ability to recognise opportunities, personal perseverance, superior social skills, and human and social capital, the closer will be the person-entrepreneurship fit. Consequently, the greater will be the likelihood or magnitude of their success (Markman & Baron, 2003:281).

2.2.2.2.1 Dimensions of competence

The four competence categories used for this study (cognitive, functional, social and meta) was based on the models discussed in the next section. These models are briefly investigated in order to determine how to categorise ECs.

In Figure 2.4 a unified typology of competence, knowledge and skills that are necessary for particular occupations, developed by Winterton *et al.* (2006:40) is distinguished by indicating four dimensions of competence which form an over-arching framework to developing a typology of knowledge, skills and competence. Skills are captured by functional competence, knowledge is captured by cognitive competence, attitudes and behaviours are captured by social competence, while meta-competence, which is rather different from the first three dimensions, is concerned with facilitating the acquisition of the other substantive competences (Winterton *et al.*, 2006:41).

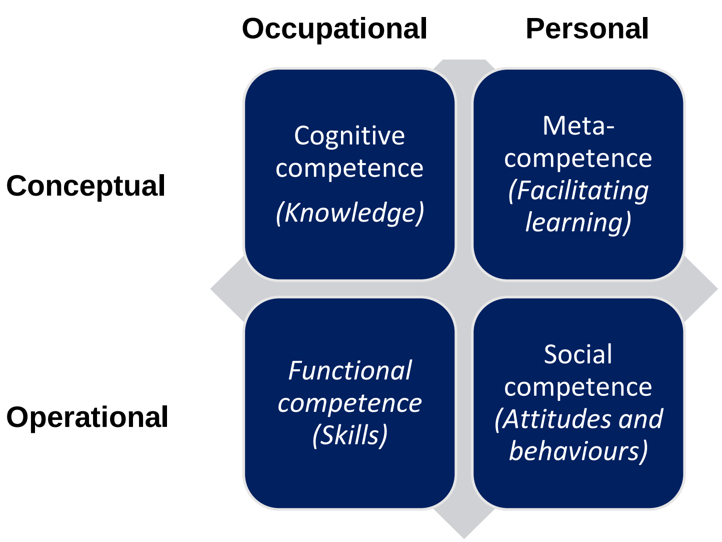


Figure 2.4: A unified typology of competencies

Source: Adapted from Winterton *et al.* (2006:40)

Cheetham and Chivers (1996:20) constructed a model of professional competence that is similar in the sense that it incorporates both functional and behavioural competence as well as meta-competence and ethics. Their model (Cheetham and Chivers (1996:27) attempts to bring together a number of apparently disparate views of competence, including the “outcomes” approach and “reflective practitioner” approach, growing the body of knowledge relating to vocational competence, which is recognised in professional education programmes. The provisional model of professional competence includes: meta-competencies, knowledge/cognitive competence, functional competence, personal or behavioural competence and values/ethical competence. The model also allows for the possibility that different professions will require a different mix of core components (Figure 2.5). Through SEM, Vargas-Halabí, Mora-Esquivel and Siles (2017:86) have taken some elements of this holistic model to build a model of intrapreneurial competencies, by using an employee innovative behaviour scale.

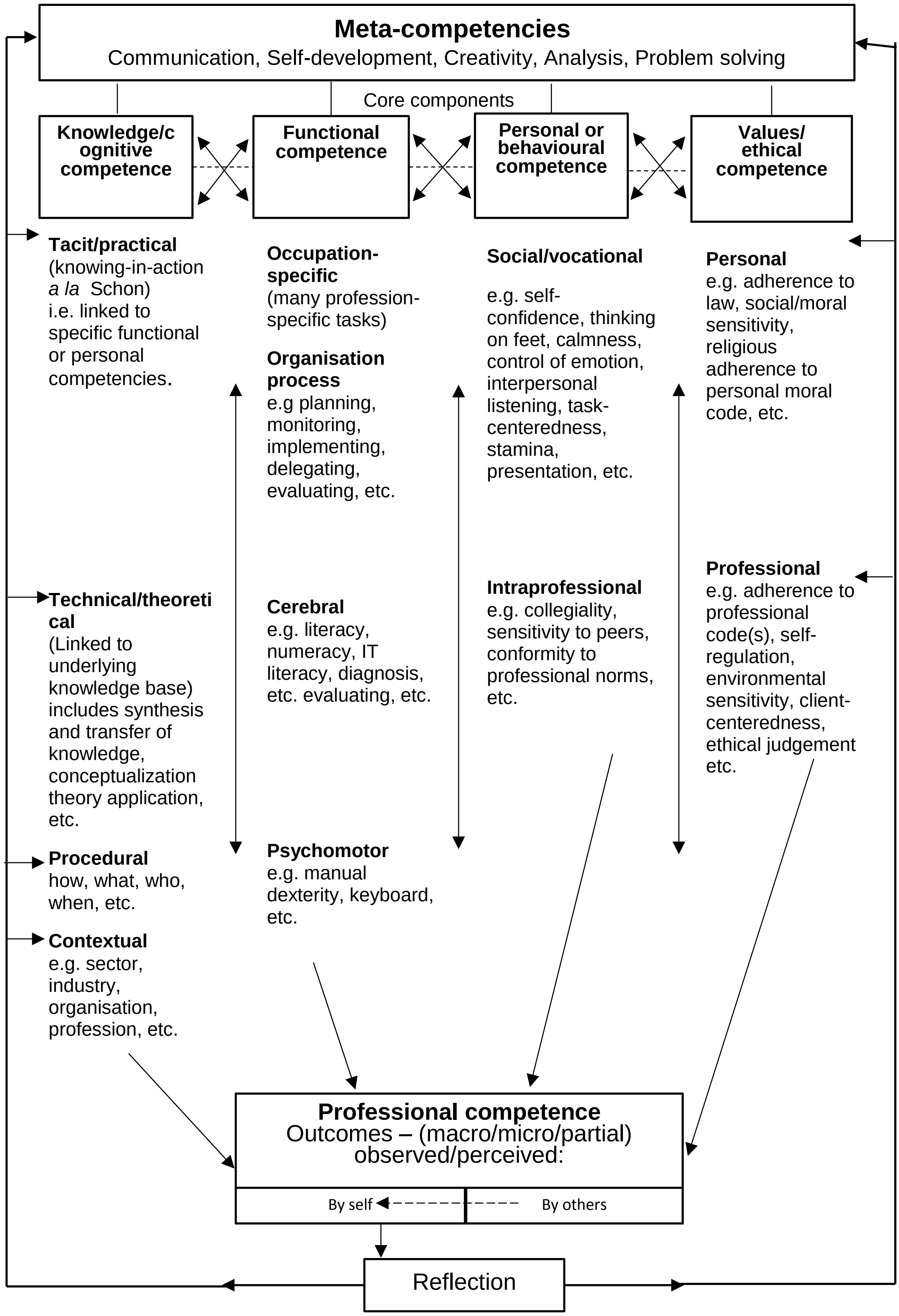


Figure 2.5: Provisional model of professional competence (compatible with "outcomes" and "reflective practitioner" approaches)

Source: Adapted from Cheetham and Chivers (1996:27)

Based on research conducted by Botha, Van Vuuren and Kunene (2015a:4), their integrated entrepreneurial performance model indicates that there are two sets of competencies. *Enterprising competencies* are abilities responsible for the enterprising functions that assist with business development and motivation, while *functional competencies* assist the entrepreneur to function in the business and find the balance between opportunity, resources and the entrepreneurial team that depends on management/general business and technical skills.

To understand the organisational founding requires cross-level and multi-level theory building, which aims to explicate how constructs at different levels of analysis relate to each other (Rousseau, 1985:1). Chandler and Jansen (1992:223) aimed to identify a set of relevant individual level constructs and provided empirical evidence that these constructs are linked to venture performance. The study is based on research that identifies the entrepreneurial, managerial, and technical-functional functions as three roles that founders must competently enact in order to be successful. The five competency dimensions include: human competence and conceptual competence (managerial competence); ability to recognise opportunity; drive to see venture through to fruition; technical-functional competence; and political competence. The results indicated that most successful founders with the highest levels of growth and earnings rate themselves as competent in the entrepreneurial, managerial, and technical-functional roles and see themselves as competent generalists (Chandler & Jansen, 1992:224).

Man *et al.* (2002a:133) have examined previous empirical studies into entrepreneurial competencies in an attempt to categorise all of the identified competencies into relevant activities or behaviour in an SME context. The developed theoretical framework makes use of the concept of firm competitiveness for SMEs and the competency approach to studying entrepreneurial characteristics. Consequently, they have identified six competency areas that are grouped together. These competency areas are grouped as: opportunity competencies, relationship competencies, conceptual competencies, organising competencies, strategic competencies and commitment competencies. The framework was founded upon a multi-dimensional conceptualisation of the competitiveness of SMEs, including the performance dimension, process dimension and potential dimension, developed from earlier studies of competitiveness. Man, Lau and Snape (2008:257) further attempted to investigate and empirically test the relationships between entrepreneurial characteristics and firm performance by operationalising a theoretical framework of the competitiveness of SMEs. This framework linked together ECs and SME performance with two further constructs: competitive scope and organisational capabilities. The results provided evidence for the direct and indirect contributions of the entrepreneur's opportunity, relationship, innovative, human and strategic competencies in affecting the long-term performance of an SME via competitive scope and organisational capabilities. The study also indicates that by making appropriate use of his or her competencies, an entrepreneur can perceive a widened competitive scope such as more opportunities for innovation, business growth, and the provision of new services or products. From available resources, better organisational capabilities can also be developed such as the firm's innovative capability, cost-saving capability, quality and flexibility.

According to Le Deist and Winterton (2005:27), one-dimensional frameworks of competence are inadequate and gave way to multi-dimensional frameworks (Figure 2.6). The relationship between the four dimensions of competence, adapted from Cheetham and Chivers (1996:24), forms an over-arching framework for developing a typology of competence according to Le Deist and Winterton (2005:40). They argue that a holistic typology is useful in understanding the combination of knowledge, skills and social competencies that are necessary for particular occupations. Meta-competence is presented as an over-arching input that facilitates the acquisition of output competencies at the base of the tetrahedron. This multi-dimensional holistic competence approach is becoming more widespread and has been used in research into the identification of social entrepreneurship competence (Orhei, 2011:87; Orhei *et al.*, 2015:97), and building competence-based frameworks for enhancing the employability of graduates (Moolman, 2017:32). It therefore offers the opportunity of better aligning educational and work-based provision, as well as exploiting the synergy between formal education and experiential learning to develop professional competence.

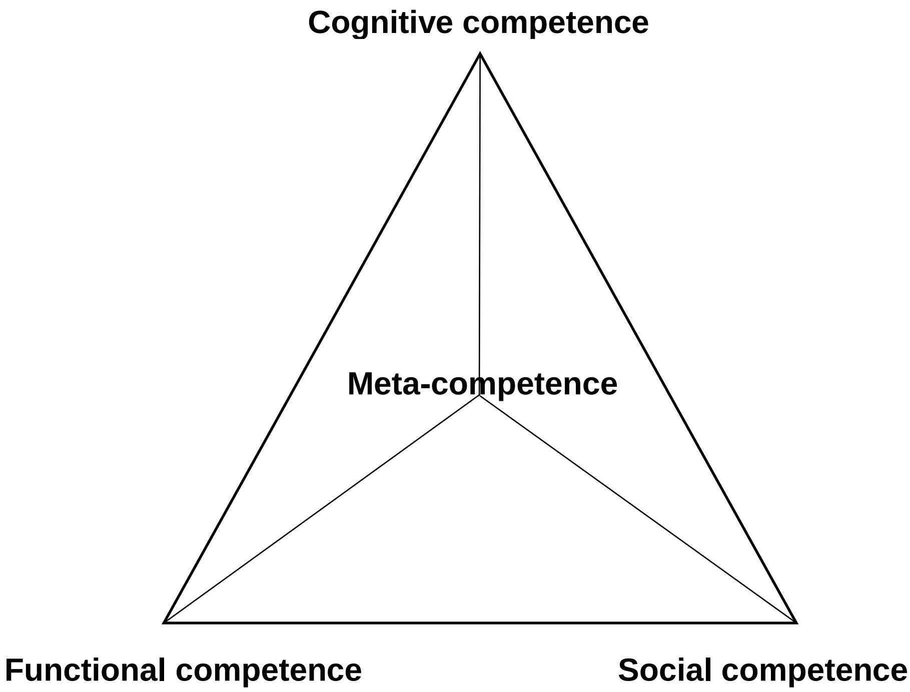


Figure 2.6: A holistic model of competence

Source: Adapted from Le Deist and Winterton (2005:40)

One of the key virtues of focusing on knowledge, skills and competencies is that these relate to learning outputs and outcomes, irrespective of the routes of acquisition involved (Winterton *et al.*, 2006:10). Winterton *et al.* (2006) investigated a unified typology of competence, knowledge and skills that are necessary for particular occupations for vocational education and training, also including the four dimensions of competence as discussed in Cheetham and Chivers (1996:22). The model has also been tested and validated in the field of Tourism in Spain in presenting a holistic competence model for tourism in higher education (López-Bonilla & López-Bonilla, 2014:312). Four broad routes are distinguished in terms of the mechanisms through which knowledge, skills and competences (KSC) are acquired and recognised (Figure 2.7).

		Recognition	
		Uncertified	*Certified*
Acquisition	*Formal*	adaptive	qualified
	Informal	tacit	accreditation

Figure 2.7: Routes of formation and recognition of KSC

Source: Winterton *et al.* (2006:5)

The four routes range from qualified KSCs gained through formal instruction and recognised by certification, to those informally gained and uncertified. Bjørnåvold and Tissot (2000:204) offer further refinement, where formal learning is where learning takes place within an organisation and in a structured context, non-formal learning is embedded in planned activities that are not explicitly designated as learning, and informal learning is where daily activities involving experiential or accidental learning. According to Edwards-Schachter, García-Granero, Sánchez-Barrioluengo, Quesada-Pineda and Amara (2015:10), the acquisition and development of competences occurs in a learning process, launching from the potential and 'masked' capacities, involving interrelated traits, knowledge, abilities and attitudes.

During an investigation on the critical ECs necessary for instructors to function in school-based enterprises, Dixon *et al.* (2005:32) used a "66 Entrepreneurial Competency Items by Cluster Category" questionnaire. Eight cluster categories were used, which included: Team Leadership, Perception of Trustworthiness, Planning and Organisational Skills; Business Skills, Problem Solving Skills, Communication Skills, Personal Traits and Creativity. The findings indicated that 39 of the 66 ECs listed in the survey instrument were critically important in order for instructors to function successfully in institution-based enterprises (Hussler & Ronde, 2009:1).

Hazlina Ahmad *et al.* (2010:67) focused on entrepreneurial competency and business success in SMEs, linking the roles of entrepreneurs as identified in the literature, namely entrepreneurial, managerial and functional roles, with the competencies required in handling successful ventures. A critical analysis that was conducted on earlier models of EC ultimately generated eight significant competencies that are recommended for further investigation, which include strategic, conceptual, opportunity, organising, relationship, technical and personal competencies. The complexity of tasks undertaken by entrepreneurs therefore dictates that they need to prepare themselves with relevant competencies that could be utilised in creating a successful organisation and that will enhance their business performance (Hazlina *et al.,* 2010:73).

Nassif, Ghobril and Silva (2010:67) have developed a dynamic approach that focuses on the personal attributes of an entrepreneurial venture (Figure 2.8). This approach is however applicable to all kinds of organisations which have the essential characteristics: innovation, potential for growth and clear strategic objectives. They developed a framework that shows the importance of affective and cognitive aspects of entrepreneurs and the way that they evolve during the development of their business.

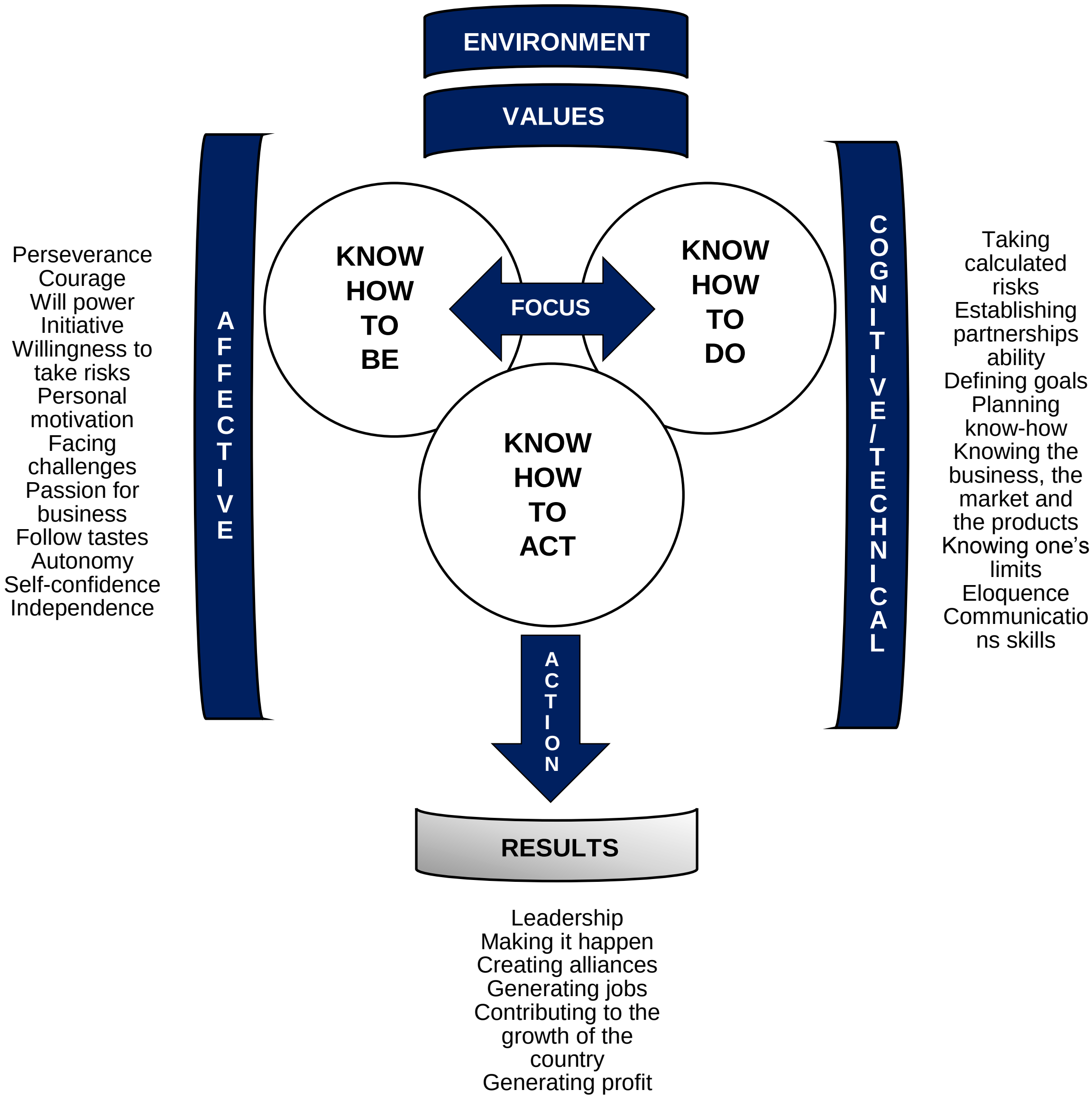


Figure 2.8: Interactive diagram of understanding the competencies of the entrepreneur

Source: Adapted from Chandler and Jansen (1992:228) in Nassif *et al.* (2010)

Boyles (2012) took a closer look at 21st century knowledge, skills and abilities alongside research and data on ECS, revealing a meaningful overlap between the two (Figure 2.9). A more in-depth analysis of ECs revealed a pattern that demonstrates significant and relevant connections between the knowledge, skills and abilities relevant for the 21st century. Four major categories of the 21st century knowledge, skills and abilities are also illustrated in the study; however, while specific ECs have been identified, they generally appear to fall into three major categories/dimensions, which include cognitive, social and action-oriented competencies (Boyles, 2012:44). *Cognitive* competencies emphasise that entrepreneurs have distinct ways of thinking, which increases their likelihood of identifying opportunities and developing new ventures to exploit those opportunities. Moreover, this “entrepreneurial mindset” is also learnable and able to be developed by deliberate practice (Baron & Henry, 2006; Mitchell, 2005:193). Entrepreneurial cognitions are referred to as “the knowledge structures that people use to make assessments, or decisions” (Mitchell, Busenitz, Lant, McDougall, Morse & Smith, 2002a:97). The communication and collaboration category of the 21st century KSAs is particularly concerned with the development of *social* skills. It emphasises the ability to interact cooperatively to solve problems and create innovations, to communicate and create meaning through mechanisms (Lemke, Coughlin, Thadani & Martin, 2003), and to read and manage emotions of self and others (Boyles, 2012:48). *Action-oriented* competencies are categorised under productivity and results, and are organised around concepts of drivers of productivity and the autonomy necessary to act. They reflect the need for independent motivation, action and decision-making required for both entrepreneurs and effective employees in today’s economy. Key skills sets include planning, monitoring progress and adapting (Boyles, 2012:48-49).

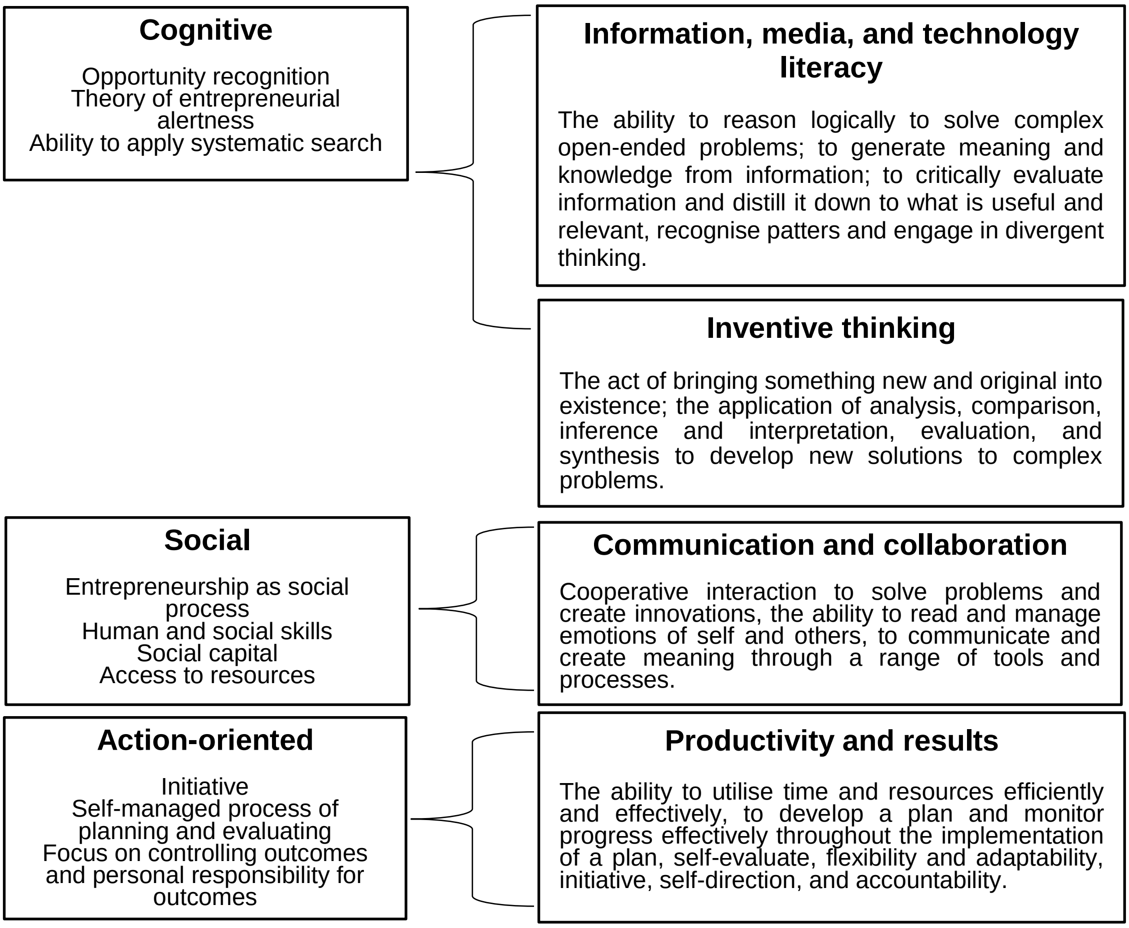


Figure 2.9: Entrepreneurial competencies and 21st century KSAs

Source: Boyles (2012:47)

According to Santandreu-Mascarell, Garzon and Knorr (2013), individual competencies that characterise the entrepreneur are also found in innovative organisations. Innovative organisations were found to value four characteristics in their employees which are related to entrepreneurs' characteristics, and they describe individuals within the organisation that are able to work in teams, are committed to their work, seek information and new opportunities, and are able to take risks in innovative ventures (Santandreu-Mascarell *et al.*, 2013:1084).

Matthews and Brueggemann (2015:3) have compiled an innovation and competency framework which incorporates the scholarship of experts into a 12-key competency structure that is designed to improve innovation and entrepreneurship capability and success rates. It therefore combines the relevant philosophies together into a comprehensive set of competencies that can be practised more readily. For any entrepreneurial business, it is important to achieve a level of competence (what needs to be done well) in order to survive and thrive. Building on the twelve elements of innovation by Matthews and Brueggemann (2015:3): innovation degrees, innovation types, innovation direction, innovation risk, innovation principles, innovation threshold, innovation criteria, innovation process, innovation diffusion, innovation pacing, innovation value and disruptive innovation, the Innovation and Entrepreneurship Competency Framework by Matthews and Brueggemann (2015:3) is an integrated modular approach to innovation and entrepreneurship. While innovation and entrepreneurship are inexorably intertwined, entrepreneurship encompasses essential competencies. Matthews and Brueggemann (2015:231) therefore identified ten ECs that enable the ideation, conceptualisation, formulation, and implementation process.

The competency model for I4.0 of Prifti *et al.* (2017:55) was based on the SHL Universal Competency Framework's competency model, which is widely used in practice and many companies use it for specific job positions. It is composed of three hierarchical levels: the "Great Eight", the competency dimensions and the competency components. They kept the structure and the relationship between the elements and adapted the third level competencies based on the results of their research and considered 68 competencies as relevant for I4.0.

2.2.2.3 Competencies

2.2.2.3.1 Antecedents, process and outcomes/outputs of competencies

Research on competencies of owner/managers started in the 1960s, focusing on identification of personal traits. Later studies have stressed the necessity of researching competence from a broader perspective and believe that entrepreneurial success requires not only a certain personality profile, but also appropriate managerial competence (Wasilczuk, 2000:88). However, it was found that there are characteristics that entrepreneurs have that organisations who want to be innovative are not seeking, which include goal setting, systematic planning and monitoring, demand for efficiency and quality and persistence. On the other hand, the study found that there is a competency that innovative organisations need but entrepreneurs may not have, which is previous experience in the field. According to Řehoř, Pech, Slabová and Rolínek (2020:127) when starting a business, entrepreneurs uses the acquired experience, skills and competencies. Recent studies have emphasised that ECs are essentially viewed as competencies that are most relevant to the exercise of successful entrepreneurship (Ahmad *et al.*, 2018:5; Mitchelmore & Rowley, 2010:93) and utilising technologies of I4.0 (Kruger & Steyn, 2020:1). As such, higher education will have to face an increased demand for putting an emphasis on professional development of students to achieve the best set of competencies (Łupicka & Grzybowska, 2018:44). Morris *et al.* (2013) employed a Delphi technique, where evidence is provided of a core set of 13 ECs, placing emphasis on the role of entrepreneurship education and the entrepreneurship discipline in competency development. Alipour and Taleghani (2016) investigated the relationship between entrepreneurial skills (personal skills, interpersonal skills and process skills) of managers and organisational effectiveness in small and medium enterprises. They used a standardised questionnaire which included entrepreneurial skills, developed by Cooper-Thomas and Anderson (2006) and consisting of 22 questions. Based on the results, it showed that there is a significant relationship between entrepreneurial skills of managers and organisational effectiveness (Alipour & Taleghani, 2016:8).

Competencies can be studied from their inputs (antecedents to competencies), process (task of behaviour leading to competencies), or outcomes (achieving standards of competence in functional areas) (Man *et al.*, 2002b:131). Bird (1995:450) sees competencies as observable and behavioural but only partly intrapsychic characteristics of an entrepreneur, which builds on the competency approach of Man *et al.* (2002a:131) as a means of studying EC. The entrepreneurs' demographic, psychological and behavioural characteristics, as well as their skills and technical know-how, are often cited as the most influential factors to performance (Chandler & Jansen, 1992:223). Competencies of entrepreneurs are also seen by Man and Lau (2005:469) as having dual origins: components that are rooted in the entrepreneurs' background (i.e. traits, personality, attitudes, self-image, and social roles) and components that could be acquired at work or through theoretical or practical learning (i.e. skills, knowledge, and experience). Mamabolo *et al.* (2017:2) defines entrepreneurial competencies as "the entrepreneurial capability to perform entrepreneurial activities above required standard as a result of the combination entrepreneurial personal attributes, knowledge, skills and personality characteristics". On the contrary, Fernando (2020:65) state that "what defines an entrepreneur is his/her behaviour and attitudes and not personality traits or any other innate characteristics". Besides personality traits, there are other constructs such as *Human Capital*, which Martin *et al.* (2013:211) discuss and evaluate its outcomes on entrepreneurial education. Human capital theory predicts that individuals or groups who possess greater levels of knowledge, skills and other competencies will achieve greater performance outcomes. Common measures of human capital include work experience, level of education, upbringing by entrepreneurial parents, and other life experiences (Martin *et al.*, 2013:211; Marvel, Davis & Sproul, 2016:608). Several recent narrative reviews of the entrepreneurship education literature such as those by Kuratko (2005:580); Pittaway and Cope (2007:479); and Weaver (2006:143) have noted that there may be important positive links between Entrepreneurial Education and Training and a variety of entrepreneurship-related human capital assets and entrepreneurship outcomes. However, the predicted shift in required skills and qualifications leads to the necessity for further training in modern technologies for the workforce of today and the future (Karre, Hammer, Kleindienst & Ramsauer, 2017:209).

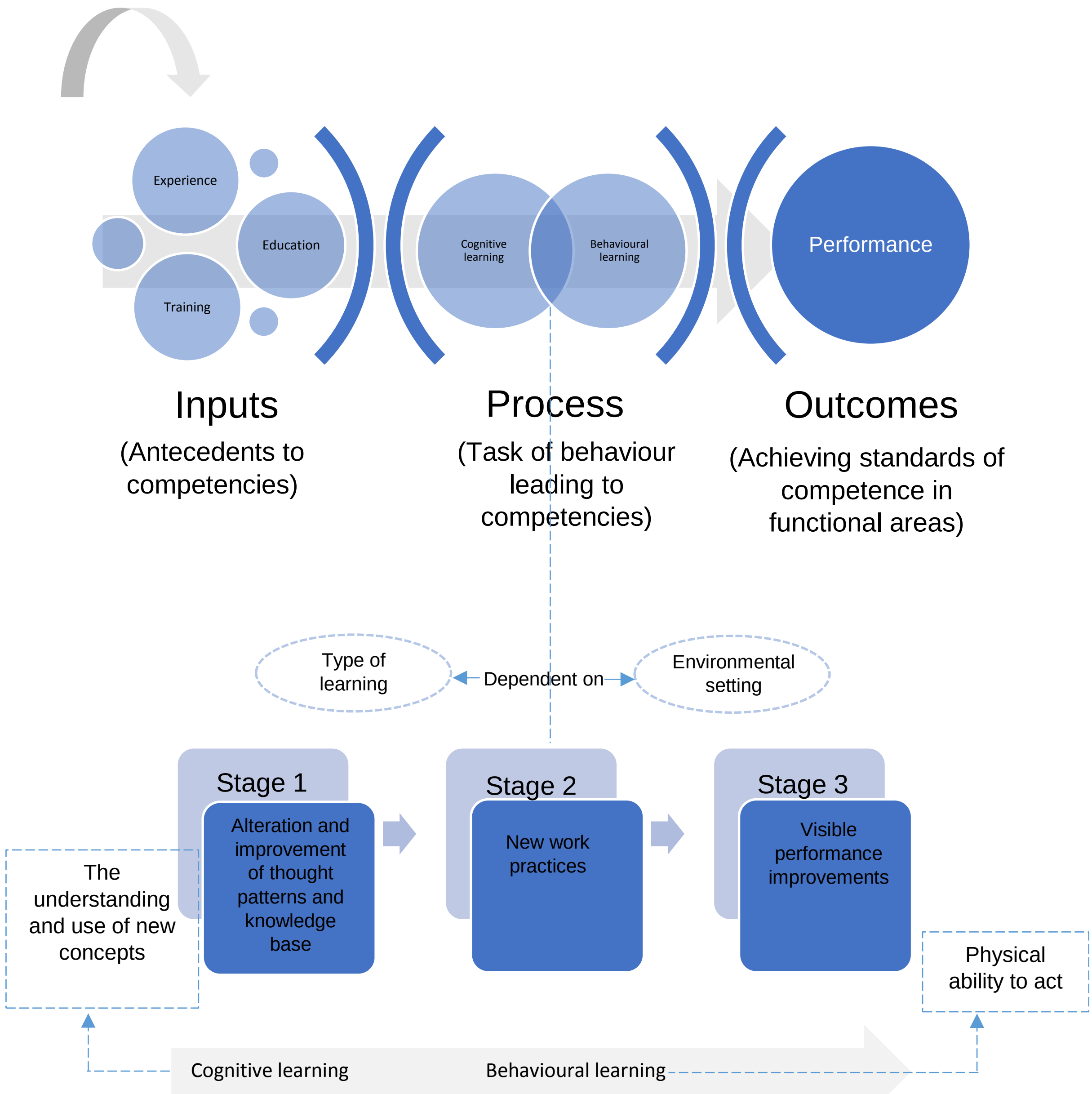


Figure 2.10: Illustration of inputs, process and outcomes of competencies
Source: Own compilation

- *Experience (antecedent/input)*

An entrepreneur's experience, education, and training can be seen as the antecedents of ECs (Man *et al.*, 2002a:135). Expertise and ECs can play a crucial role in achieving a bright professional perspective for young people (Řehoř *et al.*, 2020:127). In his study Baum (1995) identified competencies that had a strong impact on the growth of a venture; and experience in the business had an influence, although a weaker one. Two critical success factors highlighted by Chawla, Pullig and Alexander (1997:54) are "experience" and "goal orientation" of small business owners. Findings by Stoner (1987:38) are that the key distinctive competence of small firms is the experience, knowledge, and skills of the owner and workers. ECs can also be considered as higher-level characteristics, representing the ability of the entrepreneur to perform a job role successfully (Lau, Chan & Man, 1999) and they encompass skills, knowledge and personality traits, which are in turn influenced by the entrepreneurs' experience, training, education, family background and other variables (Bird, 1995:51; Fernando, 2020:65; Herron & Robinson, 1993:283; Řehoř *et al.*, 2020:127; Tittel & Terzidis, 2020:1).

In managerial research, the experience of an individual is seen to have an important influence on that person's performance. Professional development programmes, apprenticeships, conventional career paths stemming from entry-level positions, and prescribed educational requirements are common features in many organisations, and are designed specifically to standardise performance by standardising individuals' experience with work-related activities. However, there is little evidence that programmes such as these exist for business owners. This has led to the suggestion that differences in the experience of owners might explain variance in the performance of their businesses (Dyke, Fischer & Reuber, 1992:72). Studies which seek to find a direct relationship between experience and performance have found mixed results. This may be due to the fact that various kinds of experience are relevant to entrepreneurship, and that the relevance of a specific kind of experience may vary in different contexts, such as in different industries (Reuber, Dyke & Fischer, 1990). The study of Wasilczuk (2000:93) found that competency components such as managerial experience and functional skills were not found to influence growth perspectives, but rather the country's stage of economic development and aspects of its culture. Chawla *et al.* (1997:47) found that owner's experience and industry trends are more critical to success of a manufacturing/construction business in the early stages of the life cycle. Empirical evidence suggest that previous work experience have a positive effect on informal Malaysian micro-enterprise's performance, but shows a low predictive relevance on performance (Al Mamun, Nawi & Zainol, 2016b:279). Kor (2003:707) developed and tested a multilevel experience-based top management team competence and its effects on the firm's capacity of entrepreneurial growth. The results showed that founders' participation in the top management team and managers' past experience in the industry contributed to the competence of the team in seizing growth opportunities. The results further indicated that because of the conflict effects, the positive effect of founders' participation in the management team on the rate of growth weakened as either the industry-specific managerial experience or the shared team-specific experience in the team increased (Kor, 2003:707). Similarly, competence ratings of aspiring entrepreneurs are found to be significantly lower than those of nascent and experienced entrepreneurs (Kyndt & Baert, 2015:2).

- *Education and training (antecedent/input)*

With the emergence of entrepreneurship education, it is becoming clear that entrepreneurship, or certain facets of it, can be taught (Kuratko, 2005:580; Lilleväli & Täks, 2017:1). Since entrepreneurship has become an important academic teaching field, the goal of entrepreneurship education is to prepare students for entrepreneurial practice and to develop profound ECs (Tittel & Terzidis, 2020:1). Competence may relate to personal models, outcome models or education and training models, as well as to the standards approach in which benchmarking criteria are used (Mangham, 1986). Drucker (1985), one of the leading management thinkers of our time, recognised entrepreneurship as a discipline and said that "it can be learned". Research conducted by Morris *et al.* (2013:352) indicates findings that clearly demonstrate significant improvement in competencies after an entrepreneurship education intervention. Results were drawn based on pre- and post-measures on 13 ECs. Further findings by Morris *et al.* (2013:352) and Bukach, Abdrakhmanova and Litvinova (2020:159) indicate that education can play an important role in the development process by providing the key building blocks or scripts (i.e., norms, values, and rules guiding desirable behaviour) and constructing experiences through which students can employ these scripts, gain feedback, confirm or disprove their assumptions and understandings, and mould their attitudes and behaviours into competencies.

At an empirical level, evidence on the relationship between entrepreneurial ability and education is somewhat mixed. Some findings showed no relationship between education and entrepreneurial performance (Storey, Keasey, Watson & Wynarczyk, 2016; Watanabe, 1970), while others found that entrepreneurs educated to degree level establish firms which are larger (Fothergill & Gudgin, 1982) and better performing (Ahmad *et al.*, 2018:5; Woodruff & Alexander, 1958:5). It therefore seems quite clear that a higher degree is a prerequisite for successful entrepreneurship in high technology (Cooper, 1971:2; Roberts, 1968:78). Results from undergraduate and postgraduate programmes have also shown great success in the development of skills and competencies (Bell, Callaghan, Demick & Scharf, 2004:109; Scharf & Bell, 2002:327) that enhances the employability of graduates (Moolman, 2017:27). Although educational programmes can produce entrepreneurial intentions, there is a need to better understand whether entrepreneurship education in its current form increases perceived behavioural control within this context (Fayolle, Gailly & Lassas-Clerc, 2006:701). Therefore, a shift is required from studying intentions and business formation to actually studying successful business development and growth as desired outcomes of education and creating successful entrepreneurs (Morris *et al.*, 2013:363; Řehoř *et al.*, 2020:127). Business education can no longer be centred only on knowledge transmission, but needs to switch towards a competence-based approach which includes knowledge, skills and attitudes (Bratianu, Hadad & Bejinaru, 2020:1).

Cheetham and Chivers (1996:20) describe a model of professional competence which attempted to bring together an outcome-based approach. It is a key feature of the UK National Vocational Qualifications, and the “reflective practitioner” approach, which is now well recognised within professional education programmes. The pace of technological innovation in products and processes, along with demographic change, has increased the importance of adaptive training and work-based learning in human resource development. This has led to the replacement of supply-driven traditional education systems with demand-driven models that favour output-related (competence-based) systems of vocational education and training. According to Le Deist and Winterton (2005:27), the multi-dimensional holistic competence approach is becoming more widespread and offers the opportunity to better align educational and work-based provision, as well as exploiting the synergy between formal education and experiential learning to develop professional competence (Drisko, 2015:111; López-Bonilla & López-Bonilla, 2014:312). Especially in Europe, lifelong learning policy emphasising informal and non-formal learning has led to initiatives like the Personal Skills Card and the European Skills Accreditation System, to identify and validate competences so acquired, whereas education and training systems have begun to validate tacit skills (Bjørnåvold, 1999:39). The German education system adopted an "action competence" approach in 1996, moving from subject (inputs) to competence (outcomes) and curricula specifying learning fields rather than occupation-related knowledge and skills content. A standard typology of competences now appears at the beginning of every new vocational training curriculum (Straka, 2004:267).

- *Process (task of behaviour leading to competencies)*

Considering the type of learning and the environmental setting, it is important to consider the actual learning process; different processes may be associated with development of different aspects of knowledge skills and competences (Adams, 2015:152; Winterton *et al.*, 2006:6). Garvin (1993:12) distinguishes between behavioural learning, related to the physical ability to act, and cognitive learning, related to the understanding and use of new concepts, and identifies three stages in the learning process (Healy, 2019:69). During the first stage, cognitive learning leads to the alteration and improvement of thought patterns and knowledge base, which are then translated into new work practices in the subsequent behavioural learning stage. During the last stage, the actions which follow cognitive and behavioural learning lead to visible performance improvements for an organisation (Garvin, 1993:12; Healy, 2019:69,75). Analysis of cognitive and behavioural learning, according to Kim (1997:41), incorporates the learning function of active memory, pivotal to the transfer from individual to organisational learning, which rather refers to "conceptual" and "operational learning" (instead of cognitive and behavioural learning).

According to information-processing approaches, intelligence is analogous to a machine with general system features such as working memory capacity, processing speed and processing capacity, which enables the individual to acquire specific knowledge and skills (Winterton *et al.*, 2006:8). Piaget (1947) assumed general cognitive competence and attributed a major role to processes of adaptation by which an individual passes through a sequence of developmental stages, leading to increasingly flexible and abstract knowledge and action competencies. Therefore, specialised cognitive competencies are identified as prerequisites for superior performance in a particular activity, whether defined narrowly (e.g. solving second-order differential equations) or broadly (e.g. analytical competence). Knowledge is often viewed as the result of an interaction between intelligence (capacity to learn) and situation (opportunity to learn), so it is more socially constructed than intelligence. Knowledge includes tacit knowledge gained as a result of experience of performing certain tasks, as well as underpinning theory and concepts (Winterton *et al.*, 2006:9). With this aim in mind, tacit knowledge is found to have a positive effect on innovation (Pérez-Luño, Alegre & Valle-Cabrera, 2019:186).

- *Performance (output)*

In entrepreneurship and small business research, various factors have been found to influence firm performance to a different extent. A firm's performance is often considered the ultimate criterion in empirical studies (Abdullahi, Abubakar, Aliyu & Umar, 2015; Barkham, 1994; Box, White & Barr, 1994; Dodoo, Appiah & Donkor, 2020; Dyke *et al.*, 1992; Ibrahim, 1993; Kurz & Bartram, 2002; Lerner, Brush & Hisrich, 1997). Competencies in particular proves to have an influence on firm performance (Hashim, Raza & Minai, 2018:1; Mohsin *et al.*, 2017:88; Ravichandran, 2018:22). Performance at work is often implied as a continuous process, an extended sequence of behaviours that have coherence for the actor and those acted upon. Performance can be thought of as choreographed sequences of behaviours that have a function and purpose, while behaviours can be described in isolation. While behaviours can only be described, performance can be judged against performance criteria. Performances can generally be judged or regarded in terms of observable activities or the outcomes they are directed towards achieving. The actor or others perceive performances as more or less effective as a function of how successful they are in achieving their intended outcomes (Kurz & Bartram, 2002:228).

Man *et al.* (2002a:125) indicate in their conceptual model that the focus is the central role of the entrepreneur in determining firm performance. It further implies that developing ECs is a more important factor than directly providing more resources and a positive environment to the entrepreneur. Further research on venture performance indicates that models of individual performance show that performance is a function of ability, motivation and opportunity (Blumberg & Pringle, 1982:560; Peters, O'Connor & Rudolf, 1980:79; Rosman, Shukry, Baharuddin, Razlan, Rosli & Razali, 2020:15; Waldman & Spangler, 1989:29). Such models have been verified in various organisational settings where the individual’s abilities and motivation are moderated by opportunity of predicting individual performance (Chandler & Hanks, 1994:78). Results indicated that the abundance of resource-based competencies, the quality of the opportunity, and entrepreneurial competence are directly correlated to venture growth. Although Chandler and Hanks (1994:78) believe that their simple model, illustrated in Figure 2.11, is appropriate for studying entrepreneurs, the application of the model to founders and venture start-ups provides additional complexities. Special consideration should also be given to the entrepreneurial business’s age, as it is found that an entrepreneur can become more competent (Brockhaus & Horwitz, 1986; Cooper, Dunkelberg & Woo, 1988:225; Rossi, 2016:220) or less entrepreneurial when he or she gets older (Begley & Boyd, 1985:147; Cragg & King, 1988:49; Liang, Wang & Lazear, 2018:1).

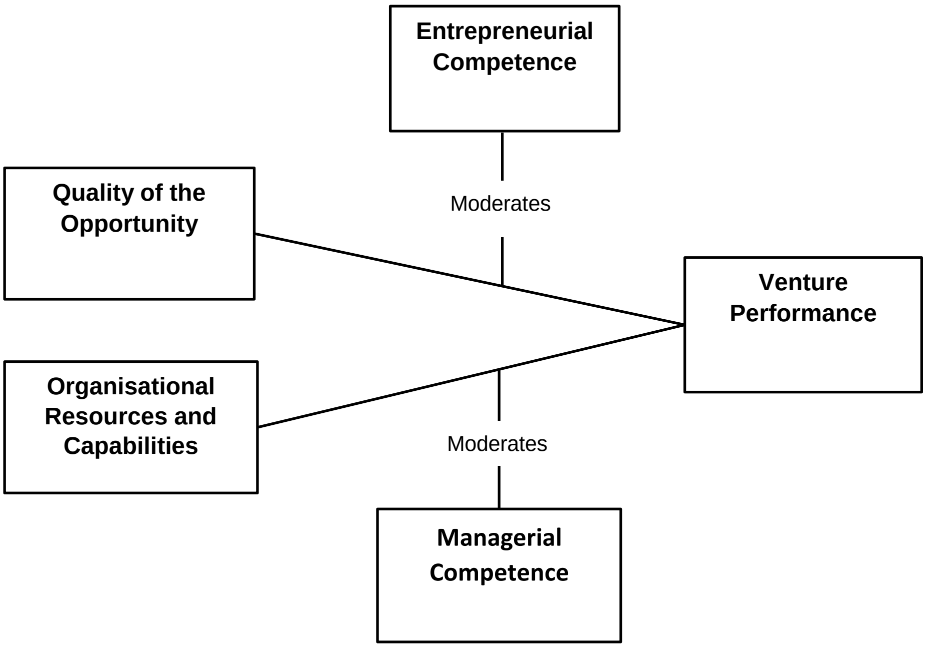


Figure 2.11: A model of the moderating effect of founder competence

Source: Adapted from Chandler and Hanks (1994:80)

Based on the evidence presented, it is obvious that performance is considered as the ultimate criterion in empirical studies in entrepreneurship. The next section particularly investigates the importance of ECs on performance.

2.3 ENTREPRENEURIAL COMPETENCIES AND PERFORMANCE

A competency model consists of desired competencies for a certain task; some models also include a description of single competencies that describes successful performance (Markus, Thomas & Allpress, 2005; Mirabile, 1997; Schley, 2003; Tikrity, 2021:6). It also serves as a means to measure performance and outcome (Prifti *et al.*, 2017:48) that describes the competencies required to perform effectively in a particular role (Tikrity, 2021:6). Spreitzer *et al.* (1997) highlight the importance of being able to identify traits that are connected to the business strategy of an organisation; including them in a competency model can be quite valuable. However, some competency models are found to be static and thus susceptible to changing job requirements (Hollenbeck & McCall, 1999). This closely relates to the critique that competencies are typically specified as "end state" characteristics, meaning that no further development can take place (Hollenbeck & McCall, 1999). On the other hand, the competencies that truly predict future performance might be those that represent abilities to learn and deal with situations that have not yet been experienced (McCall, 1998). For instance, Löwik (2013:104) found that individual absorptive capacity (IACAP) positively affects employees' innovation performance of idea generation and implementation. Although advocates argue that competency models are the most cost effective way for selecting higher-level professional and managerial jobs (Lyle & Spencer, 1993), critics argue that they do not guarantee superior performance (Hollenbeck & McCall, 1999:172).

Previous researchers have addressed future performance impacts – performance differences that are predicted by differences in competencies (Abaho, 2016:105; Levenson, 2005:5; Mohsin *et al.*, 2017:88). Bennour and Crestani (2007:151) presented a panorama of studies correlating competence with process performance. It has also been found that certain competencies can predict performance; for example Spreitzer *et al.* (1997:6) found that certain competencies predicted subsequent performance ratings by supervisors and career advancement (Bray *et al.*, 1974; Dulewicz & Herbert, 1996). Russell (2001:2) was able to show a link between competencies used for selection of general managers and the subsequent performance of their units. Empirical findings further indicate that an increase in the level of a firm's capabilities through competent managers, leads to enhanced SME performance (Abaho, 2016:105). Mohsin *et al.* (2017:97) validated a model providing support that some ECs influence innovativeness. Racela (2014:22) proposed a conceptual model that offers managerial implications by explaining the distinct nature of creativity and innovation in an organisation that can lead to superior business performance. In previous years, authors such as Boyatzis (1982); Miller (1991) and Bassellier, Reich and Benbasat (2001) offered competency models for leadership and management. Research in this field has however evolved, for example, by proposing an holistic-domain model that integrates career and mentoring skills (Asumeng, 2014:1) and suggesting a more integrative framework for global leadership competency (Kim & McLean, 2015:1). Empirical research done by Hussler and Ronde (2009:1) shows that networking ability, as an innovative competency and entrepreneurial competency (Abaho, 2016:118), is one of the core competencies that a firm should develop in order to improve its innovative performance. The question arises whether suitable entrepreneurs or employees for innovative/entrepreneurial organisations are inaccurately screened and selected, particularly if competencies that predict high levels of innovation performance are not known or identified. Therefore, if competencies are not sufficiently forward-looking, since competency requirements change over time (Bratianu *et al.*, 2020:1; Hollenbeck & McCall, 1999:172; Moolman, 2017:26), then they will not be tied closely enough to strategy, and thus will be imperfect predictors of future performance (Kyndt & Baert, 2015:17; Levenson, 2005:7).

Even if competencies are better than other selection methods, it still does not tell us how people with a given set of competencies translate that foundation into superior performance (Levenson, 2005:3). In particular, entrepreneurs may develop ECs with experience. Competency models screening for pre-existing skills may exclude candidates who will develop the skills over time while in the job, who may end up being the highest performers (McCall, 1998). Also, the problem with distinguishing superior performance is not necessarily in the entrepreneur's having the trait, but rather knowing when to apply it (Levenson, 2005:3). Competency models may also represent a broad spectrum of competencies that is so large as to encompass the vast majority of traits needed for successful performance across all situations, whereas what really matters for distinguishing performance in a given situation is only a subset of the competencies (Levenson, 2005:4).

Prifti *et al.* (2017:56) developed an I4.0 competency model based on a behavioural orientation and this model is illustrated in Figure 2.12. Focusing on the individual as a key factor in I4.0, a broad spectrum of competencies were analysed from a functional and behavioural level (Prifti *et al.*, 2017:48). Different competency approaches are used from research and practice and it offers a behavioural approach for competency modelling by focusing on the individual and considering competencies of a behavioural nature, meaning an individual can learn and adapt. The model was initially developed from the SHL Universal Competency Framework by CEB Inc. (Bartram, 2011), which is widely used in practice; many companies use it to describe their competency models for specific job positions (Klendauer, Berkovich, Gelvin, Leimeister & Krcmar, 2012:486). The competency model addresses I4.0 competencies for graduates and focuses on the adjusted competency profiles for engineers, IT professionals and Information System (IS) professionals (Prifti *et al.*, 2017:47).

Big Eight	Competency Dimensions	Competencies: *Information Systems (IS)/Economics*	Competencies: *Computer Science/IT*	Competencies: *Engineering*
Leading & Deciding	Deciding & Initiating Action	• Decision Making • Taking Responsibility		
	Leading & Supervising	• Leadership Skills		
Supporting & Cooperating	Working with People	• Teamwork • Collaborating with Others • Communicating with People		
	Adhering to Principles and Values	• Respecting Ethics • Environmental Awareness • Awareness of Ergonomics		
Interacting & Presenting	Relating and Networking	• Compromising • Creating Business Networks • Maintaining Customer Relationships		
	Persuading and Influencing	• Negotiating • Emotional Intelligence		
	Presenting and Communicating Information	• Presentation and Communication Ability		
Analysing & Interpreting	Writing and Reporting	• Targeted/Technical Communication • Literacy		
		• IT and Technology Affinity • Economics • Extract Business Value from Social Media		
	Applying Expertise and Technology	• Service Orientation/Product Service Offerings • Business Process Management • Business Change Management • Understand and Coordinate Workflows	• Network Security • IT Architectures • Machine Learning	
	Analysing	• Problem Solving • Optimization Analytical Skills Cognitive Ability		
Creating & Conceptualizing	Learning & Researching	• Life-Long Learning Knowledge Management		
	Creating & Innovating	• Innovating • Creativity Critical Thinking Change Management		
	Formulating Strategies and Concepts	• Business Strategy • Managing Complexity Abstract Ability		
Organizing & Executing	Planning & Organizing	• Project Management • Planning and Organizing Work • Management Ability		
	Delivering Results and Meeting Customer Expectations	• Customer Orientation • Customer Relationship Management		
	Following Instructions and Procedures	• Legislation • Individual Responsibility Safety Awareness		

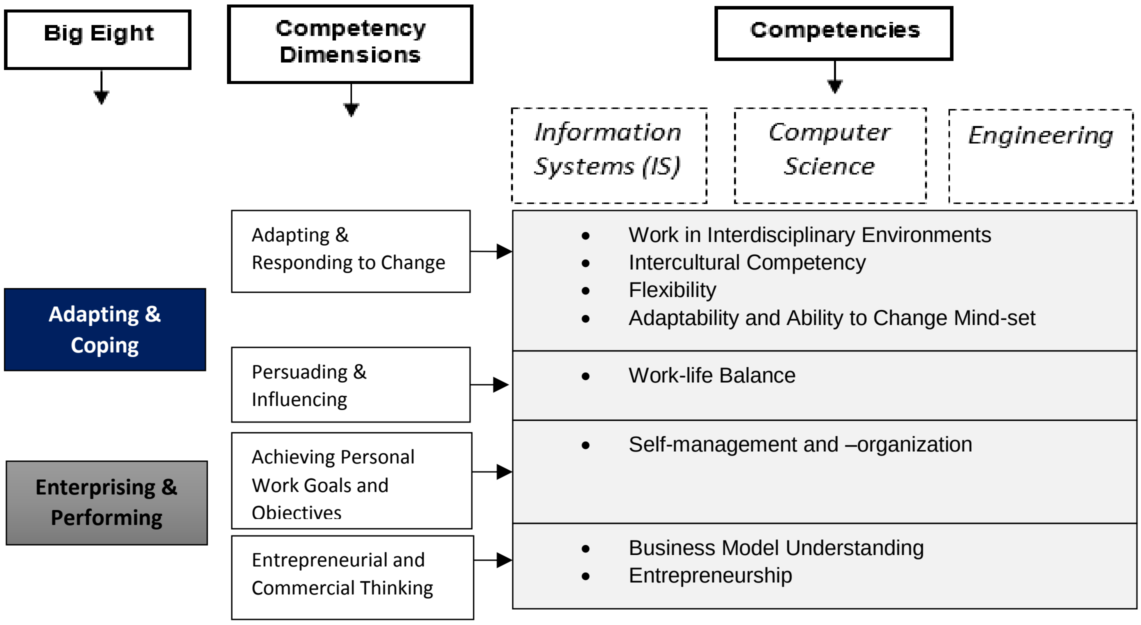


Figure 2.12: "Industry 4.0" competency model

Source: Adapted from (Prifti *et al.*, 2017:56)

From the above, it is clarified that ECs do have an impact on performance, the next section looks into specific ECs that are found in the literature to be significant for innovation, with an emphasis on the 4IR.

2.4 ENTREPRENEURIAL COMPETENCIES SIGNIFICANT FOR INNOVATION – RESULTS FROM LITERATURE

To identify ECs significant for innovation and relevant for the 4IR, a systematic literature review is conducted, which offers a rigorous view of research results (Vom Brocke, Simons, Niehaves, Riemer, Plattfaut & Cleven, 2009:2208). A concept-centric approach by following the recommendations of Webster and Watson (2002:16) was chosen. The concepts thus determine the organising framework. The main objective of this part of the literature review was to identify, classify and summarise ECs identified in the literature in order to identify those relevant for the fourth industrial revolution.

Following guidelines of Webster and Watson (2002), a search was conducted using keywords: ECs; I4.0 skills, I4.0 entrepreneurial skills, I4.0 and abilities, key competencies for I4.0, I4.0 and education, education for innovation and 21st century competencies. Due to the lack of research on I4.0 ECs, a search was also conducted on I4.0 competencies.

Based on the literature, a total of 136 competencies could be derived from 24 articles/sources that were related to ECs. Refer to Table 2.2. The different combination of competencies represents ECs, entrepreneurial skills, innovative competencies, and competencies that represent specific job profiles for I4.0. Table 2.1 is a summary of articles used to derive the competencies identified in literature in compiling the concept matrix.

Table 2.1: List of 24 articles derived for the concept matrix

	Authors	Title	Published	Publisher	Country
1	(Chandler & Jansen, 1992)	Customer orientation, innovation competencies, and firm performance: A proposed conceptual model	Procedia-Social and Behavioural Sciences	Elsevier	Thailand
2	(Cheetham & Chivers, 1996)	Towards a holistic model of professional competence	Journal of European Industrial Training	Emerald	United Kingdom
3	(Man *et al.*, 2002a)	The competitiveness of small and medium enterprises: A conceptualization with focus on entrepreneurial competencies	Journal of Business Venturing	Elsevier	China
4	(Le Deist & Winterton, 2005)	What is competence?	Human Resource Development International	Routledge	France
5	(Hisrich, Peters & Shepherd, 2005)	Entrepreneurship	Book	McGraw-Hill/Irwin	New York
6	(Dixon *et al.*, 2005)	The critical entrepreneurial competencies required by	Journal of Industrial Teacher Education	Unknown	Jamaica

		instructors from institution-based enterprises: A Jamaican study			
7	(Winterton *et al.*, 2006)	Typology of knowledge, skills and competences: clarification of the concept and prototype	Book		Office for Official Publications of the European Communities Luxembourg
8	(Man et al., 2008)	Entrepreneurial competencies and the performance of small and medium enterprises: An investigation through a framework of competitiveness	Journal of Small Business & Entrepreneurship	Routledge	Hong Kong
9	(Hussler & Ronde, 2009)	Investing in networking competences or establishing in hot spots?: The innovation dilemma	Journal of Technology Management & Innovation	Unknown	France
10	(Hazlina Ahmad *et al.*, 2010)	Is entrepreneurial competency and business success relationship contingent upon business environment? A study of Malaysian SMEs	International Journal of Entrepreneurial Behavior & Research	Emerald	Malaysian
11	(Nassif *et al.*, 2010)	Understanding the entrepreneurial process: a dynamic approach	BAR-Brazilian Administration Review	Unknown	Brazil
12	(Boyles, 2012)	21st century knowledge, skills, and abilities and entrepreneurial competencies: A model for undergraduate entrepreneurship education	Journal of Entrepreneurship Education	Unknown	

13	(Santandreu-Mascarell *et al.*, 2013)	Entrepreneurial and innovative competences, are they the same?	Management Decision	Emerald	USA
14	(Morris *et al.*, 2013)	A competency-based perspective on entrepreneurship education: conceptual and empirical insights	Journal of Small Business Management		USA
15	(Racela, 2014)	Customer orientation, innovation competencies, and firm performance: A proposed conceptual mode	Procedia-Social and Behavioral Sciences	Elsevier	Thailand
16	(Botha *et al.*, 2015a)	An integrated entrepreneurial performance model focusing on the importance and proficiency of competencies for start-up and established SMEs	South African Journal of Business Management	OASIS	South Africa
17	(Matthews & Brueggemann, 2015)	Innovation and entrepreneurship : A competency framework	Book	Routledge	
18	(Robles & Zárraga-Rodríguez, 2015)	Key competencies for entrepreneurship	Procedia economics and finance	Elsevier	Prague, Czech Republic
19	(Alipour & Taleghani, 2016)	The relationship between entrepreneurial skills of managers and organisational effectiveness in small and medium enterprises – case study: representatives of Iran Khodro in Mazandaran Province	Journal of Administrative Management, Education and Training		Iran
20	(Gray, 2016)	Ten work skills for the postnormal era	World Economic Forum web page article		United Kingdom

21	(Erol, Jäger, Hold, Ott & Sihn, 2016)	Tangible Industry 4.0: a scenario-based approach to learning for the future of production	Procedia CIRP	Elsevier	Austria
22	(Boyd, 2017)	Ten work skills for the postnormal era	Web article		
23	(Prifti *et al.*, 2017)	A competency model for" Industrie 4.0" employees	13th International Conference on Wirtschaftsinformatik	Unknown	Switzerland
24	(Grzybowska & Łupicka, 2017)	Key competencies for Industry 4.0	Economics & Management	Volkson Press	Poland

Source: Own compilation

The following section gives a brief description of the most cited competencies found in the literature.

Opportunity recognition

Various authors underline the fact that opportunity recognition is one of the key competencies that founders must competently enact to be successful (Botha *et al.*, 2015a; Boyles, 2012; Chandler & Jansen, 1992; Hazlina Ahmad *et al.*, 2010; Hisrich, Peters & Shepherd, 2005; Man *et al.*, 2002b; Man *et al.*, 2008; Matthews & Brueggemann, 2015; Morris *et al.*, 2013; Santandreu-Mascarell *et al.*, 2013).

Communication

Communication was found to be a key professional competence and is categorised as a meta-competence (Cheetham & Chivers, 1996:27). Communication is also classified as an entrepreneurial technical skill, both written and oral and business management skill (Dixon *et al.*, 2005:41; Hisrich *et al.*, 2005:41). According to Nassif *et al.* (2010:220), communication is classified as a cognitive competence, but also a functional competence (Botha *et al.*, 2015a:59). In more recent studies, relevant for I4.0, it has been identified as 21st century skill (Boyles, 2012), an innovative competency (Santandreu-Mascarell *et al.*, 2013:45) and competency for I4.0 (Prifti *et al.*, 2017:56).

Technical-functional competence

Technical-functional competence is seen both as being expert at the technical part of work (Chandler & Jansen, 1992:228) and showing entrepreneurial competence (Hazlina Ahmad *et al.*, 2010; Hussler & Ronde, 2009; Matthews & Brueggemann, 2015). It is also seen as part of written and oral communication, monitoring the environment, taking advantage of technology, managing interpersonal relationships, having the ability to organise and show management style (Hisrich *et al.*, 2005) and functional competence (Botha *et al.*, 2015a:59). In more recent studies, it has been identified as a problem-specific competence (Erol *et al.*, 2016:17) and categorised under analytical and interpreting competency for I4.0 (Prifti *et al.*, 2017:56).

Planning, monitoring, implementing, delegating and evaluating

An entrepreneur is not afraid of making mistakes and has the ability to multitask; therefore planning, monitoring, implementing, delegating and evaluating are seen as a professional "functional" competence (Cheetham & Chivers, 1996:27), showing entrepreneurial skill and competency (Botha *et al.*, 2015a; Dixon *et al.*, 2005; Hisrich *et al.*, 2005; Santandreu-Mascarell *et al.*, 2013) and cognitive competency (Nassif *et al.*, 2010:219). It is also seen as important for I4.0 (Prifti *et al.*, 2017:56).

Creativity

Dixon *et al.* (2005:47) describe creativity as the ability to transfer knowledge and ideas, having good visualisation skills, being creative, and demonstrating a willingness to take chances. It is found to be a professional meta-competence (Cheetham & Chivers, 1996:27), cognitive competence for the 21st century (Boyles, 2012:45) and entrepreneurial skill (Botha *et al.*, 2015a:59; Hisrich *et al.*, 2005) and competence (Dixon *et al.*, 2005:45; Racela, 2014:16), particularly in most recent studies regarding I4.0 and ECs. Most importantly it has been identified as a critical skill for I4.0 (Gray, 2016; Grzybowska & Łupicka, 2017; Prifti *et al.*, 2017) and as an innovative competency (Matthews & Brueggemann, 2015:57).

Relationship competency

Relationship competencies are related to person-to-person or individual-to-group based interactions, such as having persuasive ability, using contacts and connections, communication and interpersonal skills, and building a context of cooperation and trust (Man *et al.*, 2002b:132; Man *et al.*, 2008:259). Relationship competency was found as an entrepreneurial skill (Hisrich *et al.*, 2005), such as being good at interpersonal relationships, establishing partnerships (Nassif *et al.*, 2010:219) and showing entrepreneurial competency (Hazlina Ahmad *et al.*, 2010) and being an important competency for I4.0 (Prifti *et al.*, 2017).

Organising and leading

Organising and leading are described by commentators (Hazlina Ahmad *et al.*, 2010; Hisrich *et al.*, 2005; Man *et al.*, 2002a; Prifti *et al.*, 2017).

Problem-solving

Entrepreneurs should further have problem-solving skills (Botha *et al.*, 2015a; Cheetham & Chivers, 1996), which demonstrate good analysis skills, good critical thinking skills and ability to prioritise problems (Dixon *et al.*, 2005; Grzybowska & Łupicka, 2017; Matthews & Brueggemann, 2015; Prifti *et al.*, 2017; Robles & Zárraga-Rodríguez, 2015).

Self-efficacy

Self-efficacy is cited by researchers (Boyles, 2012; Cheetham & Chivers, 1996; Man *et al.*, 2008; Morris *et al.*, 2013; Nassif *et al.*, 2010); it also includes maintaining a high self-esteem, wanting to succeed, being positive and self-confident and sustaining self-awareness (Dixon *et al.*, 2005).

Strategic and innovative abilities

Being strategic is regarded as an entrepreneurial competency (Hazlina Ahmad *et al.*, 2010; Hisrich *et al.*, 2005; Man *et al.*, 2002a; Man *et al.*, 2008) and innovative competency (Matthews & Brueggemann, 2015) for I4.0 (Prifti *et al.*, 2017).

Managerial competence

Managerial competence, also seen as human and conceptual competence (Chandler & Jansen, 1992; Hisrich *et al.*, 2005; Prifti *et al.*, 2017), is cited and classified as a functional competence (Botha *et al.*, 2015a).

Initiative

Initiative is classified as a cognitive competence of an entrepreneur (Matthews & Brueggemann, 2015; Nassif *et al.*, 2010; Robles & Zárraga-Rodríguez, 2015; Santandreu-Mascarell *et al.*, 2013) and important for the 21st century (Boyles, 2012). Entrepreneurship and innovation are interlinked because innovation is the specific tool of entrepreneurs, who are able to create, manage, and assume risk of a new venture; it embraces the total innovative process (Santandreu-Mascarell *et al.*, 2013:1084).

Innovation/innovating

Innovation/innovating is therefore found to be an important innovative (Santandreu-Mascarell *et al.*, 2013) and entrepreneurial competency (Botha *et al.*, 2015a; Matthews & Brueggemann, 2015; Prifti *et al.*, 2017). Innovation has been linked to performance (Racela, 2014) and seen as a cognitive ability (inventive thinking) (Boyles, 2012).

Conceptualisation

Another competency also cited in the literature includes conceptualisation (Ahmad *et al.*, 2010; Cheetham & Chivers, 1996; Prifti *et al.*, 2017), which is reflected in the behaviour of the entrepreneur, such as absorbing and understanding complex information, and possessing decision skills, risk-taking and innovativeness (Man *et al.*, 2002a).

Learning

Learning (Botha *et al.*, 2015a; Erol *et al.*, 2016; Man *et al.*, 2008; Prifti *et al.*, 2017), and analytical ability (Cheetham & Chivers, 1996; Grzybowska & Łupicka, 2017; Man *et al.*, 2008; Prifti *et al.*, 2017) are also used as a competence dimension (analysing) in the SHL competence framework, and described as the ability to analyse numerical data and all other sources of information (Bartram, 2011).

Literacy

Literacy includes numeracy, IT, diagnosis, evaluating and ICT (Botha *et al.*, 2015a; Boyles, 2012; Erol *et al.*, 2016). It also involves the ability to reason logically, to critically evaluate information, recognise patterns and engage in divergent thinking (Cheetham & Chivers, 1996).

Financial skills

Financial skills (Botha *et al.*, 2015a; Hisrich *et al.*, 2005; Hussler & Ronde, 2009; Matthews & Brueggemann, 2015), persistence, tenacity and perseverance (Hisrich *et al.*, 2005; Morris *et al.*, 2013; Nassif *et al.*, 2010; Santandreu-Mascarell *et al.*, 2013) are all seen as an entrepreneurial skill or competency.

Other skills mentioned

According to the World Economic Forum (Gray, 2016) *judgement* and *decision-making* is one of the key skills the workforce will need in 2020, including the viewpoint of Botha *et al.* (2015a); (Grzybowska & Łupicka, 2017; Prifti *et al.*, 2017).

Innovativeness (Hisrich *et al.*, 2005; Man *et al.*, 2008), is also classified under inventive thinking: "the act of bringing something new and original into existence; the application of analysis, inference and interpretation, comparison, evaluation, and synthesis to develop new solutions to complex problems" (Boyles, 2012).

Teamwork (Matthews & Brueggemann, 2015; Prifti *et al.*, 2017; Santandreu-Mascarell *et al.*, 2013), building and using networks (Morris *et al.*, 2013) is also seen as establishing social connections (Erol *et al.*, 2016) and creating business networks

(Prifti *et al.*, 2017), and also just *networking* ability, which includes persuasion (Botha *et al.*, 2015a; Santandreu-Mascarell *et al.*, 2013).

Critical thinking is seen as a critical skill for the 21st century (Boyles, 2012) and in the latest I4.0 literature (Gray, 2016; Prifti *et al.*, 2017).

Cognitive flexibility (Erol *et al.*, 2016; Prifti *et al.*, 2017) is defined as “the ability to generate or use different sets of rules for combining or grouping things in different ways” (Gray, 2016).

Efficiency orientation (Grzybowska & Łupicka, 2017; Robles & Zárraga-Rodríguez, 2015; Santandreu-Mascarell *et al.*, 2013), is associated with research ability (Botha *et al.*, 2015a; Grzybowska & Łupicka, 2017; Robles & Zárraga-Rodríguez, 2015) and resource leveraging (Botha *et al.*, 2015a; Morris *et al.*, 2013), also classified under social competence (Boyles, 2012).

Need for achievement is also seen as being motivated (Botha *et al.*, 2015a), having the drive to see the venture through to fruition (Chandler & Jansen, 1992) and being results orientated (Robles & Zárraga-Rodríguez, 2015).

Risk taking/propensity (Botha *et al.*, 2015a; Hisrich *et al.*, 2005; Nassif *et al.*, 2010; Robles & Zárraga-Rodríguez, 2015; Santandreu-Mascarell *et al.*, 2013) and negotiation skills (Botha *et al.*, 2015a; Gray, 2016; Hisrich *et al.*, 2005) are often cited.

The following competencies were only mentioned twice (human relations skills, marketing skills, vision, leadership skills, operational skills, goal setting, independence, risk management/mitigation, value creation, adaptability, complex problem-solving, service-orientation, emotional intelligence, reporting, taking responsibility, change management, legislation awareness).

2.4.1 Entrepreneurial competencies and the link with innovation

According to Floyd and Lane (2000), organisational renewal involves the building and expansion of organisational competences over time. Therefore, a theory of strategic renewal must recognise that maintaining adaptiveness requires both exploring existing competencies and new ones (Floyd & Lane, 2000:155).

Entrepreneurship and innovation are interlinked because innovation is the specific tool of entrepreneurs and the means by which they exploit changes as an opportunity for a different business or service (Santandreu-Mascarell *et al.*, 2013:1084). Entrepreneurial innovation is defined by Kreiser, Marino and Weaver (2002:74) as the willingness to support creativity and experimentation. It is of critical importance to understand the entrepreneurial capacity of the individual (or series of individuals) leading organisations in order to produce a successful business project (Santandreu-Mascarell *et al.*, 2013:1085). Zhou, Minshall and Hampden-Turner (2010:330) identified that more studies are needed that address the interconnection between innovation, entrepreneurship and the development of capabilities. Santandreu-Mascarell *et al.* (2013:1084) therefore studied the competencies of employees of innovative companies and entrepreneurs in order to determine whether these two types of competencies are the same: if innovative companies demand an entrepreneurial profile and if entrepreneurs' companies spontaneously innovate. In the study, it was found that innovative companies value six characteristics in their employees, which are related to entrepreneurs' characteristics and describe individuals within the organisation that are able to work in teams, are committed to their work, seek information and new opportunities, and are able to take risks in innovative ventures. However, there are characteristics that entrepreneurs have that organisations that want to be innovative are not seeking.

The authors also found that there is a competence that innovative organisations need but entrepreneurs may not have, which is having previous experience in the field. Technological diversification is found to positively influence and affect the rate and specific types of innovative competence. It also has a stronger effect on exploratory than on exploitative innovative capability. The findings of this research evidence suggest that technological diversity may mitigate core rigidities and path dependencies by enhancing novel solutions that accelerate the rate of invention, especially that which departs from a firm's past activities (Quintana-García & Benavides-Velasco, 2008:492). Markman and Baron (2003:297) emphasised in their research that one important contributor to entrepreneurs' success is indeed the extent to which they possess "what it takes" – the skills, abilities, and characteristics required for creating a new venture. When they do possess "what it takes", then that is when such person-entrepreneurship fit is high.

As discussed in chapter 1, the person-entrepreneurial fit theory forms the foundation in studying the relationship between EC and IC. The theory is discussed in more detail in the following section that is used to explain some of the research objectives driving this research.

2.5 PERSON-ENTREPRENEURIAL FIT THEORY

The large interest shown in person-organisation fit research indicates that this theory suggests that the closer the match between individuals' attitudes, values, knowledge, skills, abilities and personality, the better their job satisfaction and performance (Markman & Baron, 2003:281). The theory is based on Kirton's Adaption-Innovation Theory (1976) of problem-solving at work. The construct of cognitive misfit was developed and proposed as one viable facet of person-organisation fit theory (Chan, 1996:194). It is concerned with the antecedents and consequences of compatibility between persons and the jobs they perform or the organisation in which they work (Kristof, 1996:1). Person-organisation fit is broadly defined in most research as the compatibility between individuals and organisations. Compatibility is conceptualised in a variety of ways in the sense that a distinction must be made between supplementary and complementary fit. Complementary fit occurs when a person's characteristics make up the environment or add to it what is missing (Muchinsky & Monahan, 1987:271). Supplementary fit, on the other hand, occurs when a person "supplements, embellishes, or possesses characteristics which are similar to other individuals, in an environment (Muchinsky & Monahan, 1987:269). To further illustrate the definition, Figure 2.13, by Kristof (1996:4), assists in generating a conceptual model.

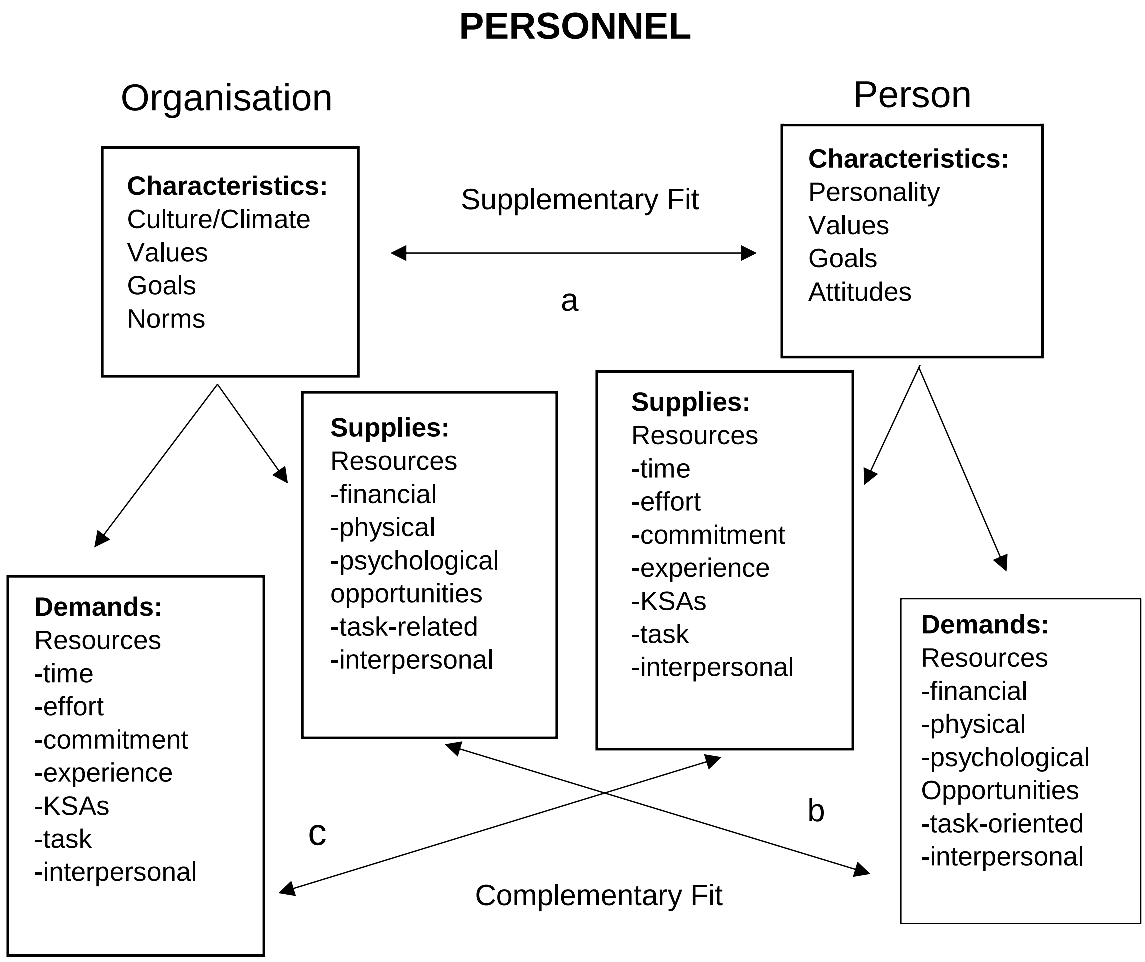


Figure 2.13: Various conceptualisations of person-organisation fit

Source: Kristof (1996:4)

In this model, supplementary fit is represented as the relationship between the fundamental characteristics of an organisation and a person. For the organisation these characteristics include the culture, climate, values, goals and norms. On the person side of the model, the characteristics indicated are values, goals, personality, and attitudes. Supplementary fit therefore exists when there is similarity between an organisation and a person with these characteristics (Kristof, 1996:3).

The view of (Pfeffer, 1998) has stimulated substantial research on person-organisational fit in that hiring the right people is crucial. Research building on the Adaption-innovation Theory of Problem-solving at Work by Kirton (1976) found that cognitive misfit predicts engineers' turnover (after three years) but does not influence their job performance (Chan, 1996:194). Cable and Judge (1996:294) also report that high person-organisation fit predicts job choice and work attitudes. According to Nieman and Nieuwenhuizen (2009:16), a positive attitude is closely related to human relations, and is an important quality that contributes to leadership and successful entrepreneurship.

Markman and Baron (2003:293) have come up with a model of person-entrepreneurship fit and entrepreneurial success, illustrated in Figure 2.14. The model suggests that becoming an entrepreneur places people in a situation where certain individual-difference factors will be instrumental to their success. The greater the person-entrepreneurship fit, the higher the likelihood of entrepreneurial success. The model presents the process at a single point in time, which incorporates both interactive and recursive interactions. It further captures the nonlinear interplay among several individual-difference factors (e.g., evaluate, deploy to market, and exploit technology-based opportunities via firm formation) to achieve entrepreneurial success, which is defined and interpreted multifariously. They further argue and acknowledge that the relationships illustrated are successively and reciprocally causal in nature.

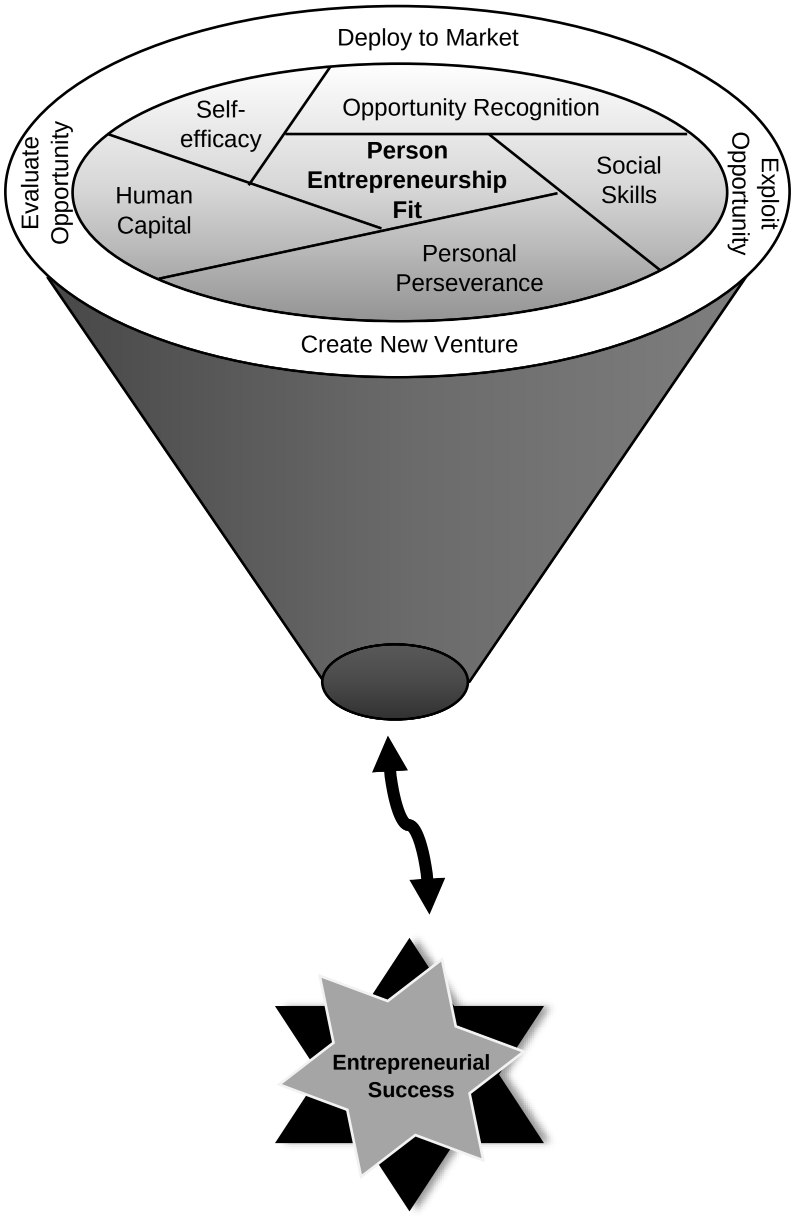


Figure 2.14: Model of Person-Entrepreneurship-Fit and entrepreneurial success

Source: Markman and Baron (2003:294)

Research on ECs shows that competencies directly correlate with job performance (Bryant & Poustie, 2001:73; Morris *et al.*, 2013:353). Morris *et al.* (2013) identified thirteen ECs, of which opportunity recognition, tenacity/perseverance and self-efficacy correlate with three of the five of Markman and Baron (2003) individual-difference dimensions. ECs are therefore a contributing factor needed for successful and sustaining entrepreneurship (Hazlina Ahmad *et al.*, 2010:184).

The next section discussed the process followed in identifying the specific competencies to be measured for this study. A two-step process was followed by conducting a Delphi study and compiling a concept matrix derived from literature.

2.6 THE PROCESS FOLLOWED TO IDENTIFY THE ENTREPRENEURIAL COMPETENCIES FOR FURTHER TESTING: LITERATURE AND DELPHI STUDY

Although Boyles (2012:41) found an overlap between 21st century knowledge, skills and abilities with ECs, ECs are different as they are seen as underlying characteristics such as generic-specific knowledge, traits, self-image, motives, social roles, and skills, which will ultimately result in venture birth, survival and growth (Bird, 1995:51).

The same codes were used in the concept matrix as developed in the Delphi study, using the SHL framework as guideline to categorise the various competencies; 136 competencies resulted from the literature study and 87 competencies from the Delphi study. Based on the concept matrix, the most cited competencies which were cited by three or more articles/authors (Table 2.1) were identified (33). This list was compared with the 28 competencies identified from the Delphi study which had a mean score of 6.33 and above. Based on the fact that empirical research has been done on ECs which are well known in the literature, the known competencies (most cited, three times or more) were used to eliminate and shorten the list of 28 competencies identified from the Delphi study. As a result, 17 competencies were eliminated from the list (taking initiative, building and using networks, persistence/perseverance, self-efficacy, decision-making capability, problem-solving, creativity, innovation/innovating, opportunity recognition, critical thinking, need for achievement, interpersonal skills (teamwork), relationship building skills, analytical ability, cognitive ability, innovativeness and individual commitment), leaving 11 competencies remaining.

In order to avoid the elimination of critical competencies that could be essential for the fourth industrial revolution, competencies were added again if they occurred in the most recent research conducted within the last five years (2014–2018) and were cited at least three or more times. Six competencies were added again to the list (decision-making capability, problem-solving, creativity, innovation/innovating, opportunity recognition and cognitive ability) resulting in a list of 17 competencies. Five competencies (communication, technical-functional competence, organising and leading, learning and research ability) were also among the most cited competencies within the last five years (2014–2018), but were not identified in the Delphi study and were therefore not part of the list of 28 competencies for elimination. It is important to note that the most cited competencies in general and within the last five years could indeed also be important competencies for I4.0 and should not be excluded from future research. The contribution of this study is therefore to identify not-so-familiar competencies that might be important for I4.0 leading to innovation that we might not be aware of.

To make sure competencies are measured specifically related to I4.0, those competencies identified from the Delphi study relevant for I4.0, with a mean score of 6.50 and more, were not eliminated further (10 out of 14). However, competencies with a mean score of 6.42 and below (14 remaining competencies) were further evaluated, and eliminated by a process of only including those competencies that were identified for the fourth industrial revolution, listed in the concept matrix (Table 2.2). Even if the competency was cited only once in I4.0 literature, it was included in the final list. An additional three competencies were added to the list of 10 competencies (networking ability, leadership skills and cognitive ability). Creativity was taken out and merged with innovation, resulting in a final list of 12 competencies that will be used for measuring, as illustrated in Table 2.4. The most mentioned competencies and their occurrence in the analysed literature are presented next in Figure 2.15 and the results from the concept matrix are illustrated in Table 2.2.

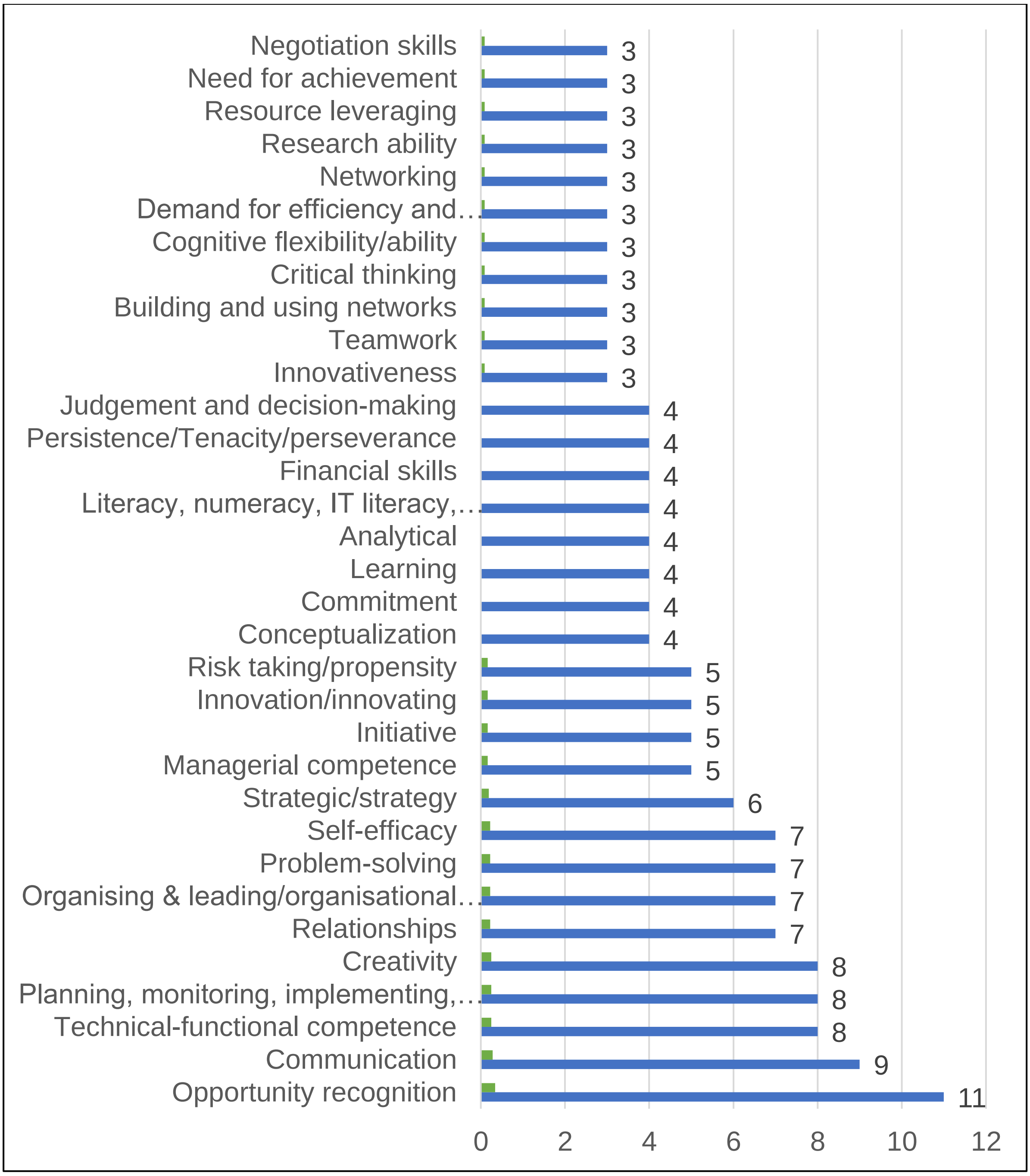


Figure 2.15: Results from the most mentioned entrepreneurial competencies in the literature

Source: Own compilation

Table 2.2: Concept Matrix of most cited entrepreneurial competencies in the literature

Most cited 33	Managerial competence	Opportunity recognition	Drive to see venture through to fruition/ Need for achievement	Technical-functional competence	Conceptualization	Communication	Creativity	Analytical	Problem-solving	Planning, monitoring, implementing, delegating, evaluating	Literacy, numeracy, IT literacy, diagnosis, evaluating, ICT	Relationships	Organising & leading/organisational & HR	Strategic/strategy	Commitment	Financial skills/management	Negotiation skills	Risk propensity/taking	Innovativeness	Learning	judgement	Initiative	Demand for efficiency and quality/efficiency orientation	Networking and persuasion	Teamwork	Innovation/innovating	Resource leveraging	Self-efficacy	Building and using networks	Critical thinking	Cognitive flexibility/ability	Conflict solving	Research skills
(Chandler & Jansen, 1992)	1	1	1	1																													
(Cheetham & Chivers, 1996)					1	1	1	1	1	1	1																	1					
(Man, Lau & Chan, 2002:132)		1										1	1	1	1																		
(Le Deist & Winterton, 2005)																																	
(Hisrich, Peters & Shepherd, 2005)	1	1		1		1				1		1	1	1		1	1	1	1		1												
(Dixon, Meier, Brown and Custer, 2005)						1	1		1	1																		1					
(Winterton et al., 2006)																																	
(Man et al., 2008)	1	1			1			1				1	1	1	1				1	1								1					
(Hussler & Ronde, 2009)				1								1				1																	
(Hazlina Ahmad et al., 2010)		1		1	1							1	1	1	1													1					
(Nassif et al., 2010)						1				1		1						1			1	1						1					
(Boyles, 2012)		1				1			1	1	1								1			1				1	1	1		1			
(Santandreu-Mascarell, Garzon & Knorr, 2013)		1				1				1					1						1	1	1	1	1	1							
(Morris et al., 2013)		1																			1						1	1	1				
(Alipour & Taleghani, 2016)																																	
(Racela, 2014)							1																			1							

Most cited 33	Managerial competence	Opportunity recognition	Drive to see venture through to fruition/ Need for achievement	Technical-functional competence	Conceptualization	Communication	Creativity	Analytical	Problem-solving	Planning, monitoring, implementing, delegating, evaluating	Literacy, numeracy, IT literacy, diagnosis, evaluating, ICT	Relationships	Organising & leading/organisational & HR	Strategic/strategy	Commitment	Financial skills/management	Negotiation skills	Risk propensity/taking	Innovativeness	Learning	judgement	Initiative	Demand for efficiency and quality/efficiency orientation	Networking and persuasion	Teamwork	Innovation/innovating	Resource leveraging	Self-efficacy	Building and using networks	Critical thinking	Cognitive flexibility/ability	Conflict solving	Research skills
(Botha, Van Vuuren & Kunene, 2015).	1	1	1	1		1	1		1	1	1		1			1		1		1				1		1	1						1
(Matthews & Brueggemann, 2015)		1		1					1				1	1		1						1			1								
(Robles & Zarraga-Rodriguez, 2015)			1																			1	1										1
(Leopold et al., 2016)							1										1													1	1		
(Boyd, 2017)																																	
(Prifti et al., 2017)	1			1	1	1	1	1	1	1		1	1	1						1				1	1	1			1	1	1		
(Erol, et al, 2016)				1		1	1				1									1									1		1		
(Grzybowska & Lupicka , 2017)		1					1	1	1														1									1	1
	5	11	3	8	4	9	8	4	6	8	4	7	7	6	4	4	3	3	3	4	4	5	3	3	3	5	3	7	3	3	3	1	3

Source: Own compilation

The final competencies as illustrated in Table 2.4 therefore include competencies identified from the Delphi study (17/28) with mean score 6.3–6.67; the most cited competencies (3 times or more) within the last five years (2014–2018) (6/17), illustrated in Table 2.2; and competencies identified for I4.0 specifically (7/17) were included, illustrated in Figure 2.15, resulting in a final list of 12 competencies.

Table 2.3: Entrepreneurial competencies identified for the 4th industrial revolution

	Competencies
1	Positive attitude
2	Decision-making capability
3	Proactiveness
4	Value creation
5	Resilience
6	Problem solving
7	Creative Problem Solving & Imaginativeness
8	Innovation/Innovating
9	Opportunity recognition
10	Networking ability
11	Leadership skills
12	Cognitive ability

Source: Own compilation

Since the topic is new, only a little research exists on ECs for the 4IR. The topic is of high practical relevance and broadly discussed in practitioners' texts. However, a literature review was conducted to summarise the state of the art before gathering data. As recommended by (Levy & Ellis, 2006:182), the inclusion of practical articles, White Papers and reports that propose competencies for I4.0 was also considered. Finally, 24 articles, including research and practitioners' publications, were considered and analysed. The mentioned competencies were extracted from each article and a concept matrix was built, as proposed by Webster and Watson (2002). The SHL

Universal Competency Framework (UCF) was used as generic foundation for competency modelling (Bartram, 2011). This framework was used to further confirm proper identification of the individual competencies and a process of clustering was used. If the same competency had been covered as a synonym in different papers, it was considered as one competency and the more popular term was used. Based on the results from the Delphi study, a total of 108 competencies were recorded, of which 87 competencies were identified. Twenty-one competencies were found to be similar. The next section discusses the four competence domains used to categorise the 12 competencies.

2.7 CLUSTERING ENTREPRENEURIAL COMPETENCIES FOR THE 4TH INDUSTRIAL REVOLUTION INTO FOUR CATEGORIES

Many scholars have used dimensions or domains to cluster competencies. The literature distinguishes three main clusters of competencies related to behaviours, namely emotional competencies (the ability to recognise, understand, and manage one's own ability), social competencies (managing others' emotions), as well as cognitive competencies (the ability to analyse information and situations) (Bonesso, Gerli, Pizzi & Cortellazzo, 2018:216). Chandler and Jansen (1992) conducted a study that is based on research identifying the entrepreneurial, managerial, and technical-functional functions as three roles that founders must competently enact in order to be successful. The five competency domains included managerial competence (human and conceptual), ability to recognise opportunity, drive to see venture through to fruition, technical-functional competence and political competence. The eight cluster entrepreneurial competency categories used by Dixon *et al.* (2005) included: team leadership, perceptions of trustworthiness, planning and organisational skills, business skills, problem-solving skills, communication skills, personal traits and creativity. Also using eight entrepreneurial competency domains, Hazlina Ahmad *et al.* (2010) used the following domains: strategic, commitment, conceptual, opportunity, organising and leading, relationship, personal and technical. Focusing on the importance of proficiency of competencies for start-up and established SMEs, functional and enterprising competencies were identified and clustered (Botha *et al.*, 2015a:59).

Certain professional competence models are similar, such as that of Cheetham and Chivers (1996:20), which includes meta-competencies, cognitive competence, functional competence, personal and behavioural competence and ethical competence. Similar to Cheetham and Chivers (1996) and Le Deist and Winterton (2005:40) and used in (Bharwani & Talib, 2017), Winterton *et al.* (2006) developed a holistic model of competence and a unified typology of knowledge, skills and capabilities, including meta-competence, cognitive competence, functional competence and social competence. Four major categories identified for 21st century knowledge, skills and abilities (KSAs) are: information media and technology literacy, inventive thinking, communication and collaboration, productivity and results (Boyles, 2012). Boyles (2012) further identified ECs and 21st century KSAs into cognitive, social and action-oriented categories in formulating a model for undergraduate entrepreneurship education.

Based on the research conducted on competence domains, the following categories will be used for the purpose of this study: cognitive competence (Boyles, 2012; Cheetham & Chivers, 1996; Le Deist & Winterton, 2005; Nassif *et al.*, 2010; Winterton *et al.*, 2006), functional competence (Botha, Van Vuuren & Kunene, 2015b; Cheetham & Chivers, 1996; Le Deist & Winterton, 2005; Winterton *et al.*, 2006), social competence (Boyles, 2012; Cheetham & Chivers, 1996; Erol *et al.*, 2016; Winterton *et al.*, 2006) and meta competence (Cheetham & Chivers, 1996; Le Deist & Winterton, 2005; Winterton *et al.*, 2006). These four categories are also grounded in Figure 2.4 (A Unified typology of Knowledge Skills and Capabilities) and Figure 2.6 (A Holistic model of competence) and will be used to categorise the 12 competencies identified for measurement in this study and further analysis. These four competence dimensions were only used to categorise the final list of 12 identified competencies of this study.

2.7.1 Cognitive competencies

Cognitive competence is based on the possession of appropriate work-related knowledge and skills (Ommi & Zeng, 2018:4) and the ability to put them to effective use (Cheetham & Chivers, 1996:24). It concerns the ability to think about and analyse information and situations (Bonesso *et al.*, 2018:218), including underpinning theory and concepts, as well as informal tacit knowledge gained experientially (Li, Paulin, Fast-Berglund, Gullander & Bligård, 2018:160; Nordin & Purwaningrum, 2018:19; Pfeiffer, 2016; Popadiuk & Choo, 2006:302). Cheetham and Chivers (1996) describe their set of cognitive competencies as tacit/practical, technical/theoretical, procedural and contextual. When examining the practical utility of cognitive competencies in the workplace and those most predictive of performance, Ryan, Emmerling and Spencer (2009:861) identified cognitive competencies such as analytical thinking, conceptual thinking, and expertise, representing important competencies that serve to categorise cognitive and technical abilities. Boyatzis (2006:127) used pattern recognition, systems thinking and knowledge to measure cognitive competencies in predicting the performance of managers/leaders.

Earlier cognitive competencies such as attentive behaviour, verbal ability and working memory and intermediate numerical skills have also been shown to support later fraction outcomes (Ye, Resnick, Hansen, Rodrigues, Rinne & Jordan, 2016:255). In analysing the mediating effect of emotional, social and cognitive competencies, these competencies were found to predict entrepreneurial intent (Bonesso *et al.*, 2018:215). Cognitive skills therefore enable individuals to approach problem-solving processes by addressing every situation as a component of a larger system, rather than as independent aspects with unrelated consequences (Ackoff, 2008). According to Dyer, Gregersen and Christensen (2008), entrepreneurs have the ability to recognise patterns, a cognitive skill which enables them to “connect the dots”. Therefore, they use their existing cognitive frameworks and knowledge to notice connections between diverse events and trends, hence being able to identify new business opportunities (Baron, 2006). Baron and Ensley (2006) found that experienced entrepreneurs demonstrate cognitive competencies at a higher level than novice entrepreneurs. Adapting the competence model from Delamare Le Deist and Winterton (2005), Bharwani and Talib (2017:408) built a competency framework for hotel general managers and identified nine cognitive competencies. Boyle’s (2012) 21st century competency model, which is based on undergraduate entrepreneurship education, included five cognitive skills and four entrepreneurial cognitive competencies. Not only has cognitive ability been identified as a personal competency, but also identified as a problem-specific competency focused on Industry 4.0.

2.7.2 Functional competencies

Functional competencies are defined as the ability to perform a range of work-based tasks effectively to produce specific outcomes (Cheetham & Chivers, 1996:24). They assist the entrepreneur to function in the business and find the balance between opportunity, resources and the entrepreneurial team that depends on management/general business and technical skills (Botha *et al.*, 2015b). Functional competencies are therefore occupation-specific, part of an organisation's process, cerebral and psychomotor (Cheetham & Chivers, 1996), which includes: planning, monitoring, implementing, delegating, evaluating, literacy, numeracy, IT literacy, diagnosis, evaluating and manual dexterity. These functional competencies therefore depend on business management/general business and technical skills (Botha *et al.*, 2015b), which also include: marketing management, financial management, operational and legal skills, general management, ICT skills, human resources management, networking, planning, research and development, business systems management, value chain management, technical skills, numeracy skills and communication (Botha *et al.*, 2015b:59). Self-assessed functional skills necessary for the success of woman entrepreneurs refer to skills a manager is supposed to have acquired, which include general marketing, sales strategies and financial planning (Schneider, 2017:255).

2.7.3 Social competencies

Social competencies comprise attitudes and behaviours and are defined as the ability to adopt appropriate, observable behaviours in work-related situations (Cheetham & Chivers, 1996:24). They are often called "soft skills" and have become the most demanded capabilities from graduates by employers worldwide (Warleta, Suplet, Slocum & Schmitz, 2019:243). Interpersonal competencies are often categorised as social competencies; they are useful in establishing and maintaining relationships with others. People skills include effective communication, teamwork orientation and developing and coaching others (Bharwani & Talib, 2017:408). One of the four major categories of 21st century KSAs identified by Boyles (2012) included communication and collaboration (social competence), identifying problem-solving, innovation and emotional intelligence as part of this category. In their research on social entrepreneurship competencies of managers in social entrepreneurship organisations, Amini, Arasti and Bagheri (2018:13) identified five main dimensions including social competencies, with competencies including teamwork, leadership and networking. Certain managerial social competencies have also been identified when determining business performance (Veliu & Manxhari, 2017:59). Social competencies within the framework for higher education qualifications seem to be more related to social and communication skills, or as part of a broader set of professional competencies, based on the research conducted by (Rattray & Raaper, 2019:37).

2.7.4 Meta competencies

Meta competence facilitate learning and are described as meta-qualities such as creativity, mental ability and balanced learning skills, which are reinforced by other qualities (Cheetham & Chivers, 1996:22). It can be defined as an overarching ability that allows an individual to judge the availability, applicability and “learnability” of personal competencies (Weinert, 2001a). Winterton *et al.* (2006) define them as “the ability to cope with uncertainty, as well as with learning and reflection”. It is further conceptualised as an individual’s knowledge of their own intellectual strengths and weaknesses, how to apply skills and knowledge in various task situations and how to acquire missing competencies. According to Arisó, Girotto and Fernandez (2016:51), their approach to meta-competency puts the focus on the ability to know how to combine and relate a set of skills in different situations, rather than emphasise a specific skill for a separate competency. Nel (2016:iv) describes the three competencies identified in his research as: knowing why, knowing how and knowing whom, which was investigated as a mediator between protean career orientation and both objective and subjective career success. In studying the technology of forming workers’ meta-competencies, present a model of forming meta-competencies in modern worker’s training. These included comprehensive knowledge, free and critical thinking, readiness for using a personal approach in work and establishing the strategy of professional and personal development, as well as capacity for self-actualisation.
Table 2.4 is a summary of competencies identified from the literature in studies that categorised competencies into cognitive, meta, functional and social.

Table 2.4: Competencies and categories identified from the literature

Cognitive competencies		Meta competencies	
Competencies	**Authors**	**Competencies**	**Authors**
Synthesis and transfer of knowledge	(Cheetham & Chivers, 1996); (Boyatzis, 2006)	Communication	(Cheetham & Chivers, 1996)
Conceptualisation	(Cheetham & Chivers, 1996)	Self-development	(Cheetham & Chivers, 1996)
Theory application	(Cheetham & Chivers, 1996)	Creativity	(Cheetham & Chivers, 1996)
Taking calculated risks	(Nassif *et al.*, 2010)	Analysis	(Bharwani & Talib, 2017)
Establishing partnerships	(Nassif *et al.*, 2010)	Problem-solving	(Bharwani & Talib, 2017)
Defining goals	(Nassif *et al.*, 2010)	Comprehensive knowledge	(Sopegina, Chapaev & Simonova, 2016)
Planning skills (know-how)	(Nassif *et al.*, 2010) (Bharwani & Talib, 2017)	Free and critical thinking	(Sopegina *et al.*, 2016)
Knowing the business, market and products	(Nassif *et al.*, 2010)	Personal approach readiness	(Sopegina *et al.*, 2016)
Knowing one's limits	(Nassif *et al.*, 2010)	Professional and personal development strategy	(Sopegina *et al.*, 2016)
Eloquence	(Nassif *et al.*, 2010)	Self-actualisation capacity	(Sopegina *et al.*, 2016)
Communication skills	(Nassif *et al.*, 2010)		
Analytical skills and critical thinking	(Ryan *et al.*, 2009) (Bharwani & Talib, 2017)		
Conceptual thinking	(Ryan *et al.*, 2009)		
Expertise	(Ryan *et al.*, 2009)		
Attentive behaviour	(Ye *et al.*, 2016)		
Verbal and non-verbal intellectual ability	(Ye *et al.*, 2016)		
Working memory	(Ye *et al.*, 2016)		
Pattern recognition / Associational thinking	(Dyer *et al.*, 2008); (Boyatzis, 2006); (Bonesso *et al.*, 2018)		
Lateral thinking / Creative problem-solving	(Bonesso *et al.*, 2018)		
Systems thinking	(Bonesso *et al.*, 2018); (Boyatzis, 2006) (Bharwani & Talib, 2017)		
Strategic thinking	(Bharwani & Talib, 2017)		
Decision-making	(Bharwani & Talib, 2017)		
Creativity and innovation	(Bharwani & Talib, 2017) (Boyles, 2012)		
Information gathering	(Bharwani & Talib, 2017)		
Risk-taking	(Bharwani & Talib, 2017)		
Change management	(Bharwani & Talib, 2017)		
Logical reasoning	(Boyles, 2012)		
Complex problem-solving	(Boyles, 2012)		
Literacy	(Boyles, 2012)		
Divergent thinking	(Boyles, 2012)		
Inventive thinking	(Boyles, 2012)		
Opportunity recognition	(Boyles, 2012)		

Alertness	(Boyles, 2012)		
Ability to apply systematic search	(Boyles, 2012)		
Functional competencies		**Social competencies**	
Competencies	**Authors**	**Competencies**	**Authors**
Planning	(Cheetham & Chivers, 1996) (Botha *et al.*, 2015a)	Self-confidence	(Cheetham & Chivers, 1996)
Monitoring	(Cheetham & Chivers, 1996)	Thinking on feet	(Cheetham & Chivers, 1996)
Implementing	(Cheetham & Chivers, 1996)	Calmness	(Cheetham & Chivers, 1996)
Delegating	(Cheetham & Chivers, 1996)	Task-centeredness	(Cheetham & Chivers, 1996)
Evaluating	(Cheetham & Chivers, 1996)	Stamina	(Cheetham & Chivers, 1996)
Literacy & numeracy	(Cheetham & Chivers, 1996) (Botha *et al.*, 2015a)	Presentation	(Cheetham & Chivers, 1996)
IT literacy	(Cheetham & Chivers, 1996) (Bharwani & Talib, 2017)	Intra-professional skills	(Cheetham & Chivers, 1996)
Diagnosis	(Cheetham & Chivers, 1996)	Empathy	(Bonesso *et al.*, 2018)
Evaluating	(Cheetham & Chivers, 1996)	Organisational awareness	(Bonesso *et al.*, 2018)
Manual dexterity	(Cheetham & Chivers, 1996)	Service orientation	(Bonesso *et al.*, 2018)
Marketing management	(Botha *et al.*, 2015a) (Schneider, 2017)	Conflict management	(Bonesso *et al.*, 2018) (Bharwani & Talib, 2017)
Financial management	(Botha *et al.*, 2015a) (Bharwani & Talib, 2017) (Schneider, 2017)	Coaching and mentoring	(Bonesso *et al.*, 2018)
Operational	(Botha *et al.*, 2015a)	Influence	(Bonesso *et al.*, 2018) (Veliu & Manxhari: 2017)
Legal skills	(Botha *et al.*, 2015a) (Bharwani & Talib, 2017)	Inspirational leadership	(Bonesso *et al.*, 2018)
General management	(Botha *et al.*, 2015a)	Teamwork	(Bonesso *et al.*, 2018) (Bharwani & Talib, 2017) (Amini *et al.*, 2018) (Carmo, 2019)
ICT skills	(Botha *et al.*, 2015a)	Being a change catalyst	(Bonesso *et al.*, 2018)
Human resources management	(Botha *et al.*, 2015a) (Bharwani & Talib, 2017)	Effective communication	(Bharwani & Talib, 2017)
Networking	(Botha *et al.*, 2015a)	Cultural intelligence	(Bharwani & Talib, 2017) (Carmo, 2019) (Veliu & Manxhari: 2017)
Research and development	(Botha *et al.*, 2015a)	Networking	(Bharwani & Talib, 2017) (Amini *et al.*, 2018)
Business systems management	(Botha *et al.*, 2015a)	Diversity management skills	(Bharwani & Talib, 2017)
Value chain management	(Botha *et al.*, 2015a)	Fostering motivation	(Bharwani & Talib, 2017)
Technical skills	(Botha *et al.*, 2015a)	Active listening skills	(Bharwani & Talib, 2017)
Communication	(Botha *et al.*, 2015a)	Developing others	(Bharwani & Talib, 2017)
Service orientation	(Bharwani & Talib, 2017)	Leadership	(Amini *et al.*, 2018) (Carmo, 2019)
Business and industry expertise	(Bharwani & Talib, 2017)	Problem solving	(Boyles, 2012)
Commitment to quality	(Bharwani & Talib, 2017)	Innovation	(Boyles, 2012)
Resource allocation skills	(Bharwani & Talib, 2017)	Emotional intelligence	(Boyles, 2012)
Crisis management skills	(Bharwani & Talib, 2017)	Interpersonal abilities	(Carmo, 2019)
Ability to manage stakeholders	(Bharwani & Talib, 2017)	Communication	(Carmo, 2019) (Veliu & Manxhari: 2017)

Sales strategy	(Schneider, 2017)	Ability to work in international contexts and global awareness	(Carmo, 2019)
		Acquiring of ethical commitments	(Carmo, 2019)
		Effective relations	(Veliu & Manxhari, 2017)
		Orientation to customer	(Veliu & Manxhari, 2017)
		Goal-setting	(Veliu & Manxhari: 2017)
		Delegation of authority	(Veliu & Manxhari: 2017)
		Change management	(Veliu & Manxhari: 2017)
		Performance management fairness	(Veliu & Manxhari: 2017)
		Responsibility	(Veliu & Manxhari: 2017)
		Flexibility	(Veliu & Manxhari: 2017)
		Development skills	(Veliu & Manxhari: 2017)

Source: Own compilation

Based on evidence from the literature and the Delphi study, the classification into categories of the 12 competencies identified for analysis is as follows:

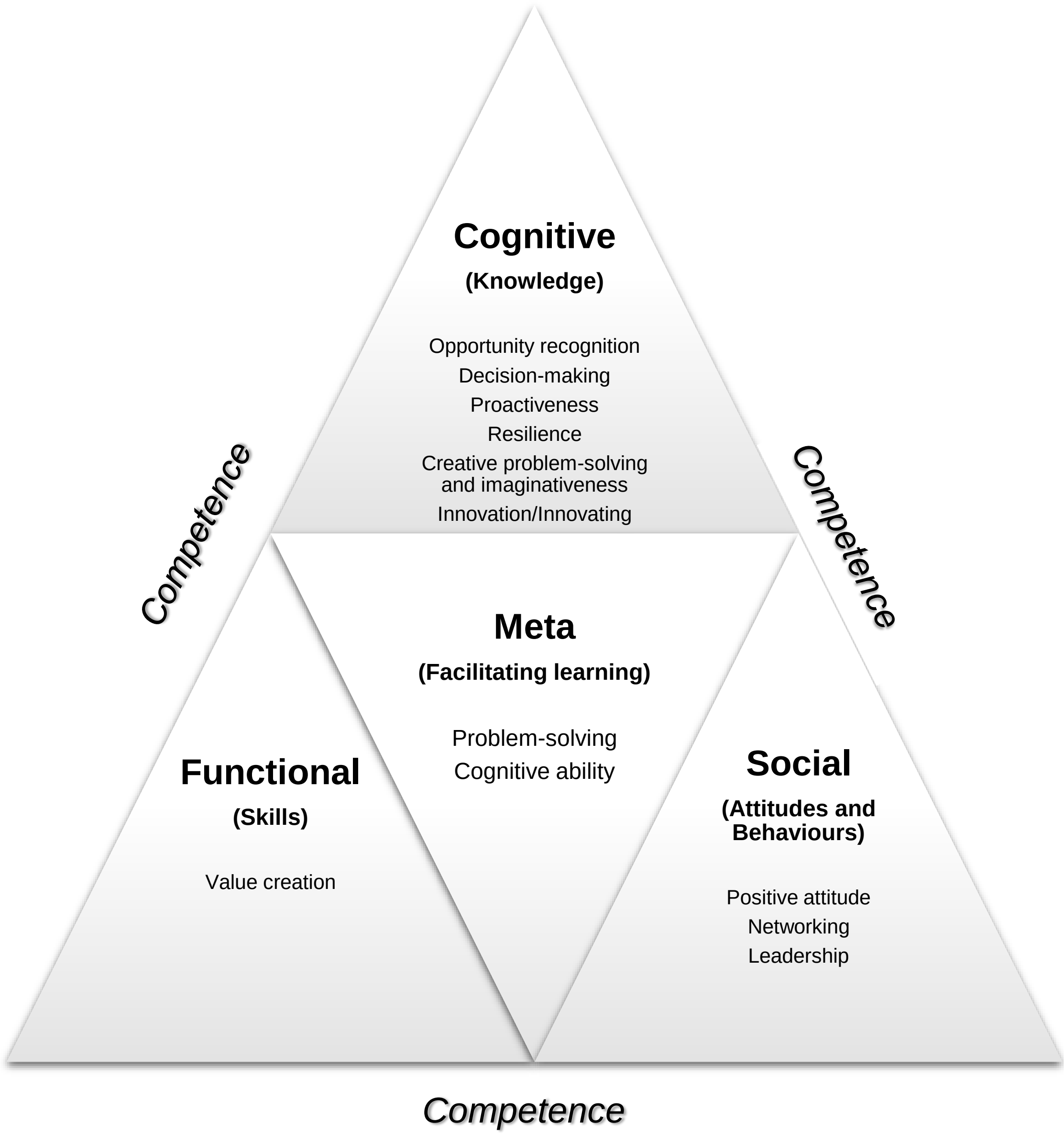


Figure 2.16: An Entrepreneurial competency framework for the 4th Industrial revolution

Source: Own compilation as adapted from Le Deist and Winterton (2005)

2.8 CONCLUSION

The main focus of this chapter was to identify which ECs are required for the 4IR. It also identified possible competencies significant for innovation. In order to do this, a conceptual underpinning was conducted of the constructs, knowledge, skills and competencies, with distinction between competency, competence and competencies.

Competence can be defined in different ways and on different levels (organisation, department, team, individual); however, for the purpose of the study the individual competencies of an entrepreneur are defined as

> a combination of learnable behaviours that encompass (wanting to do), skills (how to do), knowledge, (what to do), practical experiences (proven learning), and natural talents of a person in order to effectively accomplish an explicit goal within a specific context (Matthews & Brueggemann, 2015:10).

It further distinguishes four categories of competence that form a framework to developing a typology of knowledge, skills and competence, namely functional (skills), cognitive (knowledge), social (attitudes and behaviours) and meta competencies (facilitating learning).

To further understand the competencies of entrepreneurs and a means to study competencies, a closer look was taken into their inputs (antecedents), such as experience and education and training, process (task of behaviour leading to competencies), and outcomes (achieving standards of competence), for example, by means of performance. Various competency models were looked into in order to compare current literature on competency models that illustrate desired competencies for a certain task or a means to measure performance or an outcome (Prifti *et al.*, 2017) or even as a predictive measure (McCall, 1998).

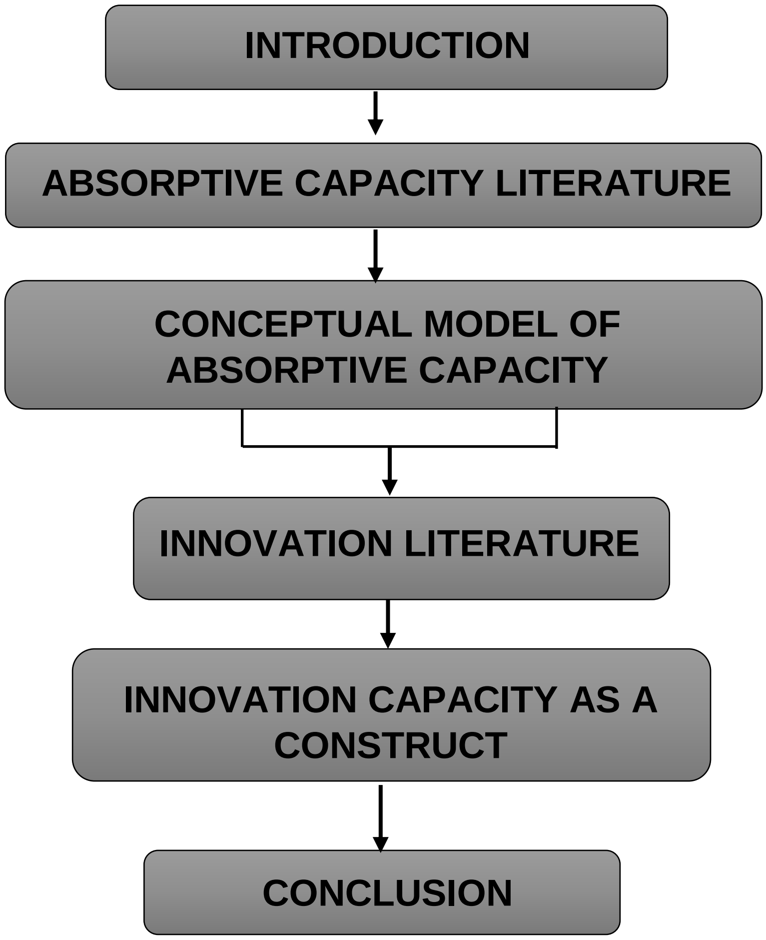
An overview of competencies found in the literature search revealed 136 independent and complementary competencies and the Delphi study, 87 competencies. The combined methods, which included a Delphi study and systematic, concept centric approach, led to a final list of 12 competencies for further testing. This was followed by an explanation of the Person-Entrepreneurial Fit Theory, with a closer look at the model of person-entrepreneurship fit and entrepreneurial success, which focuses on the fact that becoming an entrepreneur places people in a situation where certain individual-difference factors will be instrumental in their success.

The next chapter discusses entrepreneurial absorptive capacity, grounded in ACAP theory and innovation capacity as constructs.

CHAPTER 3:

ABSORPTIVE CAPACITY AND INNOVATION CAPACITY

DIAGRAMMATIC SYNOPSIS



3.1 INTRODUCTION

This chapter presents a review of existing research on Absorptive Capacity (ACAP) and Innovation Capacity (IC) and how they relate to the level of invention of entrepreneurs. As science and technology continue to be revolutionised, South Africa needs to sharpen its innovative edge and continue contributing to global scientific and technological advancement. As a middle-income country, South Africa needs to use its knowledge and innovative products to compete globally. Innovation is therefore necessary for middle-income country development (Moura, Madeira, Duarte, Carvalho & Kahilana, 2018). Given the performance of organisations in an increasingly global market, it is becoming more and more critical for policymakers to strengthen and differentiate economy and market trends by defining public policies that stimulate innovation. It is therefore of critical importance to understand the determinants of innovation (Moura *et al.*, 2018:3).

The Commission of South Africa, according to the National Development Plan, believes that improving skills and innovation could also contribute to job creation. However, inadequate human capacity will constrain knowledge production and innovation (Commission, 2013:40). Although South Africa has a strong culture of innovation, there is still a gap in the National Innovation System (NIS), as most research outputs have not related to commercially-viable products and services and the creation of new industries (CIPC, 2016-2017:29). It is therefore critical to investigate what leads to successful innovations and whether competencies and the use of knowledge (ACAP) plays a role. In search of the success factors for new organisations, studies have often turned to entrepreneurs' human capital. However, little is known about the determinants of entrepreneurial skills for the 4IR and where they come from. This is of particular importance for policy makers and educators aiming to promote entrepreneurship and economic growth (Stuetzer, Obschonka, Davidsson & Schmitt-Rodermund, 2013:1183). Seminal theorising argues that these skills predominantly result from knowledge and experiences (Becker, 1964).

In this chapter a thorough investigation is made on the different constructs of ACAP and IC and how they are both linked to innovation. The first part of this chapter investigates the literature on ACAP and considers the importance of ACAP as a capability to assimilate new knowledge in order to create new products and services, for knowledge is known for increasing an organisation's capacity for effective action (Nonaka, 1994:15). The most recent convergence in ACAP theory has led to an extended model of Zahra and George (2002) and Todorova and Durisin (2007) by adding individual (entrepreneurial) ACAP (Löwik, 2013:198). Löwik *et al.* (2012) conceptualised individual ACAP as the activities of individuals and developed a multi-dimensional measure for individual ACAP. In order to understand the origins of this approach, the historical developments of the ACAP theory and knowledge spillover theory are discussed in section 3.2.2.

Furthermore, to fully understand the ACAP construct and theory, the concepts "knowledge" and "learning" are unfolded, where the link is drawn from knowledge to learning, since knowledge comes about through the integration of information, which is a process of integration called learning. The link between individual and organisational learning is discussed in order to understand the nature of the learning organisation and the individual learning process. Educators, psychologists, linguists and others have researched the topic of learning at the individual level intensively. Discoveries have been made about cognitive limitations, as well as the seemingly infinite capacity of the human mind to learn new things (Kim, 1997:2). Studies in the area of cognitive and behavioural sciences at the individual level, as well as memory development, are looked into in order to explain the notion of ACAP. The notion of ACAP is seen as a multidimensional construct consisting of four capabilities (acquisition, assimilation, transformation, exploitation). The underlying dimensions of ACAP, which are assumed to be processes and routines, each with different antecedents and outcomes, are also looked into. A specific outcome of ACAP is innovative outputs; innovation capacity is discussed in more detail in the second part of this chapter.

The second part of this chapter concentrates on the construct IC, as it is conceptualised as the stock of all available inventive knowledge (Suarez-Villa & Hasnath, 1993) and an indicator of invention and potential measure of innovation. Innovation is defined first, along with the various descriptions and concepts of innovation in order to determine how IC is measured. According to Freeman (2013), an invention is an idea, mode or sketch for a new improved product, process, system or device. An innovation is accompanied with the first commercial transaction involving the new product, process, system or device, although the word is used to describe the whole process. Thus, innovation indicates not only the generation of new ideas, but also the implementation thereof (Urabe, 1988:3). IC is therefore a concept that measures the level of invention and the potential for innovation (Suarez-Villa, 1993:335). In other words, it covers the introduction and "newness" of the idea and its potential to be absorbed into the market or transformed into a profitable product or system.

3.2 ABSORPTIVE CAPACITY LITERATURE

3.2.1 Defining absorptive capacity (ACAP)

The concept of ACAP was originated by (Cohen & Levinthal, 1989; Cohen & Levinthal, 1990) as the means which enables organisations to efficiently assimilate new knowledge among its employees, and to apply new knowledge to create new products and services. It describes the capacity to identify, assimilate and exploit external knowledge, which influences an organisation's strategy and performance (Ben-Oz & Greve, 2015:1), and ranges from an entire nation to the individual (Jansen, Van den Bosch & Volberda, 2003). The knowledge-creation competence in a learning organisation has been related to concepts such as ACAP, insight generation, organisational learning and memory (Darr, Argote & Epple, 1995:1750; Nonaka, 1994:14), as well as the structured knowledge management processes (Heinrichs & Lim, 2005:620).

Cohen and Levinthal (1990) have labelled the capability of assimilating and applying new knowledge as a firm's ACAP and suggest that it is largely a function of the firm's prior related knowledge. These authors defined ACAP as "the ability of an organisation to recognise the value of new, external information, assimilate it and apply it to commercial ends" (Cohen & Levinthal, 1990:128; Todorova & Durisin, 2007:776; Zahra & George, 2002:192). This implies that ACAP is a multi-dimensional construct, consisting of the three processes of recognition, assimilation and application. Cohen and Levinthal (1990) also conceptualised ACAP as a multi-level construct on an individual and organisational level, which consists of individuals' absorptive capabilities and organisational mechanisms that integrate the individual capabilities. In their research, the discussion focuses first on the cognitive basis for an individual's

ACAP, including in particular diversity of background and prior related knowledge, and then categorises the factors of ACAP at the organisational level (Cohen & Levinthal, 1990:128).

3.2.2 The ACAP theories

The theory of ACAP is seen as more sophisticated than some other theories of innovation, as it highlights the importance of external knowledge as a critical component in innovation (Smith, 2015:65). It integrates the external dimension, which is concerned with learning, and the knowledge transfer process within the innovating organisation. ACAP is classified as one of the dynamic capabilities in strategic management, which Teece, Pisano and Shuen (1997:1106) define as "the firm's ability to integrate, build and reconfigure internal and external competencies to rapidly changing environments". Its origin has evolved from organisational learning. Simon (1969) defines organisational learning as the growing insights and successful restructuring of organisational problems by individuals, reflected in the structural elements and outcomes of the organisation itself. Based on this definition, learning consists of the development of insights on the one hand, and structural (Cohen & Levinthal, 1990) action outcomes on the other. One is a change in states of knowledge, the other often involves a change more easily visible in terms of organisational outcome. In all instances the assumption remains that learning will improve future performance (Fiol & Lyles, 1985:803).

Zahra and George (2002) suggest that this dynamic capability perspective could contribute to empirical and theoretical development of ACAP in three ways. Firstly, the notion of ACAP as a multi-dimensional construct consisting of four capabilities could provide new insights into their relationships and processes, thereby guiding practitioners to develop, maintain and renew their organisation's ACAP. Secondly, a dynamic capability view could encourage studies on the influencing factors and conditions under which ACAP would create value; therefore informing scholars and practitioners on why organisations show different performance in the same industry, and how organisations can sustain performance over time. Thirdly, ACAP could be better related to competitive advantage and broader strategic outcomes, instead of merely innovation and learning.

For the purpose of this study, high levels of individual ACAP are expected to have a positive effect on individuals' idea generation and idea implementation outcomes. Further, high levels of individuals' ACAP are expected to be dependent on high levels of EC. High levels of EACAP and EC are expected to have a positive effect on higher levels of IC.

In order to adequately address the relationship between knowledge and entrepreneurship, the new ACAP theory of *knowledge spillover entrepreneurship* (Acs *et al.*, 2009), an advancement of the knowledge spillover theory by Marshal (1920), provides insights into the relationships between new knowledge and knowledge embodied in people and entrepreneurship. If the strategically most important resource of an organisation is knowledge, and if knowledge resides in specialised form among individual organisational members, the essence of organisational capability is then the integration of these individuals' specialised knowledge (Grant, 1996a:375). In order to adequately address the term organisational capability, learning and knowledge are discussed in the next section. Learning is critical in terms of accommodation, assimilation, and transformation, dependent on issues, context and conditions, and on individuals, organisations and nations in terms of new skill formations to be able to produce new knowledge (Merx-Chermin & Nijhof, 2005:135). The sequence of these terms is important to indicate which comes first, in particular with regard to innovation, in some cases where "unlearning" of existing knowledge needs to take place.

In order to better understand "organisational learning", as the origin of ACAP theory and ACAP being identified as a dynamic capability, organisational capability is discussed next, with a distinction made between learning and knowledge.

3.2.2.1 Organisational capability

Literature on organisational learning and knowledge has explored the role of organisations in the acquisition, processing, storage, and application of knowledge (Argyris & Schon, 1978; Godbole, Burke & Aylott, 2017:130; Levitt & March, 1988; Ochoa Jiménez, Cervantes Hurtado, Jacobo Hernández & Flores López, 2020; Raudeliūnienė, Davidavičienė & Jakubavičius, 2018; Starbuck, 1992), with the primary emphasis on the acquisition of information by organisations (Grant, 1996a:376; Nordin & Purwaningrum, 2018). Much research on management issues concerning the integration of different types of specialised knowledge has been within the context of new product development (Chang, Bai & Li, 2015; Clark & Fujimoto, 1991; Nonaka, 1990; Wheelwright, 1992). While some innovations result from reconfiguring existing knowledge to create "architectural innovations", others are the result of the application of new knowledge (Han, 2017; Henderson & Cockburn, 1994; Henderson & Clark, 1990; Yusr, Mokhtar, Othman & Sulaiman, 2017).

3.2.2.1.1 Learning

It is important to note the linkage between learning and action, as scholars have developed several models to account for how entrepreneurs learn (Cope, 2005; Corbett, 2005; Harrison & Leitch, 2005; Minniti & Bygrave, 2001; Rae & Carswell, 2001). Previous conceptualisations concentrated on learning and its asymmetries and its effect on entrepreneurial action (Corbett, 2005; Rae & Carswell, 2001); the accumulation of experiential knowledge by entrepreneurs (Cope, 2005; Politis, 2005); and the mechanisms that entrepreneurs employ to acquire, assimilate, organise, and use entrepreneurial knowledge (Young & Sexton, 1997).

Agreement exists that there is a distinction between individual and organisational learning. Although individual learning is important to organisations, organisational learning is not simply the sum of each employee's learning. Unlike individuals, organisations develop and maintain learning systems that not only influence their immediate members, but are transmitted to others by means of organisational history and norms (Lawrence & Dyer, 1983; Martin, 1980; Mitroff & Kilmann, 1976). However, as an organisation grows, a distinction between individual and organisational learning emerges and a system for capturing the learning of its individual members evolves (Kim, 1997:6).

Campbell and Armstrong (2013:241) argue that for the proponents of the cognitive perspective of organisational learning, the focus of "who" learns is firmly the individual. Individuals learn via cognitive processes and the learning is shared; it contributes to organisational learning. All learning therefore takes place inside the individual's head, whereby an organisation learns either by learning from individuals inside the organisation or by ingesting new members who have knowledge the organisation did not previously have. It is therefore believed that when looking at it from the cognitive perspective (Kim, 1997:1) individuals' "mental models" are crucial elements in the intermediary process of translating individual learning into organisational learning, Entrepreneurial learnings are defined by Holcomb, Ireland, Holmes Jr and Hitt (2009:172) as

> "the process by which people acquire new knowledge from direct experience and from observing the behaviours, actions, and consequences of others; assimilate new knowledge using heuristics to confront discrepancies that are common with information acquired in uncertain contexts; and organize assimilated knowledge by linking it with pre-existing structures".

One of the conditions for knowledge creation identified by Nonaka and Takeuchi (1995) is based on the principle of requisite variety, which suggests that the internal diversity of an organisation (in terms of its formation, operations, and mental models) should match the external variety of the environment for effective adaptation (Popadiuk & Choo, 2006:308). Mental models are interpreted as directing action (Huff, 1990); they provide the context in which to view and interpret new material and they determine how stored information is relevant to given situations (Kim, 1993a:37). Learning is said to take place when these mental models are created, validated or changed (Campbell & Armstrong, 2013:242). For organisational learning to be effective, it must be a dynamic process of sharing, negotiation and validation that challenges existing cognitions. It is also necessary to promote a duality of approaches to promote individual diversity and formulate shared consensus (Campbell & Armstrong, 2013:244). Campbell and Armstrong (2013:244) developed a model of organisational learning that takes account of how the concept is argued to influence an organisation's alignment with its external environment. The model is presented in Figure 3.1 and illustrates that as an organisation moves through time, individual mental models may be reinforced, or change. This is due to information that is received regarding the internal and external business environment, where some of these individual mental models may be translated directly into action. Other mental models will be made explicit, and then become shared through processes such as dialogue, negotiation and argument (Campbell & Armstrong, 2013:245).

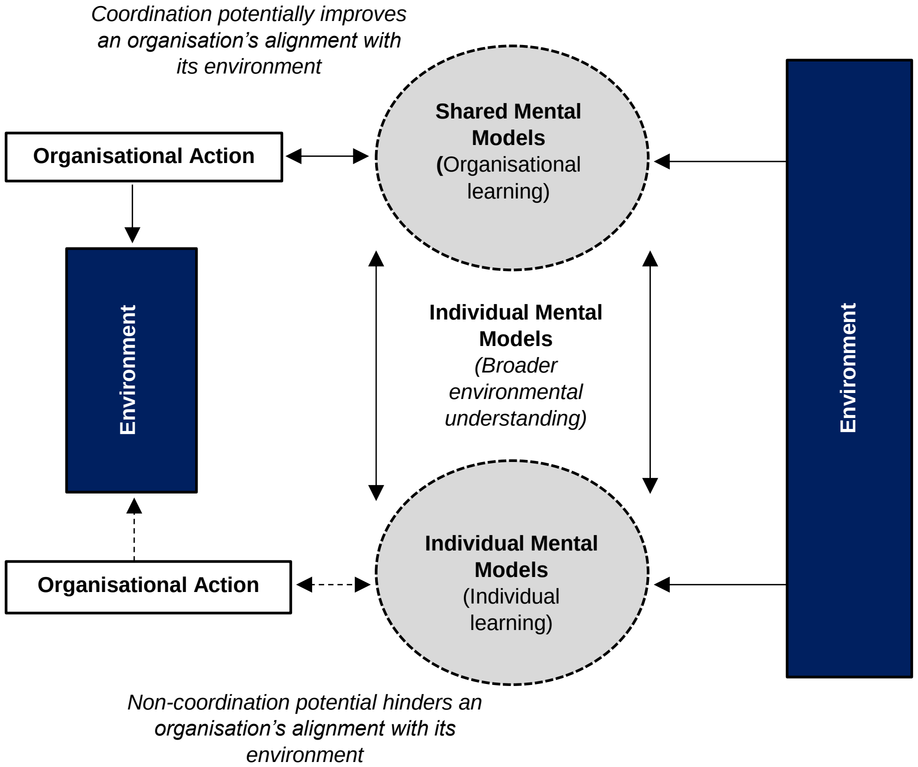


Figure 3.1: A model of the process of organisational learning and its utility for aligning an organisation with its environment

Source: Campbell and Armstrong (2013:244)

Information about a product or service is often the awareness of its existence; knowledge is usually required to use it effectively. Information is defined as the description of "what", which can exist in a document form that stands by itself.

Entrepreneurial action is seen as something all would engage in if they knew what to do, as only some people, such as entrepreneurs, "know" what to do. Entrepreneurs are thought to have taken action because they somehow escaped the ignorance and paralysis produced by uncertainty. Such action is known to induce learning that changes knowledge; learning occurs with each action even if the action is in part or wholly the same as taken previously (Holcomb *et al.*, 2009:173). According to Venkataraman (2019:123), the ability to execute the actions necessary to exploit these opportunities, cognitive limits and judgements that bias learning explains the failure of other people to "recognise" an opportunity, and possibly explains why some people that exploit opportunities fail to produce the expected return (Holcomb *et al.*, 2009:173).

3.2.2.2.2 Knowledge

Knowledge, on the other hand, is held only by people and contains instruction on "how" things are accomplished (Miller & Morris, 2008:75). To have knowledge is not just to know that something can be done, but more so, to know how to do it (Miller & Morris, 2008:77). Knowledge can be used in many ways to multiply output of physical assets, produce wealth, gain competitive advantage and/or enhance the value of other types of capital. Efforts to convert the know-how, know-why and the care-why, either embodied in individuals or embedded in organisations as processes or practices, involves knowledge and ideas from different areas such as sociology, psychology, philosophy, management, computer science and knowledge management (Battistutti & Bork, 2017:461). There is a big difference between the individual who is aware that airplanes fly and another who knows precisely how this is accomplished, and who can actually fly the plane. Having knowledge of the second is a superior capability precisely because it is much more than information. For an organisation with many individuals to sustain their competitiveness in changing environments, the fact of rapid change creates a continuing need for new knowledge. This knowledge always resides in individuals, and the aggregate of all the knowledge in the employees of an organisation is the critical attribute called "organisational capability". However, without applying digitized knowledge, problems cannot be solved in I4.0. Knowledge-intensive activities such as knowledge acquisition, representation, dissemination, utilization, and management play a vital role in problem-solving, particularly in engineering (Ullah, 2020:1). Possessing the ability to create, use and transfer knowledge inevitably allows the creation or improvement of new products or services (Battistutti & Bork, 2017:461).

The importance of the role of the organisation in knowledge creation is to develop the conditions that would enable knowledge creation at the individual, group, organisational, or inter-organisational level (Nonaka & Takeuchi, 1995). Knowledge is known as increasing an organisation's capacity for effective action and defined as "justified true belief". However, the quality of tacit knowledge, which is accumulated by the individual through direct "hands on" experience, is influenced by the "variety" of an individual's experience and "knowledge of experience" (Nonaka, 1994:15; Nordin &

Purwaningrum, 2018:20; Pfeiffer, 2016). Nordin and Purwaningrum (2018:19) and Li *et al.* (2018:160) found face-to-face meetings essential for tacit knowledge to be shared and acquired. People actually benefit from understanding their own knowledge needs and gain necessary knowledge through knowledge sharing activities, which is done primarily through meetings when it comes to pre-Industry 4.0 organisations. It is further suggested that knowledge sharing in organisations can be benefitted from I4.0 enabling technologies, introducing it as Organisation 4.0 (Li *et al.*, 2018:160). However, if the "variety" factor is limited to routine operations, the amount of tacit knowledge obtained from monotonous and repetitive tasks will tend to decrease over time. Routine tasks work against creative thinking and the formation of new knowledge. However, in order to raise the quality of tacit knowledge, increasing the variety of experience is not sufficient. The essence of "knowledge of experience" as a second factor is therefore an embodiment of knowledge through a deep personal commitment to bodily experience (Nonaka, 1994:21-22).

Ullah (2020:17) highlight the importance of digitalized knowledge as critical to the I4.0 ecosystem, defined as the knowledge ecosystem. In their research on defining knowledge in I4.0, they introduced a three-element-based definition of knowledge consisting of knowledge claim, knowledge provenance, and knowledge inference. These elements have been defined specifically in order to help distinguish between knowledge and data/information. Consequently, enabling the construction of knowledge graphs for human or machine learning (Ullah, 2020:20). Hall and Andriani (2003:145) define knowledge as including all the factors that have the potential to influence human thought and behaviour and includes factors such as intuition, skills, reputation, organisational culture and codified theory. All these factors can be placed on a spectrum of knowledge, as illustrated in Figure 3.2, which runs from tacit (uncodified) knowledge at one extreme to explicit (codified) knowledge at the other. According to Battistutti and Bork (2017:461) knowledge is undoubtedly a fluid mix of experience, values, contextual information, expertise and insight that provides a suitable environment and a structure for evaluating and incorporating new information and experiences.

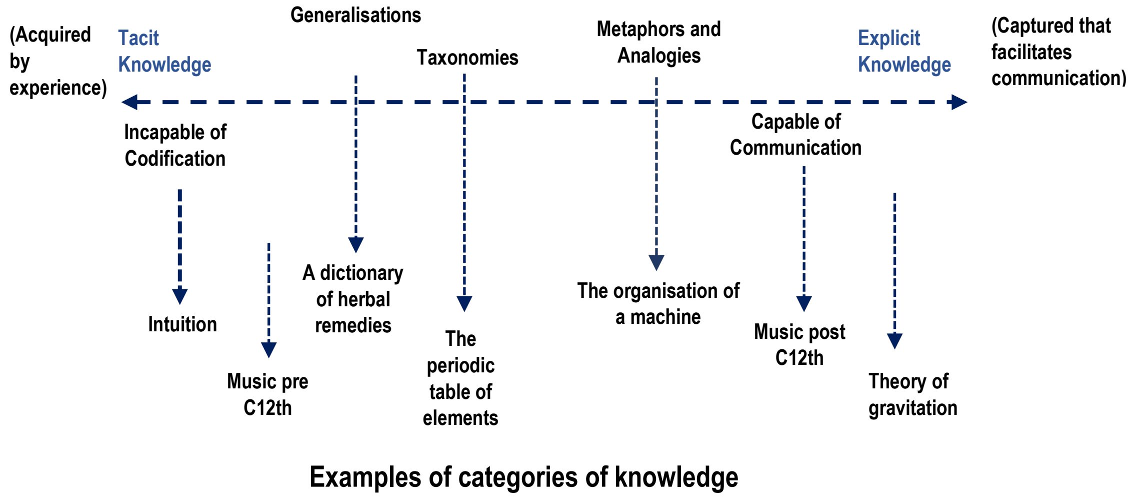


Figure 3.2: The knowledge spectrum

Source: Hall and Andriani (2003:146)

The concept of ACAP can be further examined and best developed through an examination of the cognitive structures that underlie learning (Cohen & Levinthal, 1990:129). As discussed in Chapter 2, knowledge is known to be captured by cognitive competence (Winterton *et al.*, 2006:41) and shown to evolve as the business develops (Chandler & Jansen, 1992:228). The routes of formation and recognition of KSC (knowledge, skills and competencies) was discussed in Chapter 2 and illustrated in Figure 2.7; the line between formal and non-formal learning is distinct. Studies in the area of behavioural and cognitive sciences at the individual level both justify the notion of ACAP, that the organisation needs prior related knowledge to assimilate and use new knowledge (Cohen & Levinthal, 1990).

With regard to innovation, acquiring the necessary knowledge can involve using knowledge in an additive fashion, where the process builds upon the existing pool of individual skills, organisational routines, and general knowledge. Alternatively, in a substitutive fashion, the knowledge has the potential to disrupt the existing "state of the art" and may require significant unlearning of existing knowledge, skills and routines, and leapfrogging to a new type of knowledge. Hall and Andriani (2003:149) illustrate in Figure 3.3 how the amount of new knowledge to be acquired and applied is linked to the nature of the new knowledge, which gives an indication of where the innovation will lead. Research findings show that the knowledge management capacity of firms, which is conceptualised as knowledge obtaining, knowledge sharing and knowledge implementation, contribute to organisational innovations (Fındıklı, Yozgat & Rofcanin, 2015:384). Findings further demonstrate that exploitation of accumulated knowledge leads to architectural innovation (Han, 2017:1). Organisational knowledge creation is however a continuous process with no ultimate end, and needs to be converged at some point in order to accelerate the sharing of created knowledge beyond the boundary of the organisation for further knowledge creation (Nonaka, 1994:26).

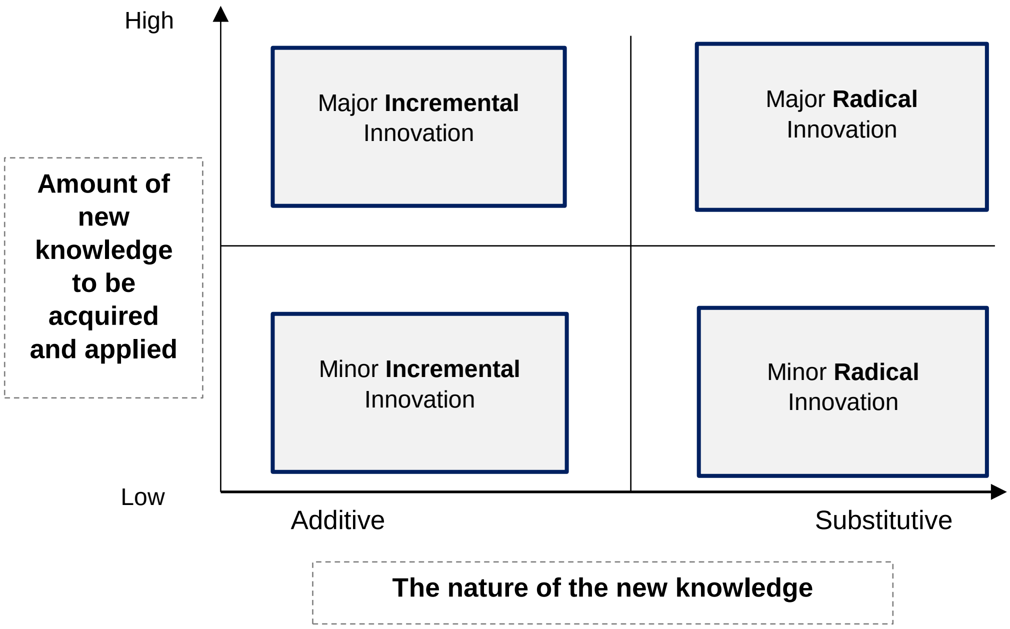


Figure 3.3: The "innovation plot"

Source: Hall and Andriani (2003:149)

Popadiuk and Choo (2006:309) introduced the role of knowledge and knowledge creation into the classification of types of innovation. Based on their analysis, two knowledge-based dimensions are especially applicable to innovation, which is the organisation's capabilities of knowledge creation; and its knowledge about the market. Graham, Logan, Harrison, Straus, Tetroe, Caswell and Robinson (2006) developed a conceptual framework, termed the knowledge-to-action cycle, providing an approach that builds on the commonalities found in a review of planned action theories. As illustrated in Figure 3.4, it concerns the creation and application (action cycle) of knowledge. The production of knowledge, or knowledge creation, is composed of three phases. The resulting knowledge after each stage in the knowledge creation process becomes more synthesised and potentially more useful to end-users. The seven action phases can occur simultaneously or sequentially, and the knowledge phases can influence the action phases at any point in the cycle, according to Straus, Tetroe and Graham (2009:181). Scholars have examined the impact of prior knowledge and learning processes on the accumulation of new knowledge, as well as how accumulated knowledge affects action (Holcomb *et al.*, 2009:168). Holcomb *et al.* (2009) seek to provide a more complete model of entrepreneurial learning that examines the influence of judgement on learning that exposes conditions that can benefit or limit effective action in an entrepreneurial setting. They argue that heuristics are consequential in explaining variations in learning.

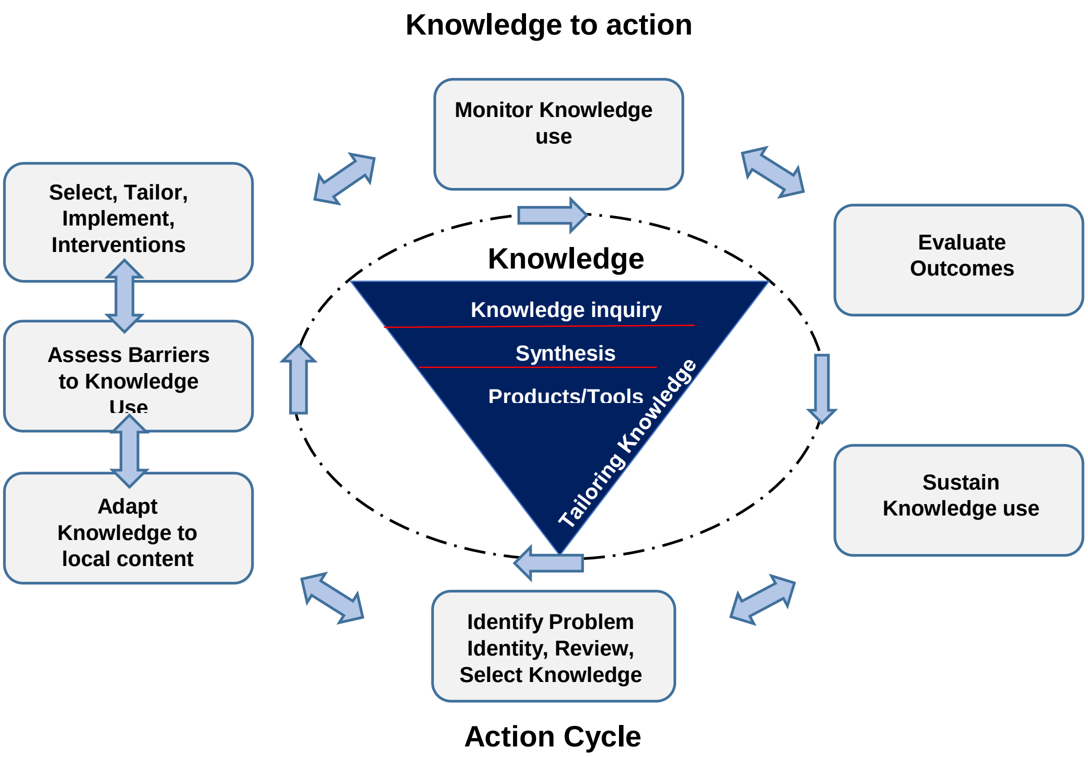


Figure 3.4: Knowledge-to-action framework

Source: Straus *et al.* (2009:167)

In order to better understand how knowledge from a person is transferred into action, some stance exists in knowledge in memory. Normal people seem to process and reprocess information, imposing on it and producing from it knowledge which has structure, of which the human memory system is a vast repository (Ortony &

Rumelhart, 2017:99). These authors raised a couple of questions in order to provide a characterisation of the way in which knowledge is structured.

- How is memory organised so as to usually permit relevant information to be accessed when required?
- How is old knowledge employed in the question of new?
- How does our current knowledge state modulate our actions?

According to their findings, higher-level ideas, such as ones which are more dominant in the logical structure, are better remembered than particular details (Ortony & Rumelhart, 2017:131). Opportunity recognition is thus conceptualised as the cognitive process of finding similarities between superficial features and structural relationships of a new stimulus (opportunity) with those of a relevant source (e.g., information previously stored in memory (Grégoire, Barr & Shepherd, 2010:416). Research findings further suggest that comparison of superficial features (e.g., characteristics of a new technology, size of a new market space, number of production processes involved, etc.) takes less cognitive effort compared with the comparison of structural relationships (e.g., potential impact of a new material on production process or on product function, the potential rate of growth of a new market, etc.), which involve higher-order relationships (Nambisan & Baron, 2013:1088). Uygur and Kim (2017:171) conceptualise entrepreneurial judgement as a cognitive process through which venture-specific knowledge of the entrepreneur is organised to guide resource allocation decisions.

Active memory is referred to as “the active structures that affect our thinking process and the actions we take” and comprises what we are, described as mental models (Senge, 1990). The roles of active memory and knowledge retention are equally important because they determine the individual and organisational outcomes of the learning process (Kim, 1993b). Individual mental models evolve as conceptual learning takes place and act as filters shaping our understanding of reality. One other aspect of active memory is the development of routines through operational learning (Winterton *et al.*, 2006:7). Qian and Acs (2013) introduced entrepreneurial absorptive capacity (EACAP) as a critical factor that affects the process of transmitting knowledge spillover by entrepreneurs. The knowledge spillover theory of entrepreneurship not only provides an explanation of why entrepreneurship has become more prevalent as the factor of knowledge has emerged as a crucial source for comparative advantage, but also why entrepreneurship plays a vital role in generating economic growth. Entrepreneurship is therefore an important mechanism permeating the knowledge filter to facilitate the spillover of knowledge, and ultimately generate economic growth (Audretsch, Keilbach & Lehmann, 2005:70). The knowledge spillover theory of entrepreneurship will be discussed in the following section.

3.2.2.2 The knowledge spillover theory of entrepreneurship

Knowledge spillover theory, originally developed by Marshal (1920) is an advancement of the microeconomic foundations of the endogenous growth theory by Romer (1990) (Acs *et al.*, 2009:15). Where contemporary theories of entrepreneurship generally focus on the recognition of opportunities and the decision to exploit them, which is generally treated as exogenous, the prevailing theory of economic growth suggests they are endogenous. Acs *et al.* (2009) further argue that knowledge created endogenously (originated internally) results in knowledge spillovers, which allow entrepreneurs to identify and exploit opportunities, hence, the emergence of the knowledge spillover theory of entrepreneurship. Thus, opportunities come from R&D activities that are "purposeful investment in new knowledge". As such, endogenous growth models fail to incorporate a crucial element in the process of economic growth, which is the transmission of knowledge spillovers through entrepreneurship. The empirical evidence supporting the knowledge spillover theory of entrepreneurship was provided by analysing variations in start-up rates across industries. This inevitably reflected different underlying knowledge contexts; in particular those industries with a greater investment in new knowledge exhibited higher start-up rates, which was interpreted as a conduit transmitting knowledge spillover (Audretsch, 1995; Caves, 1998). Audretsch *et al.* (2005:70) in particular suggest that entrepreneurship education plays a role since it facilitates the spillover of knowledge from universities and private firms, resulting in commercialisation of ideas that otherwise would remain uncommercialised, and ultimately resulting in greater innovation and economic growth. Based on a bibliographic analysis, the literature on knowledge-spillover entrepreneurship verifies that by independently commercialising the ideas that evolved from an incumbent organisation through the creation of new firms, the entrepreneur not only serves as a conduit for the spillovers of knowledge, but also resulting in innovative activity and enhanced economic performance (Ghio *et al.*, 2015:14).

Building on their previous research, Qian and Acs (2013:185) argue that the knowledge spillover theory of entrepreneurship does not adequately address the relationship between knowledge and entrepreneurship, and hence does not present a clear mechanism of knowledge-based entrepreneurial activity. Therefore, suggesting that knowledge spillover entrepreneurship depends not only on new knowledge, but more importantly on entrepreneurial absorptive capacity that allows entrepreneurs to understand new knowledge, recognise its market value, and commercialise it by creating a firm. As illustrated in Figure 3.5, the new absorptive capacity theory of knowledge spillover entrepreneurship provides insights into the relationships between new knowledge, knowledge embodied in people (i.e. human capital), and entrepreneurship (Qian & Acs, 2013:186). Human capital is highlighted in the first phase in creating new knowledge on the one hand and in building EACAP on the other hand. The second phase represents an entrepreneurial process in which the entrepreneur with appropriate ACAP brings knowledge into the market through starting a new business, therefore connecting human capital and entrepreneurship. The model also identifies two conduits through which human capital or knowledge embodied in people influences entrepreneurship. The first is by means of the creation of new knowledge that contains entrepreneurial opportunities, and the second is by means of building EACAP, which allows the entrepreneur to successfully commercialise new knowledge by starting a new business (Qian & Acs, 2013:193).

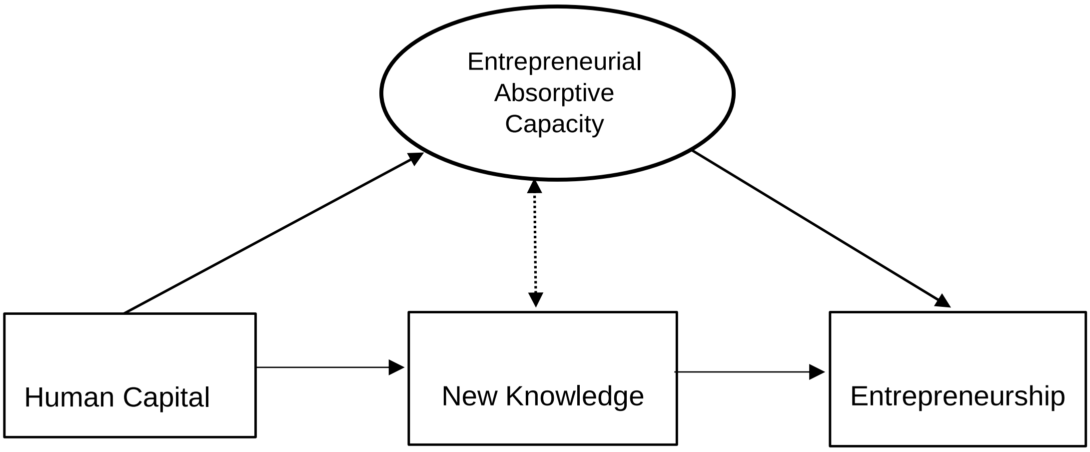


Figure 3.5: The new absorptive capacity theory of knowledge spillover entrepreneurship

Source: Adapted from Qian and Acs (2013:193)

The extent to which the market value of new knowledge is identified and exploited depends purely on the capability of the entrepreneur to recognise an opportunity and to utilise resources in order to bring new inventions into the market (Qian & Acs, 2013: 191). Having a particular capability in an organisation determines whether the people can perform a particular activity within an effective context. In today's highly competitive world, differences in capability separate leaders from followers, as capability is the basis on which work is accomplished (Miller & Morris, 2008:75). Begley and Boyd (1987:79) also noted that the ability to grow and launch a sustainable business demands that an entrepreneur develop certain skills and even more so, capabilities.

The next section discussed the conceptual model of absorptive capacity as a multidimensional construct, consisting of four capabilities (acquisition/recognition, assimilation, transformation, exploitation) and its underlying dimension,

3.3 CONCEPTUAL MODEL OF ABSORPTIVE CAPACITY

Cohen and Levinthal (1989:569-570) introduced ACAP as "the firm's ability to identify, assimilate and exploit knowledge from the environment". They later defined it in their widely cited paper (Cohen & Levinthal, 1990:128) as a firm's "ability to recognise the value of new information, assimilate it, and apply it to commercial ends." However, in the same paper Cohen and Levinthal (1990:128) refer to ACAP as, "the ability to evaluate and utilise outside knowledge". For the purpose of this study the lowest level to apply ACAP will be looked into at the individual's level, where the link between ACAP and learning is most evident (Van Den Bosch, Van Wijk & Volberda, 2003:6). Kayes, Kayes and Yamazaki (2005:582) indicate that the knowledge-absorption process in itself needs specific individual competencies such as gathering (listening and observing; generating (valuing different cultures and building relationships); applying (translating complex ideas and taking action); and organising (coping with ambiguity and managing others) (Kayes *et al.*, 2005:578-582).

Cohen and Levinthal (1990:128) identified three factors as being critical in developing and extending an organisation's capacity to learn and hence its ability to assimilate and apply new ideas. These factors are: 1) exposure to relevant knowledge, 2) presence of prior related knowledge, and, 3) diversity of experience. They argue that the development of ACAP, and in turn, innovative performance are history- or path-dependent and that lack of investment in an area of expertise early on may foreclose the future development of a technical capability in that area. They developed a model of organisational investment in research and development (R&D), in which R&D contributes to an organisation's ACAP. One is then able to test predictions relating to a firm's investment in R&D to the knowledge underlying technical change within an industry. Zahra and George (2002:283) identified four dimensions of ACAP, which include acquisition, assimilation, transformation and exploitation of external knowledge. The model of Todorova and Durisin (2007) has been refined and extended in Zahra and George's (2002) model. The four dimensions of ACAP are extended with a fifth dimension – recognition. Löwik (2013:196-197) took the model of Todorova and Durisin (2007), which is a refinement of the original model of Zahra and George (2002), and developed a refined conceptual model of ACAP, illustrated in Figure 3.6.

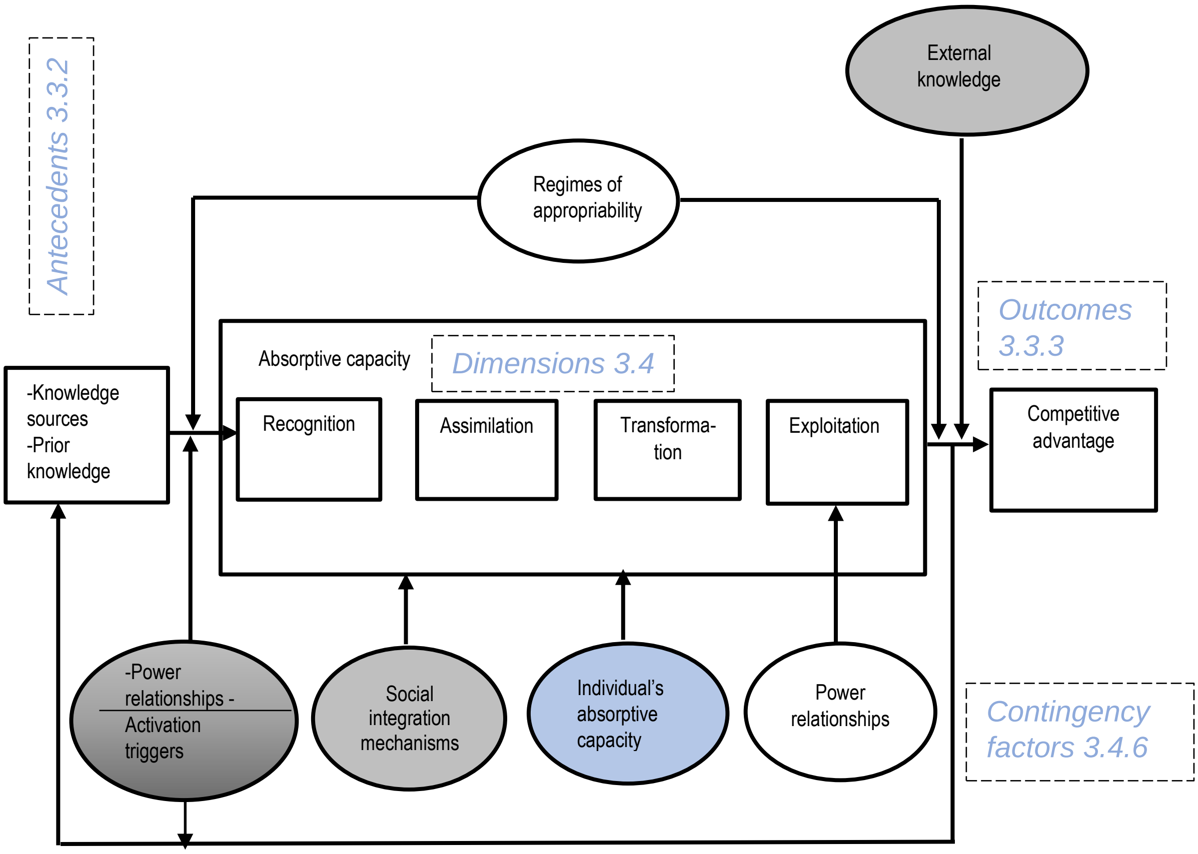


Figure 3.6: Refined conceptual model of ACAP

Source: Adapted from Löwik (2013:197)

The first dimension of ACAP illustrated in Figure 3.6 is *recognition*, which includes the search for new knowledge sources, implying that the extent to which an organisation has developed ACAP determines this search and its subsequent finding of external knowledge sources. After the search process, the new knowledge can be *acquired* as input for further processing (Löwik, 2013:197). Recognition includes the 'technical processes' of knowledge acquisition, but also denotes the more entrepreneurial ability to sense and identify new opportunities, which is a crucial ability for absorbing novel knowledge (Todorova & Durisin, 2007:783). Recognition is also an ability to identify new knowledge that is critical to the organisation's operations and to access, transfer and acquire externally generated knowledge (Löwik, 2013:17). The individual's recognition activities are concerned with searching for new knowledge, identifying it, and evaluating it as opportunities for potential beneficial use. These activities are related to the notion of "entrepreneurial alertness". It consists of scanning and searching, making associations and connections, and evaluating and judgement (Tang, Kacmar & Busenitz, 2012:80).

Therefore, an organisation first needs ACAP before knowledge from external sources can be acquired (Cohen & Levinthal, 1990; Todorova & Durisin, 2007). *Assimilation* is the ability to analyse, process, interpret and understand the information gathered from external sources and is related to sense-making. Research has shown that increasing an organisation's internal capability is a prerequisite for effectively assimilating and utilising this knowledge from the outside (Lund Vinding, 2006:514). Assimilation is used when new knowledge relates to existing knowledge in such a way that cognitive schemas do not need to be changed. The individually recognised and acquired knowledge is transformed into organisational knowledge by making it understandable and transferable. The individuals' activities that facilitate assimilation are: articulation, interpretation and codification (Huber, 1991:702; Zollo, Reuer & Singh, 2002). When new knowledge does not fit into existing cognitive frames, the process of transformation is needed to absorb the new knowledge. *Transformation* is the ability to develop and refine routines that facilitate the combining of new and existing knowledge (Zahra & George, 2002:190).

The last capability, *exploitation* in Figure 3.6., is the ability to refine, extend and leverage existing competencies to create new ones by incorporating acquired and transformed knowledge into its operations (Zahra & George, 2002:190). Exploration activities further represent organisational efforts to experiment and innovate, while exploitation includes activities such as refinement, selection and implementation (Welsch, Liao & Stoica, 2001:12). The contingency factors of ACAP are illustrated by activation triggers, social integration mechanisms and power relationships (Löwik, 2013).

3.3.1 Entrepreneurial absorptive capacity

Individuals are the primary locus of knowledge creation and learning, their prior knowledge of which determines the extent to which they are able to recognise and identify the value of new knowledge (Cohen & Levinthal, 1990; Grant, 1996c). The more diverse an individual's knowledge base, the easier it is to associate the newly encountered knowledge with what is already known (Cohen & Levinthal, 1990). The authors further note that an individual's problem-solving and learning capabilities determine the creativity with which new knowledge is created. Therefore, individuals act as knowledge-processing entities who create and store knowledge, and whose characteristics determine the foundations on which organisational ACAP is built. Cohen and Levinthal (1990:131-132) state that an organisation's ACAP is not simply the sum of the absorptive capacities of its employees, but also depends on transfers of knowledge across and within subunits that may be quite removed from the original point of entry. This knowledge transfer is referred to as the exchange of knowledge by individuals that act at the interface of the organisation and its environment as so-called gatekeepers (Tushman, 1977). Ter Wal *et al.* (2017:1050) portray gatekeepers as individuals who combine high levels of external search breadth with active involvement in assimilation. Schweisfurth and Raasch (2018:687) note that knowledge is often located outside the firm and needs to be absorbed in order for innovation to occur. This brings us to the second function of individuals regarding organisational ACAP identified by Löwik (2013:105), which relates to the knowledge exchange processes needed to exploit the new knowledge. In existing ACAP literature, an individual's ACAP is conceptualised and operationalised as a set of competences consisting of the individual's prior knowledge and experience (Hayton & Zahra, 2005:256; Jane Zhao & Anand, 2009:967), values and beliefs, technical skills (Matusik & Heeley, 2005:558) and motivation (Minbaeva *et al.*, 2003:586). In more recent years, scholars have examined the link between a firm's ACAP and a number of individual-level behaviours or characteristics, including leadership (Flatten, Adams & Brettel, 2015), social interaction (Tortoriello, 2015), organisational citizenship behaviour (Hart, Gilstrap & Bolino, 2016) and individual learning orientation and behaviour (Yao & Chang, 2017).

Based on a review of the literature on problem-solving processes and learning at the individual level, Cohen and Levinthal (1990:130) suggest that both these processes develop similarly. An observation was made that "the prior possession of relevant knowledge and skills is what gives rise to creativity", and that these processes require time and intensity of effort. They also noted that at the individual level the diversity or breadth of knowledge domains is important in learning and the absorption of new related knowledge. This connection points out that "knowledge diversity also facilitates the innovation process by enabling the individual to make novel associations and linkages" (Cohen & Levinthal, 1990:131).

As discussed earlier, Cohen and Levinthal's (1990) theory on ACAP focuses on the ability of the organisation. Therefore, the ideal unit with which to study EACAP is the individual (Qian & Acs, 2013:191), which is consistent with the knowledge spillover theory of entrepreneurship (Audretsch *et al.*, 2005). It is important to note that EACAP not only involves the ability to absorb external knowledge but also the ability to start a new business to exploit the knowledge. It does not necessarily involve the action of creating a new business but rather the individual's ability to do so (Qian & Acs, 2013:191). Cohen and Levinthal (1990) focus primarily on the ACAP of incumbent firms.

EACAP has two dimensions, which vary among people who are potential entrepreneurs. On the one hand it involves the scientific knowledge the individual should have in order to understand what an invention really is and further to recognise its market value. On the other hand, it relies on the business or market knowledge with which the individual can successfully create and operate a new business (Qian & Acs, 2013:192). Both scientific and market knowledge are indispensable for knowledge spillover entrepreneurship, as discussed by Acs *et al.* (2009:100) and Audretsch (1995:117). The inventor who develops a new technology already has the scientific knowledge, and thus her/his success in commercialising the new technology depends greatly on the market knowledge the entrepreneur has of how to start up and operate a business. The antecedents and outcomes of Individual ACAP are illustrated as follows in Figure 3.7 and explained in section 3.3.2.

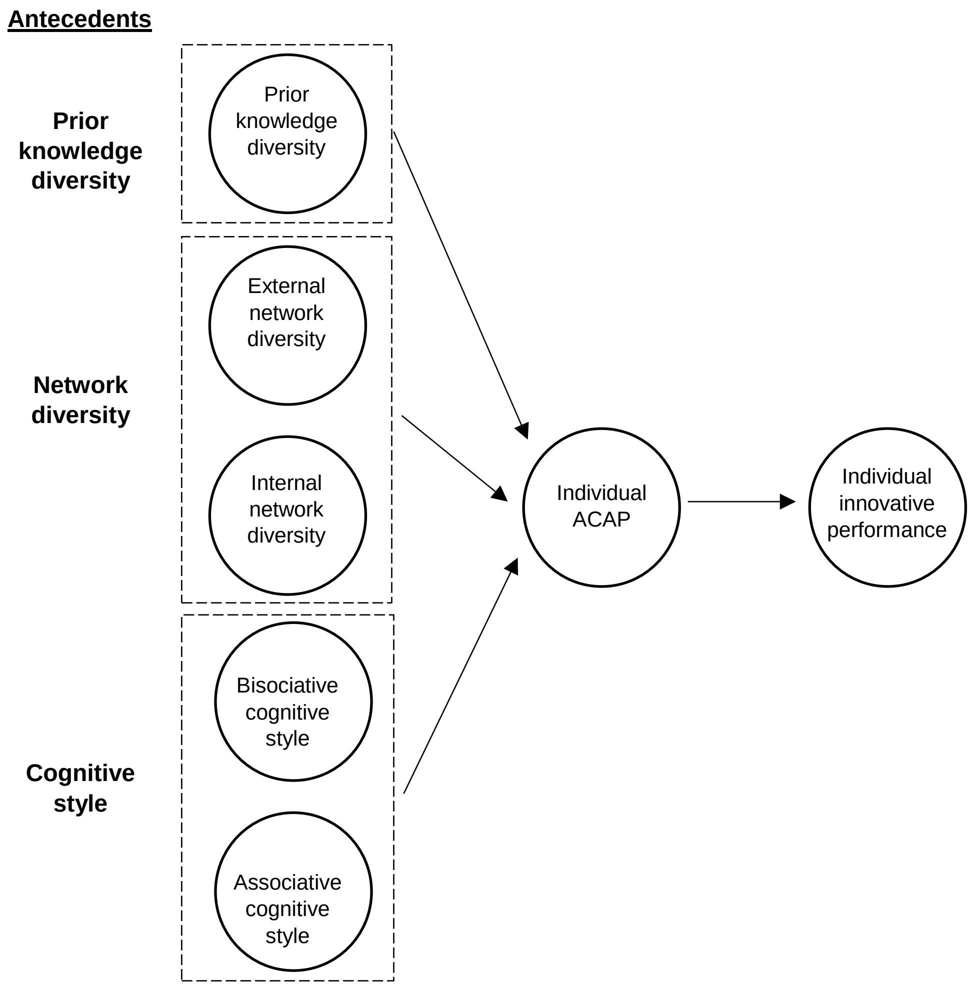


Figure 3.7: Antecedents and outcomes of individual ACAP

Source: Adapted from (Löwik, 2013:113)

3.3.2 Antecedents of ACAP

To address the multi-level nature of ACAP, there has been a growing body of research calling for an improved understanding of the micro-foundations underlying ACAP (Tian & Soo, 2018; Tutida, Possamai, Barcelos & Rossetto, 2020; Yildiz, Murtic, Klofsten, Zander & Richtnér, 2020) with most of the work focusing on capabilities and routines in general (Tutida *et al.*, 2020:10). Whilst the antecedents of ACAP vary, extant literature highlights three antecedents that are important, which can be related to individual ACAP: prior knowledge diversity, network diversity and cognitive style (Cohen & Levinthal, 1990; Hayton & Zahra, 2005; Jane Zhao & Anand, 2009; Lane *et al.*, 2006; Löwik, Kraaijenbrink & Groen, 2017; Ojo, Raman & Chong, 2017); Sopegina *et al.* (2016:7836); (Todorova & Durisin, 2007; Zahra & George, 2002). In an integrative framework of the ACAP learning process, Rezaei-Zadeh and Darwish (2016:7) categorise the antecedents of the ACAP learning process as; exploratory learning, transformative learning and exploitative learning. In examining goal-orientation as an antecedent (learning-orientation, prove-orientation, avoid-orientation) affecting individual-level ACAP, analysis shows that individuals' learning and prove orientation are important predictors of their ACAP, and that aggregate ACAP leads to positive innovation outcomes (Yildiz *et al.*, 2020:4). Tian and Soo (2018:22) demonstrate that the tested antecedents; intrinsic motivation and perceived organisational commitment to learning influence their willingness to engage in potential ACAP. In addition, their results also confirm that high levels of realised ACAP enables employees to better leverage their knowledge in the form of increased creativity. However, some of the antecedents of ACAP may arguably have greater impact on developing its components (Rezaei-Zadeh & Darwish, 2016:2).

In this section the antecedents are discussed in relation to individuals' ACAP and its outcomes as illustrated in Figure 3.7.

a) Prior knowledge diversity (IACAP)

ACAP is seen as a powerful multilevel and transdisciplinary construct in both theory building and empirical research. Key antecedents distinguished as influencing ACAP are prior related knowledge, which includes basic skills and learning experience, and organisational factors, such as the structure of communication and distribution of knowledge. This construct is in principle able to bridge various literatures, such as the knowledge-based view and organisational learning (Van Den Bosch *et al.*, 2003:2). Cohen and Levinthal (1989:569) introduced the term of a firm's "learning" or "absorptive capacity" and proposed to consider prior related knowledge as a key antecedent. From an individual's level, Cohen and Levinthal (1990) refer to memory development, in which accumulated prior knowledge enables the ability to store new knowledge into one's memory and to recall and use it. Prior knowledge diversity encompasses the individual's existing knowledge base, based on education, work and life experience. This dynamic process gives rise to the theory that prior related knowledge facilitates the learning or absorption of new related knowledge (Van Den Bosch *et al.*, 2003:6). The ACAP processes of recognition, assimilation, transformation and exploitation of new knowledge all include learning and knowledge transfer to some extent. Prior knowledge diversity also affects recognition in the process, as it influences the locus of search, in that people tend to search in areas that they already know (Shane, 2000:448; Zahra & George, 2002). Acquisition can also occur as a result in R&D or through prior knowledge (Noblet *et al.*, 2015:369). In contrast, Schweisfurth and Raasch (2018:668) found prior need knowledge to be negatively associated with solution ACAP.

Löwik (2013:25) and Löwik *et al.* (2017:1) specifically looked into the antecedents, dimensions and outcomes of individual ACAP and determined the effects of three antecedents – prior knowledge, network diversity and cognitive style, on an individual's ACAP, explaining the differences in individual ACAP. The results indicated that an individual's bisociative cognitive style is more important than an individual's prior knowledge, and that external network diversity is also a relevant antecedent for individual ACAP (Löwik, *et al.,* 2017:1). Prior knowledge diversity is operationalised by Diamantopoulos and Winklhofer (2001:270) as a formative construct, consisting of prior knowledge diversity, education and age. However, beyond diverse knowledge structures, the sort of knowledge that individuals should possess to enhance organisational ACAP is also important. This sort of knowledge can be knowledge of who knows what, who can help with what problem, or who can exploit new information (Cohen & Levinthal, 1990). However, while prior knowledge improves learning effectiveness, reliance on experiential learning alone can be problematic. Knowledge accumulated this way is less diverse than knowledge accumulated from less familiar domains (Lant, Milliken & Batra, 1992:602; Priem, 1994:421). Therefore optimal learning occurs when experience is diverse, although still related to permitting effective assimilation of new knowledge (Schilling, Vidal, Ployhart & Marangoni, 2003:45).

Experience

Consistent with information-processing approaches, knowledge absorption is a process of learning from experience (Cohen & Levinthal, 1990). In entrepreneurs, experiential learning occurs when entrepreneurs learn from experience and accumulate newly formed knowledge in memory (Kolb, 1984). It consists of two elements: prior knowledge and the processes people employ to acquire, assimilate and organise new knowledge. Learning is a process in which knowledge is created by transforming experiences and is closely related to practical experiences (Miller & Morris, 2008). Learning is also viewed by proponents as the transformation of experiences into knowledge, in that learning processes continuously create and re-create new knowledge and linkages between knowledge structures (Holcomb *et al.*, 2009:174). Holcomb *et al.* (2009) further state that experiential learning creates path dependencies in which prior experience within a particular domain channels entrepreneurs' attention to that domain, making it more efficient to acquire and assess diagnostic cues, as well as identifying opportunities within familiar areas.

Cohen and Levinthal (1990) rightfully acknowledge that the ability to learn from experience, and therefore the ability to increase organisational knowledge absorption capacity, rests on individual skills. ACAP also entails individual and team capabilities, which depend on prior experience. The creation of shared understanding is therefore essential for the transition of an individual's knowledge assimilation capability into team's knowledge utilisation capability (Ojo *et al.*, 2017:990). Based on the experiential learning theory by Kolb (1984), learning is described as the process of transforming experience into new knowledge. Learning is seen as a fourfold process that starts with experience. The uniqueness of experiential learning lies in the idea that individuals must develop specialised abilities to manage each of the four aspects of learning (Kayes *et al.*, 2005:580). For example, managing concrete experience requires interpersonal abilities, managing abstract conceptualisation requires cognitive abilities, managing reflective observation requires perceptual abilities and active experimentation requires behavioural abilities. As illustrated in Figure 3.8, experience serves as the basis for reflective observation, which in turn leads to abstract conceptualisation, which then serves as the basis for active experimentation. Active experimentation then leads to another experience, and the process of learning starts again (Kayes *et al.*, 2005:580). As mentioned earlier, tacit knowledge is also acquired by experience and is caused by causal ambiguity (Hall & Andriani, 2003:145), which allows the prediction of previously experienced phenomena (Hall & Andriani, 2003:146; Nordin & Purwaningrum, 2018:1).

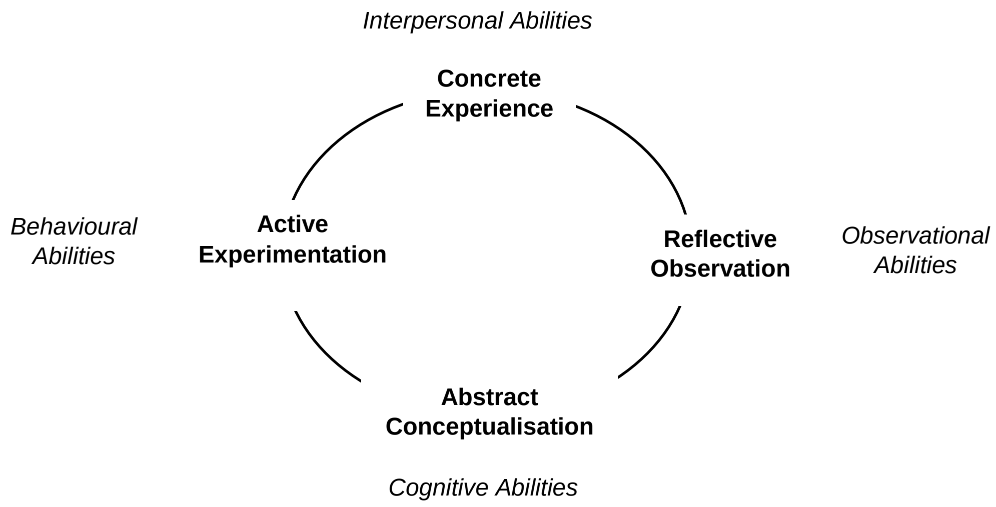


Figure 3.8: Experiential learning cycle

Source: Kayes *et al.* (2005:580)

b) Network Diversity

According to Ahuja (2000:425), the larger and more diverse an individual's network, the more likely it is that the person will get in contact with new knowledge. An individual's external and internal networks are also distinguished, as both affect individuals' performance differently (Cross & Cummings, 2004:929). Individuals with high external network diversity are more likely to be exposed to various sources with potential new knowledge, which has a positive effect on the search and identification of new knowledge (Cohen & Levinthal, 1990:587; Tushman, 1977). Thus, the more external contacts and the more diverse they are, the more recognition capabilities and individual ACAP are increased (Todorova & Durisin, 2007). Datta (2012:2) show in their theoretical model that networks are indeed antecedents of ACAP and ambidexterity (ability to explore and exploit) and that ACAP is needed to explore and exploit knowledge. It is empirically proven that knowledge embedded in network ties help firms to promote their innovative activities. As such, the ACAP of SMEs are found to be a key driver that assimilates, transforms, acquires and exploits knowledge that passes through the network ties into commercial ends (Jayathilake, 2018:229). Findings by Najafi-Tavani, Najafi-Tavani, Naudé, Oghazi and Zeynaloo (2018:193) suggest that the collaboration with different partners can enhance a firms' innovation capabilities only if the managers have developed the capacity to scan and acquire external knowledge. The use of social networking sites have also proven to provide a wealth of information about individuals and their networks and how it can be utilised (Scuotto *et al.*, 2017a:409; Scuotto, Del Giudice & Obi Omeihe, 2017b:280). The authors Scuotto *et al.,* (2017:419) point out the relevance of the digital eco-system, focused on the role of social networking sites in relationship to innovation and knowledge. Results confirm that social networking sites have a positive role in affecting both absorptive capacity and innovation performance of SMEs.

c) Cognitive Style

Cognition refers to the way individuals tend to process information and make decisions (Fiske & Taylor, 2013; Saad, Kumar & Bradford, 2017). An individual's cognitive structures are considered to be important antecedents of ACAP (Cohen & Levinthal, 1990; Ojo *et al.*, 2017; Todorova & Durisin, 2007). An individual's cognitive style therefore determines what knowledge is identified and acquired, how it is assimilated and how it is transformed (Hayes & Allinson, 1994:53). Ojo *et al.* (2017:1000) demonstrate that cognitive motivation (i.e. need for cognition) accounts for some of the variation in knowledge recognition and assimilation capabilities of employees. Contributing to emerging scholarly thinking on the domain-specific and micro-foundations of absorptive capacity. In light of individuals using cognitive schema to identify solutions to a given need, Schweisfurth and Raasch (2018:687,696) found that individuals with more need knowledge (more unstructured, more uncertain, more latent and stickier than solution knowledge) tend to be less able to bring external solutions into a firm than those with little need knowledge, which are both crucial for innovation. They argue that this effect is rooted in the fact that need knowledge does not provide cognitive structures for the absorption of solution knowledge, but only for the absorption of need knowledge. Cognitive science on individual learning recognises that the development of new cognitive structures follows two alternative processes: assimilation and transformation (Marshall, 1995; Piaget & Cook, 1952). Both these learning processes involve some degree of change of the new knowledge and its combination with existing knowledge (Piaget & Cook, 1952). However, acquisition is also affected by internal factors such as the low level of resources and the lack of formal cognitive and organisational structures (Burcharth, Lettl & Ulhøi, 2015:269). The two main cognitive styles identified can be distinguished as bisociative and associative. *Bisociation* is a decision-making style whereby individuals use imagination and intuition to seek solutions outside disciplinary boundaries in order to discover connections that are not readily apparent (Payne, Lane & Jabri, 1990:47). *Association*, on the other hand, is a decision-making style where an individual relies on rational thinking and articulate expression of ideas. Such thinkers usually pay attention to certain aspects of a problem for which conventional solutions are at hand, and they try to adhere to existing rules and methodologies within disciplinary boundaries (Payne *et al.*, 1990:47). The development of routines in which the new knowledge becomes embedded takes places during exploitation and becomes an important element, as this distinguishes exploitation from one-time application (Zahra & George, 2002).

The process by which people acquire, assimilate, and organise newly formed knowledge with pre-existing structures is known as entrepreneurial learning (Holcomb *et al.*, 2009:168). Anderson (1982) accounts for learning as the process by which people acquire new knowledge, including skills and specific competencies, from experience or by observing others, assimilate and organise them with prior knowledge in memory to make them retrievable for use in action. People must therefore assimilate and organise newly formed knowledge for learning to yield an advantage (Anderson, 1982; Baddeley, Hitch & Bower, 1977; Kolb, 2014). The development of these four dimensions of ACAP and its success is significantly dependent on a combination of resources, procedures, processes, cognitive structures, leadership and organisational routines that may be lacking in SMEs (Saad *et al*., 2017:10). In order to explain this knowledge absorption process, as Kayes *et al.* (2005:582) call it, the four interrelated routines of ACAP as illustrated in Figure 3.6 (Eisenhardt & Martin, 2000:1105; Zahra & George, 2002:189), and flow of knowledge absorption (Zahra & George, 2002:190) are discussed in the next section to better explain where the link between ACAP and learning is most evident in entrepreneurs.

This section discussed ACAP as a whole, which gave an overview of the antecedents of ACAP (prior knowledge diversity, networking and cognitive style). The next section specifically focuses on the ACAP process, which includes recognition/acquisition, assimilation, transformation and exploitation, which this study aims to measure.

3.3.3 The absorptive capacity process and dimensions

The conceptualisation of individuals' ACAP is based on the notion that organisational ACAP is a dynamic capability (Löwik, 2013:106) that sustains the competitive advantage of a company (Noblet *et al.,* 2015:368). It mainly consists of four routines/dimensions: to recognise, assimilate, transform, and exploit new external knowledge (Eisenhardt & Martin, 2000:1105; Zahra & George, 2002:189). From an individual ACAP perspective, these routines are inter-related and distinguished by the flow of knowledge from recognition to exploitation (Zahra & George, 2002:190), thereby including knowledge exchange processes (Löwik, 2013:106). This conceptualisation of individual ACAP is viewed as a component of organisational ACAP routines (Löwik *et al.*, 2017; Löwik, 2013:106).

3.3.3.1 Recognition / Acquisition

Acquisition refers to an organisation's capability to identify and acquire externally generated knowledge that is vital for the operation of the enterprise (Zhai *et al.*, 2018:4) and the recognition of value (Jiménez-Barrionuevo, Molina & García-Morales, 2019:3). Studies in the areas of behavioural and cognitive sciences at the individual level are both justified in the fact that an organisation needs prior-related knowledge to assimilate and use new knowledge in the notion of ACAP (Cohen & Levinthal, 1990:129). With their research on memory development, Bower and Hilgard (1981:424) suggest that accumulated prior knowledge increases both the ability to put new knowledge into memory, what we would refer to as the acquisition of knowledge, and the ability to recall and use it. With regard to the acquisition of knowledge, Bower and Hilgard (1981:424) suggest that memory development is self-reinforcing. Therefore, the more objects, patterns and concepts stored in memory, the more readily is new information about these constructs acquired and the more facile is the individual in using them in new settings. Zahra and George (2002) identified three attributes that can influence ACAP: intensity, speed, and direction. The quality of a firm's acquisition capabilities can therefore be determined by the intensity and speed of a firm's efforts to identify and gather knowledge. However, acquisition as a first component might fail to motivate these efforts by not being able to see or understand the potential of the new external knowledge, and might be overlooked, so direction is also vital.

Drawing on the resulting understanding of the process of knowledge absorption and a more extensive investigation on innovation and learning from Zahra and George (2002), Todorova and Durisin (2007:777) conceptualise that firms recognise the value of new external knowledge, as originally introduced by Cohen and Levinthal (1990). Cognitive structures of individuals and organisations provide evidence that, without prior knowledge, organisations are not able to evaluate new information and therefore fail to absorb it (Todorova & Durisin, 2007:777). From an individual's viewpoint (ACAP), recognition is concerned with the individual's recognition activities, such as searching for new knowledge, identifying it, and evaluating it as opportunities for potential beneficial use (Löwik, 2013:106). The notion of "entrepreneurial alertness" therefore connects these activities of recognition, which consists of scanning and searching, making associations and connections, and evaluating and judgement (Tang *et al.*, 2012:78). The ability to learn, that is, to absorb external knowledge, therefore depends greatly on the ability to value the new external knowledge. The individual recognition process ultimately ends when one evaluates the new idea as potentially valuable, and decides to further develop it within the organisation (Löwik, 2013:107).

3.3.3.2 Assimilation

According to Cohen and Levinthal (1990:135-136), the role of ACAP in assimilating and exploiting knowledge suggests a generalisation that applies to both the individual and the organisation. Knowledge assimilation is the ability of the enterprise to analyse and understand the external knowledge and integrate the new knowledge with existing knowledge (Zhai *et al.* 2018:4). Prior knowledge permits the assimilation and exploitation of new knowledge; a portion of the prior knowledge should be closely related to the new knowledge to facilitate assimilation, while a fraction of that knowledge must be diverse to permit effective, creative utilisation of the new knowledge. This notion has important implications for the development of ACAP over time and, in turn, the innovative performance of organisations (Cohen & Levinthal, 1990:136). Assimilation is conceptualised as a firm's routines and processes that allow it to analyse, process, interpret, and understand the information obtained from external sources (Kim, 1997; Zahra & George, 2002:189). Comprehension therefore promotes knowledge assimilation that allows organisations to process and internalise externally generated knowledge (Zahra & George, 2002:190). Assimilation activities, which include interpretation, articulation, and codification, are concerned with the individual acquiring knowledge which is transformed into organisational knowledge by making it understandable and transferable to organisation members (Löwik, 2013:107). It is also concerned with knowledge that an organisation can interpret and comprehend within existing cognitive structures. This is because it is within the organisation's search zone and compatible within the existing context, and it involves complementary assets close to its prior knowledge (Todorova & Durisin, 2007:778).

3.3.3.3 Transformation

Transformation relates to an organisation's capability to develop and refine the routines that facilitate the combining of existing knowledge and newly acquired and assimilated knowledge. This can be accomplished by deleting or adding knowledge or by interpreting the same knowledge in a different manner (Zahra & George, 2002:190). The ability of an organisation to recognise two apparently incongruous sets of information and combine them in order to arrive at a new schema illustrates a transformation capability and shapes the entrepreneurial mindset (McGrath, Mac Grath & MacMillan, 2000:1) and fosters entrepreneurial action (Smith & Gregorio, 2017:127). Transformation therefore builds new cognitive structures to cope with path dependence, indicating that it may be the transformation capability that allows an organisation to survive a competence-destroying change (Tushman & Anderson, 1986:439). Organisational members need to engage in "frame-braking" activities in order to enable alterations of organisational cognitive frames. Thus, for new organisational schemas and frames to be created, which results in new organisational capabilities, knowledge and ideas from multiple individuals need to be combined and integrated (Grant, 1996b:375; Kogut & Zander, 1992:383). The social skills required to develop ideas into feasible solutions include networking and effective communication (Ford, 1996:1112; Kanter, 1988:93). According to Löwik (2013:108), transformation as an individual ACAP activity concerns the generation of new ideas in collaboration with others.

3.3.3.4 *Exploitation*

Building on insights from Cohen and Levinthal (1990) definition of ACAP that emphasises the application of knowledge, Zahra and George (2002) incorporate exploitation as a dimension of ACAP. Knowledge application is the ability of an enterprise to commercialise new knowledge to achieve the goal of the organisation (Zhai, *et al.,* 2018:4). From an organisational capability perspective, exploitation is based on the routines that allow organisations to refine, extend, and leverage existing competencies to create new ones by incorporating acquired and transformed knowledge into its operations. The presence of routines that allow organisations to exploit knowledge provides structural, systematic, and procedural mechanisms that allow organisations to sustain the exploitation of knowledge over extended periods of time (Zahra & George, 2002:190). Exploitation on an individual level concerns the activities to internalise the knowledge in one's own work routines (Nonaka, 1994:15). Internalisation occurs through on-the-job training, learning by doing, and learning by observation (Sabherwal & Becerra-Fernandez, 2005:301). Löwik (2013:108) defines exploitation at the individual level as one's activities to apply new knowledge to one's own work routines.

3.3.3.5 *Potential and realised ACAP*

Based on these four dimensions of ACAP, they can be classified into two dimensions as illustrated in Figure 3.9: realised ACAP and potential ACAP. While the two capacities perform complimentary roles, potential ACAP represents the exploration of external knowledge and realised ACAP correspond to its exploitation (Jiménez-Barrionuevo *et al*., 2019:3). Potential ACAP captures Cohen and Levinthal (1990) description of an organisation's capability to value and acquire external knowledge, but it does not guarantee the exploitation of this knowledge. Potential ACAP is described as including the capacities to recognise value and the assimilation of knowledge that enables an organisation to be repetitive to external knowledge (Jiménez-Barrionuevo *et al*., 2019:3). Realised ACAP serves as a function of the transformation and exploitation capabilities and reflects the organisation's capacity to leverage the knowledge that has been absorbed (Cohen & Levinthal, 1990:190). Realised ACAP also enables an organisation to give commercial utility to the new knowledge acquired (Jiménez-Barrionuevo *et al.*, 2019:3). RACAP involves the transformation and exploitation of the assimilated knowledge by incorporating it into the organisation's operations, and therefore improving its performance. However, PACAP does not necessarily imply enhanced performance, since organisations can acquire and assimilate knowledge but might not have the capability to transform and exploit the knowledge for profit generation (Zahra & George, 2002:190-191).

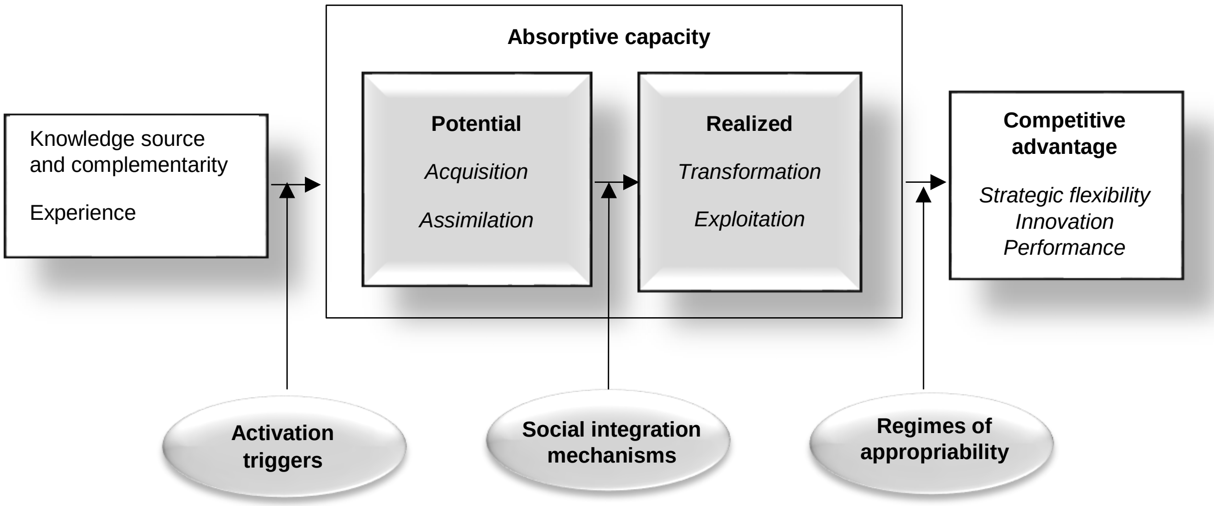


Figure 3.9: A model of ACAP: from external knowledge to competitive advantage
Source: Zahra and George (2002:192)

As illustrated in Figure 3.6, the refined conceptual model of Löwik (2013) and that of Zahra and George (2002) illustrated in Figure 3.9, includes contingency factors (activation triggers, social integration mechanisms and power relationships) that will be discussed next. These contingency factors determined a need for ACAP and the speed of ACAP development.

3.3.3.6 Contingency factors

a) Power relationships

Power relationships are used in the model of Zahra and George (2002:191-192) as antecedent, whereas Todorova and Durisin (2007:782) argue that intra-organisational power relations determine the resources that are allocated to exploit new knowledge.

Todorova and Durisin (2007) incorporated power relationships as a contingency factor and argue that this extension enhances the understanding of the functioning of ACAP. Drawing on research on innovation and learning, they added to the model the concept of power relationships, which interact with cognitive processes, learning, and capabilities learning, and capabilities in the organisation (Cohen, Burkhart, Dosi, Egidi, Marengo, Warglien & Winter, 1996:695; Contu & Willmott, 2003:284; Dosi, Levinthal & Marengo, 2003:413). Power relationships are defined as those relationships that involve the use of power and other resources by an actor to obtain his or her preferred outcomes (Pfeffer, 1981). For example, Dougherty and Hardy (1996:1120) revealed that the inability to connect new products with organisational resources, resulting from rigidity of power structures, leads to problems with innovation. Another example is the relationship of the organisation with its customers, which influences the absorption of new knowledge (Danneels, 2003:559; Hill & Rothaermel, 2003:261; Slater & Narver, 1998:1001).

b) *Social integration mechanisms*

The social integration mechanisms are needed to promote the sharing of knowledge across the organisation; the extent to which this is achieved determines the efficiency of ACAP (Zahra & George, 2002:194). Todorova and Durisin (2007:775) argue that social integration mechanisms affect all four dimensions of ACAP. Löwik (2013) extended the findings of Jansen *et al.*, (2005) in three ways. First, it shows that socialisation mechanisms complement individuals' ACAP in building organisational ACAP. Second, it identifies two different functions of social integration mechanisms, which are enabling and motivating knowledge exchange. Third, the study shows equifinality in combinations of social integration mechanisms with individuals' ACAP, indicating that there are multiple ways to achieve high levels of ACAP (Löwik, 2013:200).

c) Activation triggers

Activation triggers tend to moderate the impact of knowledge sources and experience on ACAP development (Zahra & George, 2002:193). These triggers influence the kind of knowledge searched for, while the intensity of the activation trigger affects the investments made in developing ACAP (Löwik, 2013:199). Triggers are seen as events that encourage an organisation to respond to specific internal and external stimuli (Winter, 2000:983). When a negative event or crisis occurs within an organisation, it can intensify an organisation's efforts to achieve and learn. External triggers are events that may influence the future of the industry in which the organisation operates (Bower & Christensen, 1995:44), which include radical innovations, technological shifts, changes in government policy and emergence of a dominant design (Zahra & George, 2002:194). Organisations are likely to allocate additional resources needed to develop the capabilities to acquire and assimilate externally generated knowledge as the intensity of a trigger increases (Kim, 1998:519).

3.3.3.7 The internal and external environment of the organisation

The internal structure of an organisation is known as the people and their knowledge, tools, technology and work processes, whereas the competitive architecture is primarily concerned with the external structure, including customers, suppliers and competitors (Miller & Morris, 2008:73). Research results show that both internal capabilities of a firm and their interaction with external sources of knowledge affect their level of innovativeness. Part of these capabilities result from a prolonged process of investment and knowledge accumulation within the organisation, which is known as the "absorptive capacity" (Caloghirou, Kastelli & Tsakanikas, 2004:29).

For example, SMEs often do not have highly specialised functional departments, meaning that on an organisational level, knowledge diversity of SMEs is smaller than that of larger firms. This means that the inflow of new knowledge is limited, due to only a few people maintaining linkages with the external environment (Löwik, 2013:50). The hampering effects of a small number of employees on ACAP is therefore contingent on the volatility of an organisation's environment (Wang, Wang & Horng, 2010:183). Liao, Welsch and Stoica (2003:63) conducted an empirical study on growth-oriented SMEs and examined the moderating effect of environmental turbulence on the relationship between ACAP and firm responsiveness. In their study, they hypothesised that in turbulent environments, SMEs will engage more in external knowledge acquisition and internal knowledge dissemination to be able to respond effectively to environmental changes. However, their results only showed a positive moderating effect related to internal knowledge dissemination and no support for the effect of external knowledge acquisition. It is therefore suggested that In turbulent environments, SMEs lack the required resources and capabilities to handle the complexity and volume of information, hence turn to internal knowledge dissemination instead of external knowledge acquisition (Liao *et al.*, 2003:79).

In their illustration of ACAP (Figure 3.9), the external environment where technological evolution takes place – the process of recognising external trends and technological opportunities, which is linked to the box on the left – presents the part of an organisation's ACAP that focuses on assimilation (Fiol, 1996:1019). The link from the external environment to this box represents a conduit or channel through which external ideas and opportunities are fed into the organisation (Fiol, 1996; Smith, 2015:64). Besides acknowledging that external influences are vital for innovation (Cohen & Levinthal, 1990), for effective innovation there also has to be a capability to assimilate ideas within an organisation. This means that internal environmental factors such as communication systems are required that effectively transfer knowledge across the different parts of the organisation (Smith, 2015:64). Cohen and Levinthal (1990) also note that shared knowledge and expertise are necessary for good communication.

To truly understand the determinants of organisational innovation, one needs to keep in consideration the effects of the broader institutional/market context that is the source of knowledge that accumulates. The capacity of organisations-as-sponges to absorb and recombine innovative inputs is likely to shrink. If this occurs, the internal processes, structures, and other organisational determinants of new product generation will have minimal impact. Simply squeezing harder when the sponge is dry will not generate the expected results (Fiol, 1996:1019). For effective ACAP to occur, an organisation needs to maintain a balance between inward-looking (the bottom channel in Figure 3.10) and outward-looking (the top channel in Figure 3.10) ACAP (Smith, 2015:64).

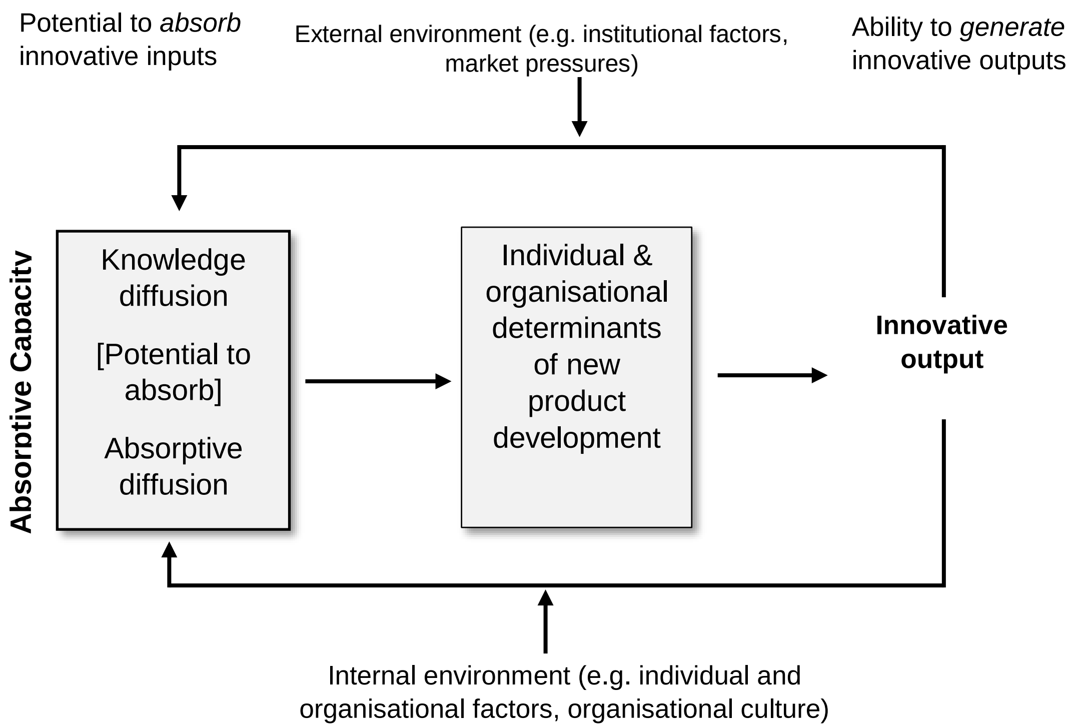


Figure 3.10: Effective absorptive capacity

Source: Adapted from (Fiol, 1996:1019) in (Smith, 2015:64)

3.3.3.8 Outcomes of ACAP

Both Todorova and Durisin (2007) and Zahra and George (2002) regarded external knowledge sources as an antecedent of ACAP, which stems from the input-processes-output view on ACAP. External knowledge sources deliver the input for ACAP in the form of external knowledge, which is processed through ACAP, and results in outputs that might lead to competitive advantage. Todorova and Durisin (2007) also added a feedback-loop between the new absorbed knowledge (as output) and the prior organisational knowledge (as input) to emphasise the path-dependent and cumulative character of ACAP. At organisational level, outcomes of ACAP are related to innovation (the development of new products, services and processes) and strategic flexibility (the ability to flexibly reconfigure the organisation's resource base to address changing situations) (Zahra & George, 2002). Other outcomes of the construct is measured in the form of performance by means of competitive advantage (Todorova & Durisin, 2007:782; Zahra & George, 2002), new business venturing and self-renewal (Jiménez-Barrionuevo *et al.,* 2019:1), technological innovation performance (innovation output), measuring the level of enterprise technology innovation activities or results, i.e., effectiveness (Zhai *et al.*, 2018:2), development of radically new products (Skilton, Bernardes, Li & Creek, 2020), number of new product introductions (Yusr *et al.*, 2017:964), in the form of innovative activities (Jayathilake, 2018:229), new product performance in terms of success in meeting sales goals, market share goals, return on investment and customer satisfaction (Najafi-Tavani *et al.*, 2018:7), innovation performance as a measure of an enterprises' innovativeness (Scuotto *et al.*, 2017a:411) and innovation, consisting of marketing, product, process and organisational innovation (Yuwono, 2020:1401). Individual innovative performance is related to the extent to which ideas are generated and implemented (Löwik, 2013:112). Individual outcomes have been measured in the form of generation of innovations (Tortoriello, 2015:587), in the form of architectural radical and incremental innovation (Han, 2017:1), innovativeness (O'Reilly III & Tushman, 2008), innovative performance (Yildiz *et al.*, 2020) and job performance (Cross & Cummings, 2004:928).

Based on the discussion in section 3.3.3.8, it is evident that innovation is regarded and measured as an output of ACAP. Not only does it form part of the ACAP process as a potential output, but it is also the foundation from where IC is measured: from invention to innovation, to measuring the level of invention and the potential for innovation on an individual level. The next section firstly discusses innovation and how it is defined, the innovation process and individual innovation, and follows a discussion on IC as a construct. All elements of IC are taken into consideration, such as, internal and external determinants, models of IC, and ultimately, how to measure IC on an individual level by looking at types of innovation (incremental to radical), disruptive innovation, innovation degrees and degrees of novelty.

3.4 INNOVATION LITERATURE

3.4.1 Defining innovation

Innovation has always played a decisive role in the economic and social development of countries: it is the main source of economic growth, it helps improve productivity, it is the foundation of competitiveness, and it improves welfare.

(World Bank, 2010)

To truly manifest innovation and reap its benefits, one must recognise that innovation consists of three different things: it is an outcome, a process, and a mindset. Innovation as an outcome emphasizes what output is sought including organisational innovation, supply chain innovation, business model innovation, marketing innovation, process innovation and product innovation. Innovation as a process attends to the way in which innovation should be organized so that outcomes can come to fruit. Innovation as a mindset addresses the internalisation of innovation by individuals of an organisation where innovation is instilled and ingrained along with the creation of a supportive organisational culture (Kahn, 2018:453). The concept of innovation has a long history, with many different meanings that are mainly based on competition between companies and the different strategies that can be used to compete (Merx-Chermin & Nijhof, 2005:136). Innovation is widely seen as a driver for generating new knowledge, economic growth, and jobs. In further research literature, the definition of innovation also includes the concepts of novelty, commercialisation and/or implementation. An idea therefore has to be developed and transformed into a product, process or service and commercialised in order to be classified as an innovation (Popadiuk & Choo, 2006:303).

Afuah and Afuah (2003) refer to innovation as new knowledge incorporated in products, services and processes that are classified according to technological, market, and administrative/organisational characteristics. Table 3.2 gives an illustration of the key terms used.

Table 3.1: Innovation terms

Term	Description
Invent	To create by thought, devise, originate, contrive, improvise, generate, formulate
Invention	Creation, fabrication, production, origination, gadget, implementation, contraption
Inventiveness	Resourcefulness, originality, creativity, ingenuity, imagination
Innovation	Introduction, establishment, institution, commencement, novelty, departure from the old, introduction of new and improved methods and things, modernisation, drastic change, breaking of a precedent

Source: Antonites (2017:102)

A common misunderstanding is the tendency to casually use the terms innovative and innovativeness as synonyms of innovation of which they are not. Innovative is an adjective whereas innovation is a noun. Innovativeness is also a noun, but rather describes the capability and capacity for innovation. Two distinctions are made when defining innovation. The first presents innovation as an outcome, which emphasizes output and the second present innovation as a process in which innovation should be organised so that these outcomes can come to fruitition (Kahn, 2018:454,457). According to Herrington, Kew and Kew (2019:26), innovative entrepreneurs are those who state their products or services are new to all or some customers and for which there are no or few competitors. Table 3.3 gives an overview of some of the definitions of innovation which have been developed over the years.

Table 3.2: Defining innovation

Author	Definition
(Kline & Rosenberg, 1986)	Innovation is uncertain, complex, somewhat disorderly, and subject to changes of many sorts. Innovation is also difficult to measure and demands close coordination of adequate technical knowledge and excellent market judgment in order to satisfy economic, technological, and other types of constraints. The innovation process must be viewed as a series of changes in a complex system not only of hardware, but also of the market environment, production facilities and knowledge and the social contexts of the innovation organisation.
(Ghoshal & Bartlett, 1991)	The term is broadly classified in two categories: those that see innovation as the final event – "The idea, practice, or material artefact that has been invented or that is regarded as novel, independent of its adoption or non-adoption" and those who see it as a process which proceeds from the conceptualisation of a new idea to a solution of the problem and then to the actual utilisation of a new item of economic or social value.
(Wheatley, 1992)	The literature on organisational innovation is rich in lessons… it describes processes that are also prevalent in the natural universe. Innovation is fostered by information gathered from new connections; from insights gained by journeys into other disciplines or places; from active collegial networks and fluid, open boundaries. Innovation arises from ongoing circles of exchange, where information is not just accumulated or sorted, but created. Knowledge is generated from connections that weren't there before.

(Rouse, 1992)	Invention is the creation of a new device or process… Innovation is the introduction of change via something new.
(Couger, 1995)	Where invention is concerned with implementation of discovery, innovation is concerned with implementation inventive ideas. Innovation is pragmatic: the conversion of an invention into a business or other useful application… Innovation is a process whereby new ideas are put into practice. To invent is to find a new thing; to innovate is to get the new thing done. Innovation is the process by which inventions are… transformed into a profitable product or system.
(Fagerberg, Mowery & Nelson, 2005)	Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry out its practice. Sometimes, invention and innovation are closely linked, to the extent that it is hard to distinguish one from another. In many cases, however, there is a considerable time lag between the two. In fact, a lag of several decades or more is not uncommon. Such lags reflect the different requirements for working out ideas and implementing them… To be able to turn an invention into an innovation, a firm normally needs to combine several different types of knowledge, capabilities, skills, and resources…
(Davila & Epstein, 2006)	Innovation is most frequently driven by: improved quality; creation of new markets; extension of the product range; it reduces labour costs; improves production processes; reduces materials; reduces environmental damage; replaces products/services; reduces energy consumption and conforms to regulations.
(Drucker, 2014)	Change that creates a new dimension of performance.
(Schumpeter, 2017)	The introduction of new goods, new methods of production, the opening of new markets, the conquest of new sources of supply and the carrying out of a new organisation of any industry.

Source: Adapted from Antonites (2017:103-106)

As seen in the previous discussion on ACAP, knowledge creation is a continuous process with no ultimate end and needs to be exploited at some point. Therefore, not only spillovers of knowledge, but also resulting in innovative activity (Ghio, *et al.* 2015:14). The next section briefly discussed the knowledge to innovation process.

3.4.2 From knowledge to innovation

The innovation process is known to be concerned with the various activities necessary to turn an idea or discovery into a commercial product or service which consumers will buy (Smith, 2015:89). From a generic level, Tidd and Bessant (2018:41) suggest that organisations have to manage four phases making up the innovation process. Innovation processes are those phases that organisations follow to build what is new and hopefully unique, the imaginative content to meet the customer promise (Matthews & Brueggemann, 2015:44). There are however different versions of an idealised model that is designed to highlight the activities that have to be undertaken (Smith, 2015:90). In the final stage, Tidd and Bessant (2018:400) illustrate in Figure 3.11 that the innovation process should be one of review of the completed project in an attempt to capture learning from the experience.

Figure 3.11: Illustration of a generic innovation process

Source: Adapted from (Tidd & Bessant, 2018) in Matthews and Brueggemann (2015:45)

Illustrated in Figure 3.12, Merx-Chermin and Nijhof (2005:135) examined the factors influencing knowledge creation and innovation in an organisation to better understand the innovative power of an organisation. Their innovation process model consists of three processes: knowledge creation, innovation and learning to learn. The model indicates an understanding of the necessity for organisations to integrate their initiatives in organisational learning, knowledge creation and innovation and gain innovative power. When innovation is seen as the transformation of valuable knowledge into added value for stakeholders, this makes knowledge generation a necessary condition for the innovation process (Merx-Chermin & Nijhof, 2005:135).

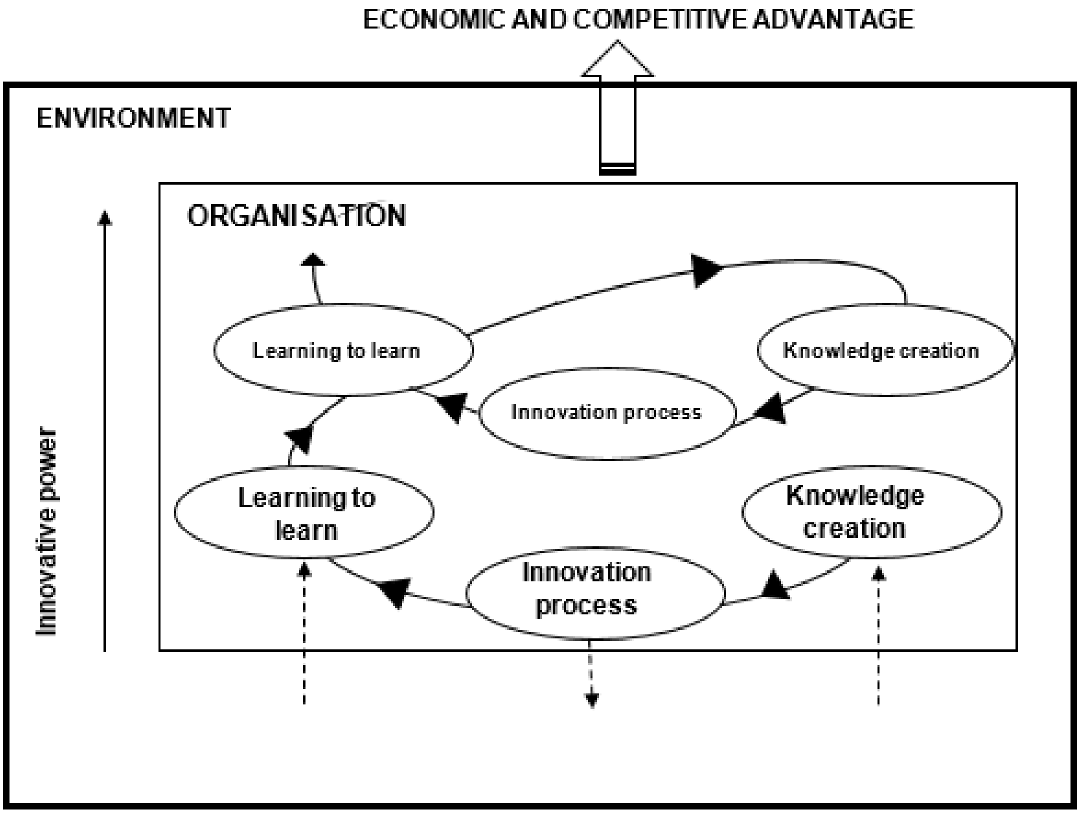


Figure 3.12: Knowledge creation-innovation-learning spiral model

Source: Merx-Chermin and Nijhof (2005:140)

Design thinking is a specialised innovation process model based on the work by Tim Brown (2008). It is an empathetic innovation process that involves an empathetic relationship with the customer and continuous interative prototyping (Brown, 2008:10). Design thinking applies concepts from both the sciences and humanities, and portrays innovators such as Steve Jobs of Apple and Edwin Land from Polaroid (Isaacson, 2011). The innovation process element or process steps for innovation by Plattner (2010) are different from other innovation processes developed by organisations. The design thinking roadmap provides for both the freedom to be creative and the discipline to achieve results (Matthews & Brueggemann, 2015:46). The extent to which ideas are generated and implemented from an individual's innovative performance perspective is discussed next. This is done in order to get an understanding of how IC is measured on an individual level for the purpose of this study.

3.4.3 Individual innovation

A growing body of knowledge on innovation at the level of the individual suggests that innovation originates from within the individual (Amabile, 1988; Hall & Andriani, 2003; Kahn, 2018; King, 1990; Schweisfurth & Raasch, 2018). Following the diffusion of innovation literature, Turan, Tunç and Zehir (2015:49) propose that highly innovative people accept and adapt to new technologies easily compared to lower innovative people. It is argued that individual innovation belongs to a general construct of high abilities, which include creativity, exceptional intelligence, giftedness and talent, of which a need to further investigate individual innovation from a psychological perspective and its external manifestations was identified (Shavinina & Seeratan, 2003:32). Research has been done on the traits, characteristics, features, properties, and qualities of innovation and innovative people, which would typically form part of their external manifestations in any real activity, but little research has been done on the psychological basis of these manifestations. Shaviniva and Seeratan's (2003:32) conception of individual innovation ventures to explore the scientific understanding of the inner essence of innovation, namely: why innovative ideas emerge in human minds. They believe that developmental and cognitive mechanisms must be taken into account. They identified five levels of the internal structure of individual innovation: (1) developmental foundation; (2) its cognitive basis; (3) its intellectual manifestations; (4) its metacognitive manifestations; and (5) its extra-cognitive manifestations. This captures the essence of individual innovation, which rests on the uniqueness of the individual's intellectual picture of the world. This could perhaps shed some light on the issue in this study of why some entrepreneurs are exceptionally able to generate new ideas and innovations and others are not.

Individual innovation starts with the generation of new ideas, which eventually manifest themselves externally in extraordinary innovative achievements that are seen in any field of human activity. It is further conceptualised to occur as a result of a specific organisation of an individual's cognitive experience which functions as a carrier of all the manifestations of individual innovation (i.e. its traits and characteristics). Cognitive experience is expressed in a specific type of the representations of reality: how an individual sees, understands, and interprets the world around; in an individual's intellectual picture of the world (Shavinina & Seeratan, 2003:31).

Shavinina and Seeratan (2003) express the importance of knowing what the carrier or basis is of the characteristics and traits associated with individual innovation. Mental or cognitive experience is defined by Kholodnaya (2002) as a system of the available psychological mechanisms, which forms a basis for the human cognitive attitude towards the world and predetermines the specifics of his or her intellectual activity. The cognitive level in the structural organisation of individual innovation (cognitive experience) is formed by conceptual structures (i.e. conceptual thinking), knowledge base, and subjective mental space. Furthermore, the importance of conceptual structures is determined by scientific findings. This indicates that conceptual thinking is the integrated cognitive formation, which is a form of the integrated functioning of human intelligence (Kholodnaya, 2002).

A second form in the organisation of the cognitive experience is the knowledge base, which plays a crucial role in the development of an individual's intellectual resources. The quantity and quality of specialised knowledge play a critical role in highly intellectual performance and in the process of acquiring new knowledge (Schneider and Bjorklund (1996). This supports Nonaka (1994:15) that the quality of tacit knowledge is influenced by the variety of an individual's experience and knowledge of experience.

Conceptual structures and the knowledge base generate the third form in the organisation of the cognitive experience, which is subjective mental space. Individual differences in integration, flexibility, differentiation, and hierarchical structure of the mental space influence a person's cognitive attitude to the world. It therefore predetermines his or her intellectual and creative abilities, which lead to new ideas resulting in innovation (Shavinina & Seeratan, 2003:33).

Cognitive experience is described as how an individual sees, understands, and interprets what is going on in the surrounding reality in the world around. It manifests itself in specific types of representations, meaning that intelligent people – in particular innovators who are intellectually gifted, creative, and talented – see, understand, and interpret the world around them by constructing an individual intellectual picture of events, actions, situations, problems, ideas, and any aspects of reality in a way that is different from other people (Shavinina & Seeratan, 2003:33). As individual innovation mainly deals with the generation of new ideas, Shavinina and Seeratan (2003) conception of individual innovation emphasises objectively new ideas, since the very essence of innovators is intellectual giftedness that resides in their ability to see the world from an objective point of view. According to Kaufmann (2003:191), novelty of ideas must be objective, and not only subjectively novel to its originator. Kholodnaya (1990) showed that a distinguishing feature of gifted individuals' representations of reality is their objective character. It is therefore suggested that the ability to objectivise cognition is important not only for innovators in science but also for innovators working in business settings (business innovators).

In order to determine how IC is measured, the meaning of innovation had to be discussed in detail, as IC includes both identifying the level of invention and potential for innovation in its measurement. The next section discusses IC as a construct from an organisational and individual level perspective and how it is measured. As innovation as an outcome emphasises output (Khan, 2018:454), IC is seen as the output for the purpose of this study. It further indicates how ACAP is linked with IC that could be transformed into successful innovation, and that knowledge and competence are internal determinants of IC (Lukjanska, 2010:43)

3.5 INNOVATION CAPACITY AS A CONSTRUCT

Improvements in innovation capability and economic growth are largely dependent on world-wide education systems. We live in a world that demands creativity and innovation across multiple social, legal, technical, political, and educational sectors. Educators at all levels, and in specific sectors, are responsible for ensuring that the future workforce has the competencies required to ideate, conceptualize, develop, and implement the intellectual capital that drives progress.

(Matthews & Brueggemann, 2015:16)

The literature discusses innovative (adjective) capacity and innovation (noun) capacity interchangeably (Khan, 2018:454), however in this study innovation capacity is defined as a concept that measures the level of invention and the potential for innovation, and not merely innovation as an output or performance measure on its own. According to Suarez-Villa and Hasnath (1993:335), innovative capacity can be conceptualised as the stock of all available inventive knowledge. A nation's innovative capacity is therefore both an indicator of invention and potential measure of innovation. The greater the number of inventions, the higher the likelihood that they may be applied as innovations in some potentially useful activity. IC is further defined as a firm's continuous improvement of capabilities and resources in order to explore the opportunities of new product development to meet market expectations (Pierre & Fernandez, 2018:140). Innovative capacity is also a measure of endogenously generated scientific and technological knowledge and capabilities (Suarez-Villa, 1990:292) and represents the firm's ability to innovate continuously ahead of its competitors (Qian & Li, 2003:882). The level of innovative capacity reflects greatly on human capital resources, economic incentives that motivate invention, and on the institutional mechanisms that support it (Suarez-Villa & Hasnath, 1993:335). Research shows that innovation is increasingly considered to be one of the key drivers of a company's long-term success in today's competitive markets. Companies with the capacity to innovate will therefore be able to respond to environmental challenges faster and better than non-innovative companies.

IC was originally introduced in 1990 by Suarez-Villa, who used invention patent data in developing a model that could provide insights on the evolution of patenting over the long term. The concept measures the level of invention and the potential for innovation in any nation, geographical area or economic activity (Suarez-Villa, 2017:1). Several authors have defined IC, but it can have a different meaning if applied to national or organisational level (Lukjanska, 2010:42). Invention has also been viewed by many as the simple outcome of individual creativity, induced primarily through environmental or biological conditions. However, the skills required for invention also tend to be unique and are often very difficult to prespecify and not widely marketed (Hull, 2010; Jewkes, 1969; Kuhn, 1970; Samson & Gurdon, 1990). Results suggest that by developing social competences, knowledge and skills, innovation processes can be supported in small and micro enterprises (Jasińska-Biliczak, Kowal & Hafner, 2016:1). As the level of invention increases, more innovations and new technologies can be expected. Measuring the level of invention therefore provides an important indicator of the potential for IC and the introduction of new technologies. For any industry or economic activity or between different locations, IC can measure its level of invention at any time (Suarez-Villa, 2017:1). In assessing IC, internal and external determinants impact on IC that are important, as illustrated in Figure 3.13. Both internal and external determinants are important for the successful development of IC, however, some of them have to be more admitted. ACAP is linked to IC in a way that absorbed knowledge can or cannot be transformed into successful innovation (Lukjanska, 2010:43).

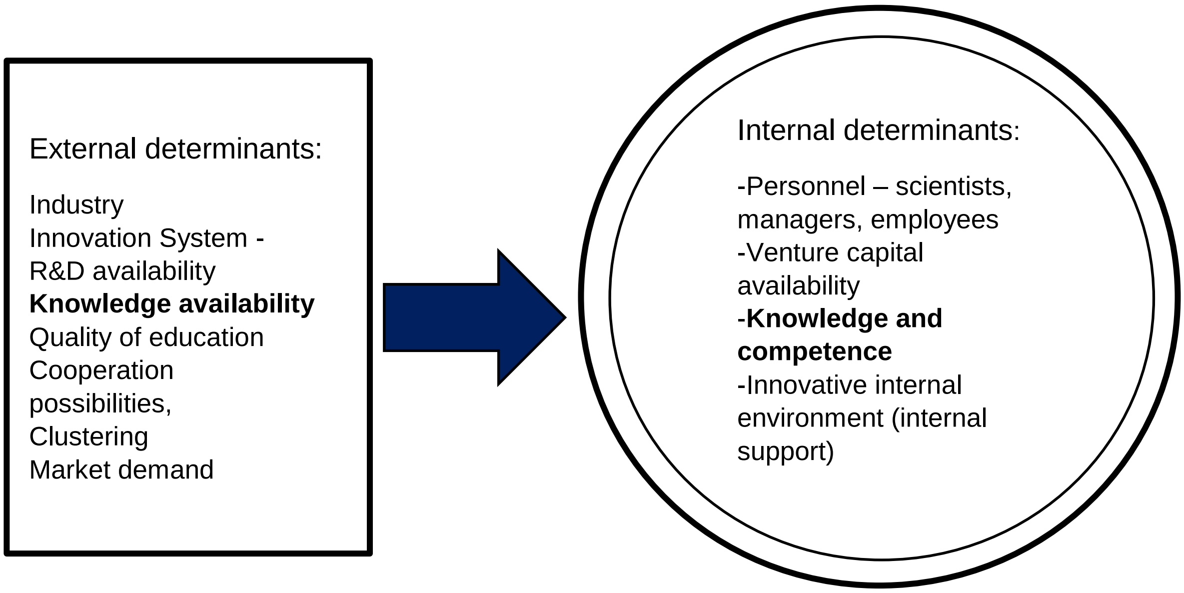


Figure 3.13: Internal and external determinants of innovation capacity

Source: Adapted from Lukjanska (2010:43)

Pierre and Fernandez (2018) explored IC in the specific context of SMEs, which is extremely difficult to define, as most SMEs' innovative activities are informal and merge into overall firm activities. Based on the results, having studied 32 innovative SMEs, their findings confirm ten critical dimensions of SMEs' IC. The findings allowed them to propose a framework that analyses SMEs' IC based on SME specificities. The framework is illustrated in Figure 3.14. The framework is built on an extended literature review highlighting diversified constructs of IC by using different dimensions of IC in an SME context: owner/manager characteristics, network integration, user/customer integration, institutional support, innovation strategy and planning, culture and structure, innovation process management, learning process, innovation-dedicated resources and processes revaluation (Pierre and Fernandez, 2018:139).

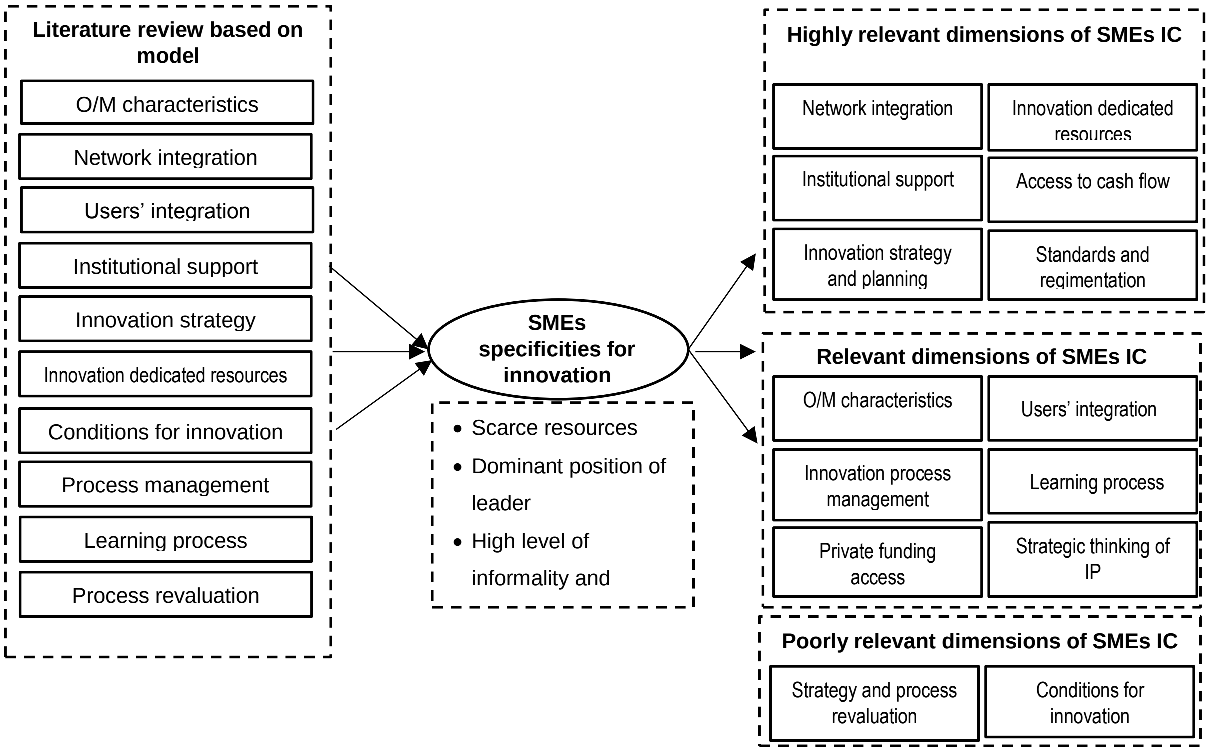


Figure 3.14: Relevant dimensions of SMEs' innovation capacity

Source: Pierre and Fernandez (2018:167)

What is of importance to note is that the owner/entrepreneur characteristics are one of the first specificities for IC. They are in most cases the initiator of innovation activities in SMEs. Pierre and Fernandez (2018:142) highlight that previous experience and the related professional capacities, which is a combination of personal knowledge, experience and training, allows the entrepreneur to manage innovation efficiently. The personality of the entrepreneur also influences an SME's IC, particularly his attitude towards risk, capacity for taking risks and dedication (Pierre and Fernandez, 2018:143), presenting a wide variety of behaviours when engaging in innovation practices (Marchesnay, 2014:112).

Persaud *et al.* (2001:13) built on Nonaka and Takeuchi (1995:19) framework for knowledge creation and encapsulated the application of knowledge in the innovation process. As illustrated in Figure 3.15, the framework indicates that tacit, explicit and cultural knowledge must be managed to effectively realise enhanced IC. The framework also indicates that IC can occur at an organisational (lab) level or individual level. Baumol (2005:37) indicated that of the most radical innovations within the last two centuries, the majority have emerged from individual entrepreneurs. Marvel and Lumpkin (2007:809) believes that although one cannot assume that the process of creating radical innovation is the same within large organisations as it is within the start-up context, the extant research suggests there is much more to learn from the independent entrepreneur. Most revolutionary new business ideas are argued to be provided by the independent entrepreneur.

It is suggested by Nonaka and Takeuchi (1995:22) that labs can enhance their innovative capacity by converting tacit knowledge into explicit knowledge, which is termed externalisation, and explicit knowledge into tacit knowledge, which is termed internalisation (Persaud *et al.*, 2001:13). This concept can determine actual or potential technological leadership by providing comparisons with other activities or industries. Keeping IC to increase is a long-term imperative, since inventive output is bound to influence the well-being of future generations and their ability to cope with the myriad economic, environmental, social and industrial challenges that are to be faced (Berry, 1991; Wenk, 1989). The creation, elaboration and diffusion of technological and scientific knowledge is a time-dependent process that can require many years to produce positive results (Berry, 1991; Machlup, 2014).

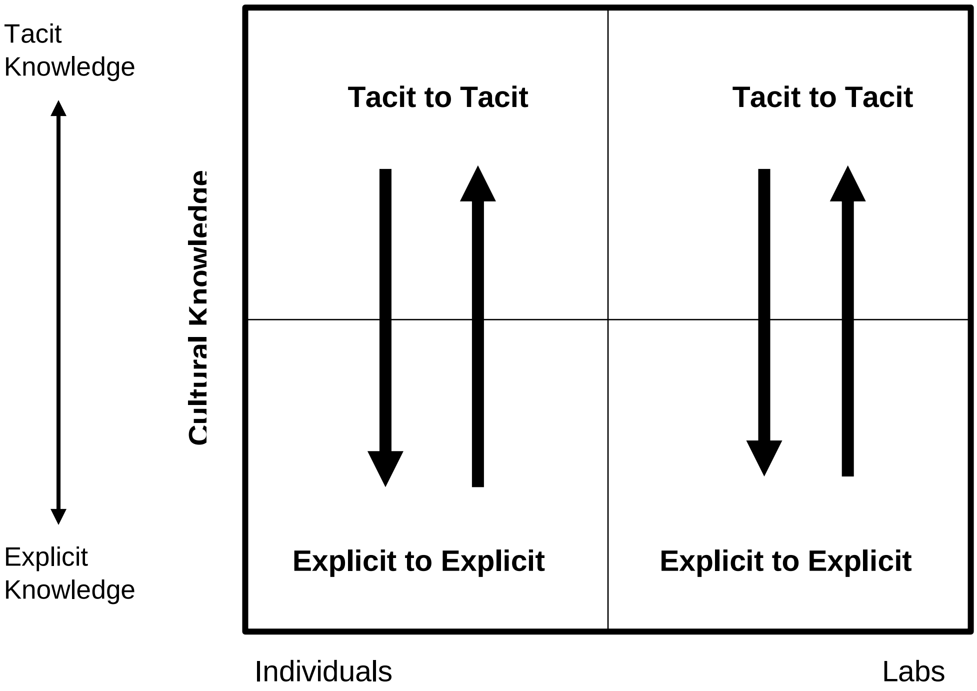


Figure 3.15: Model of innovative capacity

Source: Persaud *et al.* (2001:13)

Throughout the last decade, when the competitive environment went through a major transformation due to globalisation, organisations have intensified their search for strategies that will give them a sustainable competitive advantage. This required that organisations continuously differentiate their products and services and be constantly innovative. This is done through a well-planned system of knowledge management that enables organisations to excel in technological, market and administrative knowledge creation (Popadiuk & Choo, 2006:302). The extent to which all the innovation stimuli (both technological and human) are able to be absorbed within an enterprise over time (that is, they are dynamic) thus provides the capabilities for innovative performance. The macro framework by Prajogo and Ahmed (2006), Figure 3.16, illustrates the managing of both human and technological capital formation to build IC; it is supported by many studies. It is for this reason that such capacity building leads directly to stronger innovation performance (Smith, Courvisanos, Tuck & McEachern, 2011a:105). The framework is known as the Stimulus-Capacity-Performance (SCP) approach, in which human capital and technological capital are the stimulus factors that develop IC. Therefore, the better the IC is built, the more effectively an enterprise can conduct this innovation process and the stronger the innovation performance (Smith *et al.*, 2011a:105).

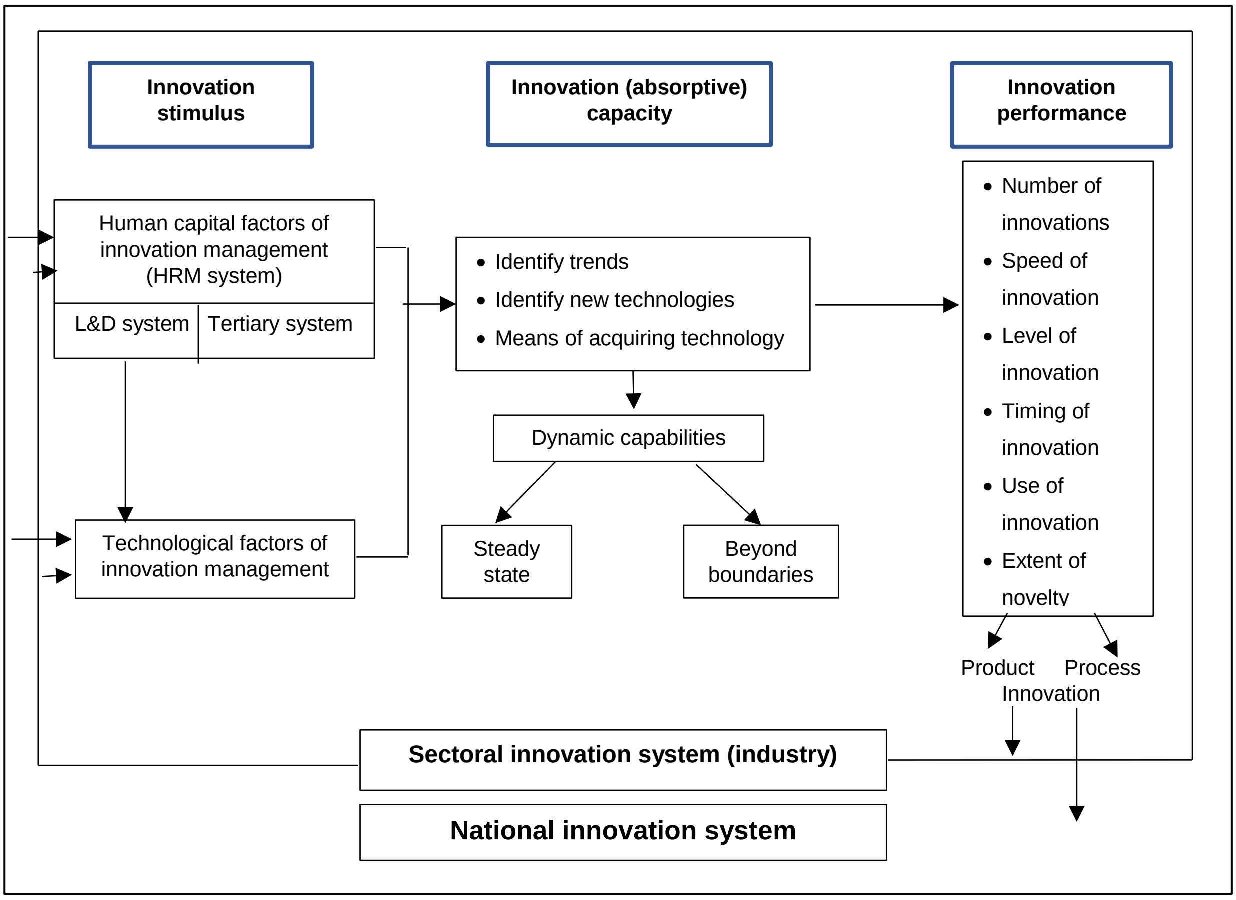


Figure 3.16: Macro-level innovation framework

Source: Adapted from Smith *et al.* (2011a:106)

As a greater understanding has been provided on the IC construct, the next section looks into how this construct is measured once effective knowledge transfer has occurred through ACAP.

3.5.1 Measuring innovation capacity

In order to measure IC, various aspects need to be taken into consideration when measuring the level of invention and the potential of innovation. According to Garcia and Calantone (2002:110), various constructs are used to model product innovation/innovativeness. They have identified no less than 15 constructs and at least

51 distinct scale items that have been used in just 21 empirical studies in the new product development literature that model product innovativeness.
Constructs used to model product innovation/innovativeness include:

- Product innovativeness
- Radicalness (discontinuous)
- Newness to firm
- Technical content
- Newness to market
- Newness to customer
- Product uniqueness
- Product (superiority)
- Synergy (fit)
- Product/market fit
- Marketing task similarity
- Product complexity
- Development complexity
- Product type

Twelve unique factors were then identified of the 21 differently labelled factors identified (Garcia & Calantone, 2002), which included:

- Product newness to the firm
- Product uniqueness (First to market)
- Product uniqueness (superiority)
- Change in behavioural patterns
- Product newness to customers
- Technical uncertainty
- Technical inexperience (newness)
- Technology cost
- Business experience
- Product innovativeness
- Discontinuity of product benefits
- Newness to the market

- Customer benefits

The ability to innovate is known to be a critical success factor for growth and future performance. However, this acceptance obscures the comprehensive perspective on how businesses can influence their IC and resulting performance. Carayannis and Provance (2008:90) proposed a ‘3P’ construct of innovation measurement that simultaneously considers the Posture, Propensity and Performance related to a business’ innovation capabilities. They developed a conceptual model of organisational innovation, illustrated in Figure 3.17, from a resource-based perspective of the firm. They draw upon the concept of knowledge as an intangible resource that flows throughout organisations to render new routines, technologies or structures that affect future performance (Carayannis & Provance, 2008:92). Empirical evidence showed that robust measurement of the performance implications of innovation requires the consideration of input, throughput and output factors simultaneously. A framework that combines the components of organisational innovation was illustrated, then a construct to measure it was developed. Understanding the role of innovation and innovation capabilities in firm performance has proved a central issue to both management of technology and strategic management disciplines (Carayannis & Provance, 2008:94). Measures were developed from a survey that included items on innovation inputs, process capabilities and performance. The independent variables comprised two factors: innovation process mechanisms and innovation inputs. The dependent variables used as output variables included the novelty of content of firms’ innovations (new to firm, new to industry nationally, new to industry internationally, inimitable, became a new industry standard) and to firm performance contribution through firm innovation (sales, profits and patents) (Carayannis & Provance, 2008:99).

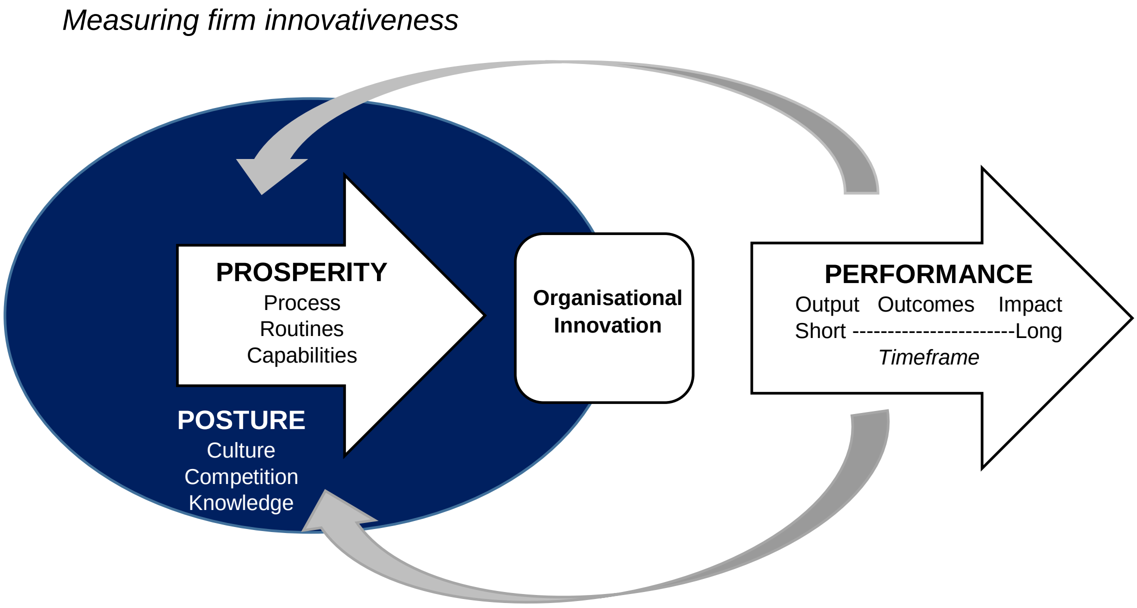


Figure 3.17: The 3P Framework: A systems view of organisational innovation

Source: Adapted from Carayannis and Provance (2008:93)

Lin (2007:316) examined the influence of individual factors, organisational factors and technology factors on knowledge-sharing processes and whether more of these could lead to superior firm IC. His study comprises aspects such as enablers, process and outcomes, illustrated in Figure 3.18. The enablers are the mechanisms that foster individual and organisational learning and also facilitate employee knowledge sharing within or across teams or work units. The knowledge-sharing process dimension refers to the effects of work-related experience, expertise, know-how, and contextual information shared with other colleagues. The outcomes dimension shows the effects of the degree of knowledge sharing effectively achieved on IC (Lin, 2007:317). Also keep in mind that IC is the level of invention and the potential for innovation.

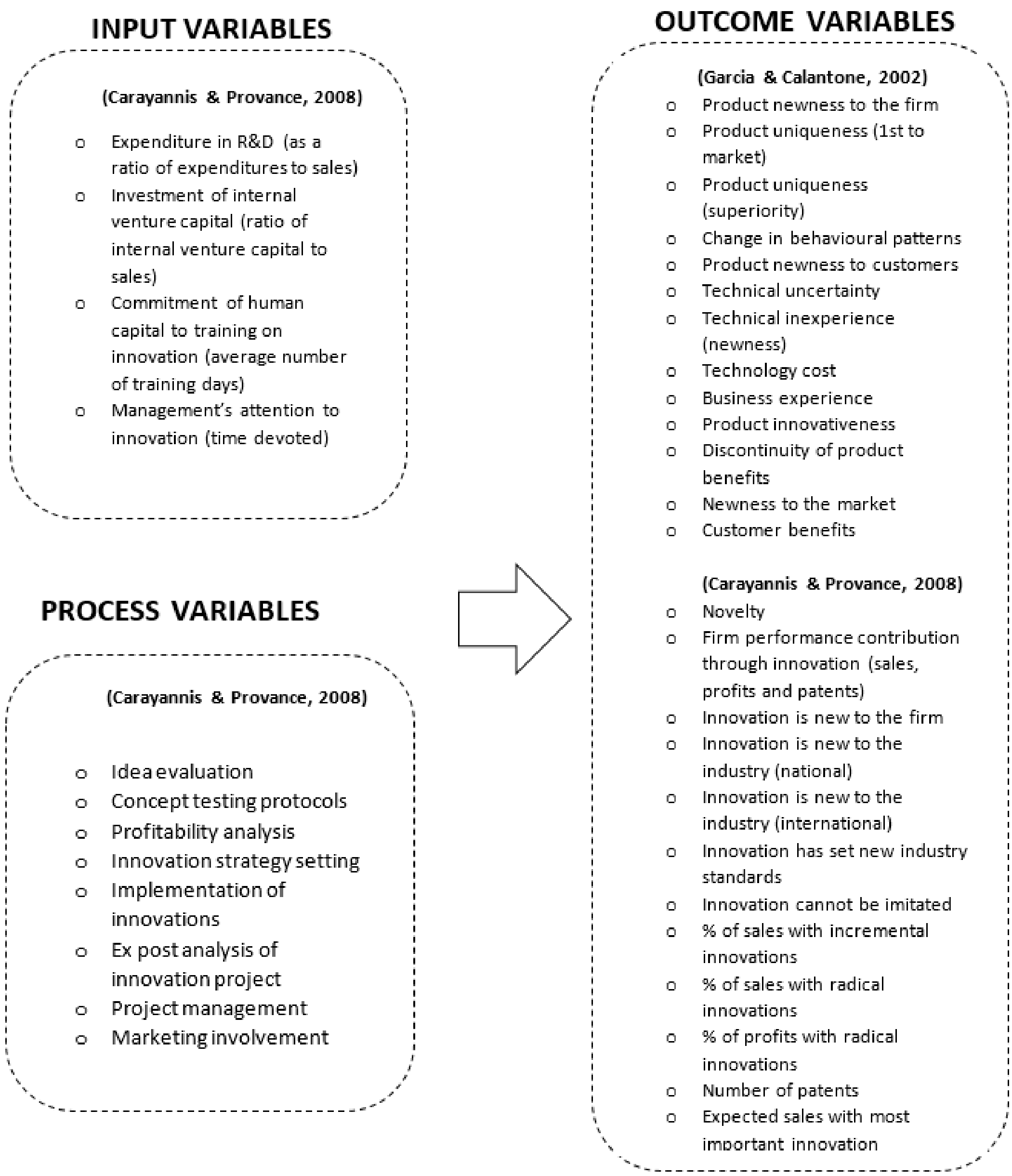


Figure 3.18: Input and output variables of innovation/innovativeness

Source: Own compilation

In the 1970s, significant attention was received in the literature on the importance of individuals and organisations being engaged in learning as a process, which could enhance organisational performance through the generation of new ideas (Chaston & Scott, 2012:1163). A variety of measures are used to achieve a better understanding of the value organisations produce, such as profitability, market capitalisation, new product introduction and patents (Carayannis & Provance, 2008:91).

3.5.2 The elements of innovation

According to Matthews and Brueggemann (2015:3), the separating of innovation into discrete elements provides more clarity for learning how the pieces of the puzzle all fit together. The foundational aspects of innovation need to be established because they serve as prerequisites and foundation for innovation competencies. The framework illustrated in Figure 3.19 provides a foundation for understanding innovation, according to Matthews and Brueggemann (2015:31), so that one is able to innovate more effectively. These elements also provide a more complete and accurate understanding of innovation and entrepreneurship, increase one's ability to innovate, and help to identify and build future talent.

Innovation Degrees (Degrees include incremental, evolutionary, and revolutionary)	**Innovation Direction** (Direction includes forward and reverse)	**Innovation Principles and Tenents** (Separate teams: teams partner with core business and teams accountable for learning)	**Innovation Criteria** (Consumer desirability, business viability, and technology feasibility)	**Innovation Diffusion** (Rate of adoption, how you get over the chasm)	**Innovation Value** (Opening up new and uncontested market space using both cost and differentiation)
Innovation Types (Types include products, services, experiences, systems, solutions, business models, and management)	**Innovation Risk** (Innovation dependency that includes both co-innovation risk and adoption chain risk)	**Innovation Thresholds** (Innovation thresholds vary by industry)	**Innovation Processes** (The process steps for innovation)	**Innovation Pacing** (The speed needed for innovation)	**Disruptive Innovation** (Both new market and low-end)

Figure 3.19: Illustration of the elements of innovation

Source: Matthews and Brueggemann (2015:31)

Due to misunderstandings of what innovation actually is, Matthews and Brueggemann (2015:31) illustrate 12 elements of innovation in Figure 3.19. It provides a foundation for understanding innovation in terms of how it is viewed, learned and practised, so that innovation can take place more effectively. While concepts such as exploration and exploitation give some sense of the activities involved in innovating, and novelty and newness help in explaining what innovation is, they do not help when it comes to explaining how individuals and companies innovate (Smith, 2015:19).

With this study focusing on innovative entrepreneurs and ECs significant for innovation within I4.0, a closer look is given into disruptive innovation in the following section. Bongomin, Gilibrays Ocen, Oyondi Nganyi, Musinguzi and Omara (2020) focused on disruptive technologies that enumerate the required skills of I4.0, since I4.0 technologies are exponentially disruptive of nature.

3.5.2.1 Disruptive Innovation

The disruptive innovation theory originated from Christensen (1997) and has been used to explain all kinds of disruptive theories over the years. According to Markides (2006:19), different kinds of innovations such as technological, business-model, and new-to-the-world innovations have different competitive effects and produce different kinds of markets and should be treated as distinct phenomena. The original theory of Christensen (1997) articulated the basic theory of disruptive technology. Christensen (2003) later replaced disruptive technology with the term “disruptive innovation” to widen the application of the theory. This was done to include not only technological products, but also innovation in services and business models. The disruptiveness of innovations refers to the extent to which an emerging customer segment sees value in the innovation at the time of introduction, which over time disrupts the product’s mainstream customer use. The disruptiveness is a market-based dimension and the radicalness is a technology-based dimension (Govindarajan & Kopalle, 2006:14). According to Schumpeter (1939) each new long wave, in Kontdratiev’s long-wave cycle, was the product of a new set of technological innovations that profoundly reshaped the patterns of consumption and production, in which each wave represents a new set of enabling/transforming technologies.

Currently, we are in a long wave that has transformed the availability and use of information. The early stages of each long wave are associated with a “swarm” of new technology-based innovations appearing on the market, accompanied very often by a sense in the public imagination that technology change is speeding up (Smith, 2015:55). In a study conducted by Bongomin *et al.* (2020:3), 35 disruptive technologies have been identified in 70 publications over the last few years. Mensch (1979) showed that, as Schumpeter predicted, the rate of innovation over time tends to vary.

Emerging as strategically important is the disruptive innovation, as popularised by Christensen (1997) (Govindarajan & Kopalle, 2006:12). A survey done by the Economic Forum's Global agenda on the Future of Software and Society shows that by 2026, people expect artificial intelligence machines to be part of a company's board of directors (Gray, 2016:1). This revolution comes with the promise of transformative social, economic and environmental advances from eliminating disease, protecting the environment, and providing plentiful energy, food and water, to reducing inequity and empowering individuals and communities. On the other hand, this powerful source of fusion between online resources, modular and open-source technology, and point-of source production devices, such as 3D printers, will enable entrepreneurs to set up shop almost anywhere (Maynard, 2015:1005). It might come with a slower revolution, with entrepreneurs continuing to experiment with conveying technologies and taking advantage of limited oversight to get their innovations to market (Gray, 2016:1).

Technology is about the application of knowledge so that it becomes embedded in "artefacts" (equipment and machines), which are the most obvious examples and readily identifiable forms of technology. Forbes and Wield (2002) further noted that technology is not only embedded in artefacts, but also in people and organisations. This form of knowledge is proprietary and firm-specific (Smith, 2015:47); knowledge is seen as a mixture of organised experiences, values, information and insights offering a framework for the evaluation of new experiences and information (Sydänmaanlakka, 2002:200).

3.6 CONCLUSION

The purpose of this chapter was to investigate existing literature on the ACAP and IC construct and to further determine their connection with one another since both are linked to innovation. To achieve this purpose, it was important to determine the underlying factors of ACAP and IC.

Innovation was discussed in conjunction with the ACAP theory, which leads to innovative outputs, where external knowledge sources deliver the inputs for ACAP, regarded as antecedents, which are processed through ACAP, and result in outputs in the form of innovative performance. A specific focus and link is made with knowledge and competence as an internal determinant of IC (Lukjanska, 2010:43). In order to understand the various activities necessary to turn an idea into a commercial product or service, the innovation processes is looked into. Knowledge generation as a role player in the innovation process is of critical importance, when innovation is seen as the transformation of valuable knowledge into added value (Merx-Chermin & Nijhof, 2005:139). Since the focus of this research is on the individual entrepreneur, innovation was explored at the level of the individual in order to understand why innovative ideas emerge in entrepreneurial minds and manifest themselves in extraordinary innovative achievements. Based on models of ACAP and IC, IC is therefore seen as a form of "performance outcome", as it is measured by the level of invention and the potential for innovation.

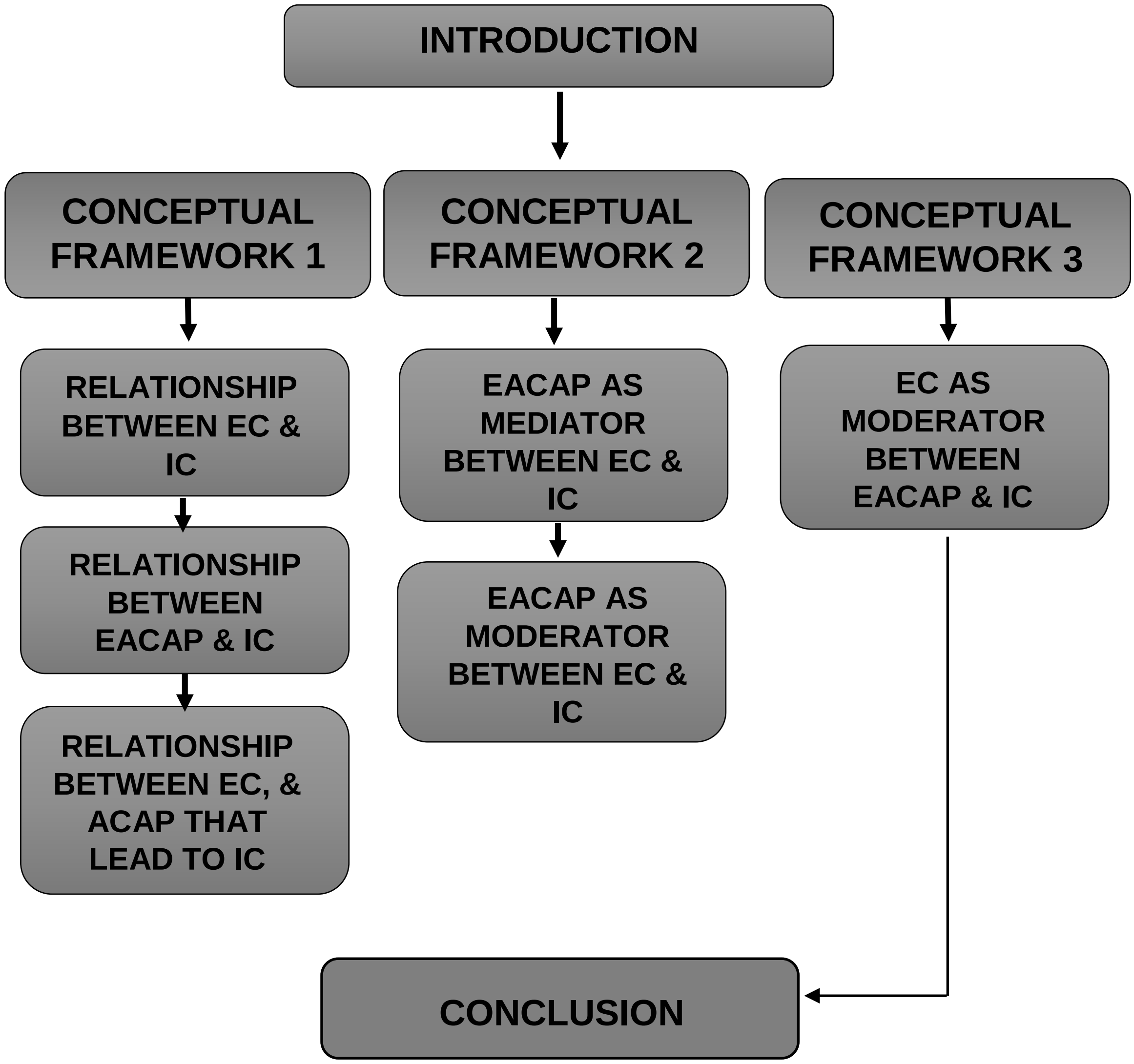
Matthews and Brueggemann (2015:24) state that we are in an early transition towards viewing innovation as a discipline with competencies that can be learned; innovation has not yet reached a state where it is a discipline on its own, such as engineering or accounting. The transition of personalised learning should be seen as each individual entrepreneur having a "competency bank account", into which he or she makes a deposit. This is done through the retention of competencies, that is, knowledge and learnable skills and behaviours (Matthews & Brueggemann, 2015:334-335). The Innovation and Entrepreneurship Framework illustrated in Figure 3.1 typically provides a structure that allows each person to develop the foundation for a more precise understanding of the who, what, where, and when of entrepreneurship. Therefore, enough learning "deposits" need to be made in order to have something to withdraw.

The next chapter investigates existing literature relating to the relationships between ECs, ACAP and IC and presents three theoretical frameworks illustrating their interrelationships.

CHAPTER 4:

RELATIONSHIPS AND CONCEPTUAL FRAMEWORKS WITHIN THIS STUDY

DIAGRAMMATIC SYNOPSIS



4.1 INTRODUCTION

We need an integrated, efficient system of post-school education and complementary measures to promote knowledge-driven innovation in order to create a society in which opportunities are continuously broadened. This can be achieved by finding new ways to grow the economy and address development challenges and in which citizens are equipped with the skills and knowledge they need to use those opportunities. To grow the economy and create jobs, our innovation system must have a sufficient focus on turning ideas into marketable products, services and process improvements. (DA, 2013:3)

Developing the manpower needed for innovation is an essential building block in developing an innovation system that can meet demands, contribute to growth and solve problems. An effective innovation system must go beyond, in such a way that the system must allow and support innovators to turn ideas into products and solutions. This means that South Africa must have a greater emphasis on design, and developing the necessary infrastructure, financial support and incentives to sustain every phase of the innovation cycle (DA, 2013:19). This is why our innovation policy must support innovators to turn their ideas into marketable products, services and solutions.

The results of the literature review found in chapters 2 and 3 have provided insights into the importance of entrepreneurial competencies (ECs), entrepreneurial absorptive capacity (EACAP) and innovation capacity (IC). Entrepreneurs who have high levels of ACAP and ECs are more likely to have the capacity to innovate, with a better understanding of why they invent the way they do, in particular with regard to those innovations that are found to be relevant for Industry 4.0. Although ACAP focuses mainly on the organisation, the unit in which to study individual ACAP is the entrepreneur (Qian & Acs, 2013:191). According to the literature study, IC has different meanings if it is applied to national or organisational level (Lukjanska, 2010:42); invention is viewed as the simple outcome of individual creativity. For the purpose of this study, IC is applied on organisational level and measured on individual level. The more an individual’s level of invention increases, the more innovations and technologies can be expected. Therefore, the competencies required for invention and innovation tend to be unique. The competencies used to measure the construct were based on the results of the Delphi study, on experts’ opinion and the most cited competencies in the concept matrix. Each competency was found to be classified under entrepreneurial, innovative or I4.0 competencies.

In its attempt to determine the relationships between entrepreneurial competencies, entrepreneurial absorptive capacity and innovation capacity. Building on existing theories, this chapter illustrates and discussed three conceptual frameworks of the interrelationships between these constructs as synthesised from the literature. The grounding theories includes: knowledge spillover theory, ACAP theory and person entrepreneurship-fit theory. The frameworks illustrate how open innovation fits in, in particular since it plays a role in the ability to absorb external knowledge, which has become a major driver for competition (Spithoven *et al.*, 2011:2). The framework lastly indicates that both the internal and external environment plays a role in this whole process, in particular in the inflow and outflow of knowledge. As mentioned in Chapter 3, both the internal capabilities of an organisation and its interaction with external sources of knowledge affect the level of innovativeness (Caloghirou *et al.*, 2004:29). From a review of the literature, several hypotheses are enunciated that illustrate the links between EC, EACAP and IC.

4.2 CONCEPTUAL FRAMEWORK 1

This study hypothesises that there is (1) a significant positive relationship between Entrepreneurial Competencies and Innovation Capacity; (2) Entrepreneurial Absorptive Capacity and Innovation Capacity, and a significant positive relationship between (3) Entrepreneurial Competencies and Entrepreneurial Absorptive Capacity that leads to Innovation Capacity. This is illustrated in Figure 4.1 below.

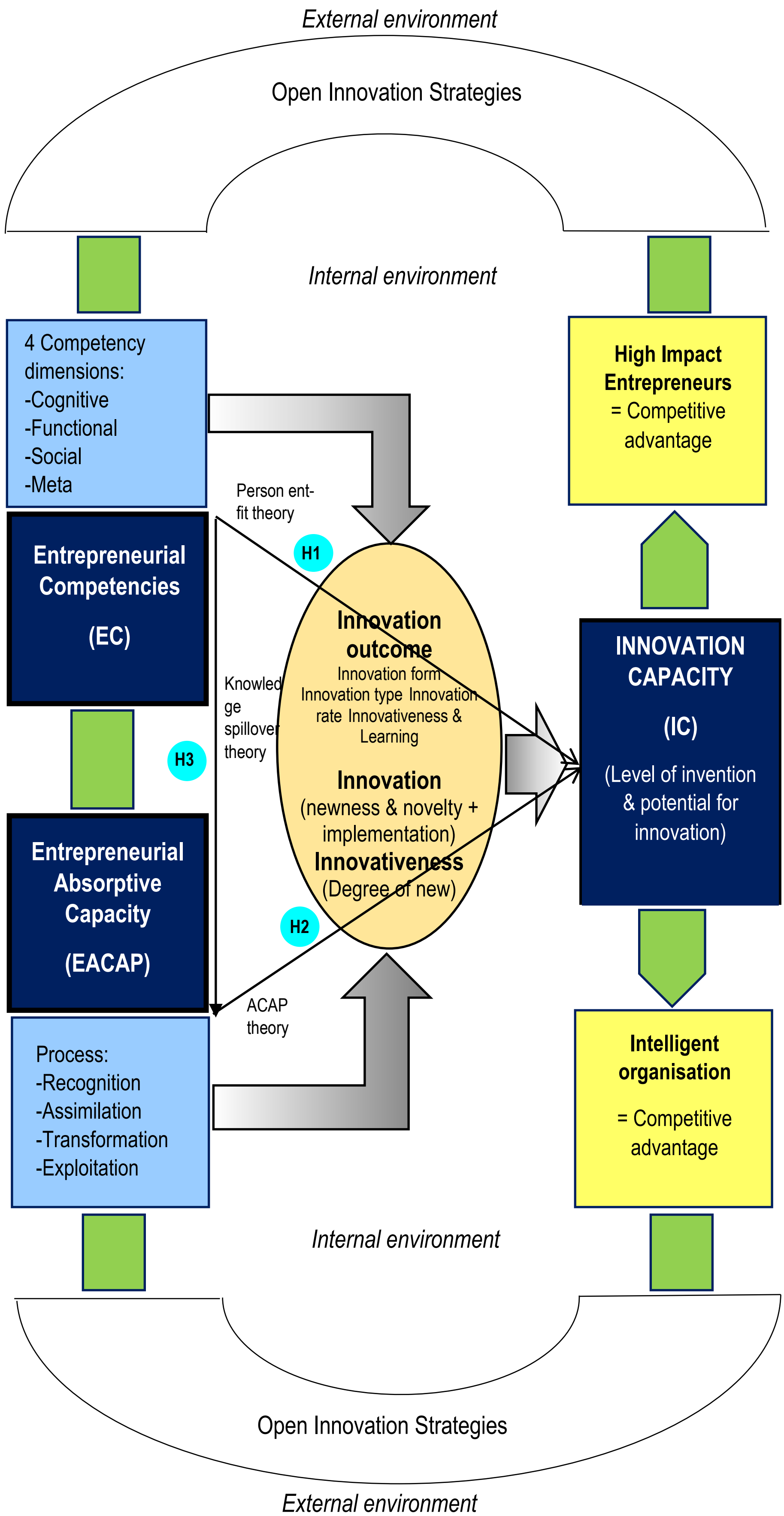


Figure 4.1: Conceptual framework 1: Relationships (Hypothesis 1, 2, 3)
Source: Own compilation

4.2.1 The relationship between entrepreneurial competencies and innovation capacity

From the primary objective, a secondary objective of the study was formulated, namely to determine whether the specific entrepreneurial competencies enhances an entrepreneur's innovation capacity. In order to explain Hypothesis 1, the relationship between the constructs of EC and IC should be explained. Many studies have attributed the success of small businesses to the competencies of the entrepreneurs (Abaho, 2016; Al Mamun *et al.*, 2016b; Boyles, 2012:41; Covin & Miles, 1999; Gwadabe & Amirah, 2017; Hashim *et al.*, 2018; Jasińska-Biliczak *et al.*, 2016; Jimenez-Jimenez & Sanz-Valle, 2005; Mitchelmore & Rowley, 2013; Mohsin *et al.*, 2017; Pierre & Fernandez, 2018:139; Ravichandran, 2017). However, research on ECs and their impact on innovative performance is still lacking (Mohsin *et al.*, 2017) and their innovation capacity. Based on their competency approach, Sánchez (2012:257) developed a theoretical framework using the concept competitiveness for SMEs. This framework focuses on the entrepreneur's role in determining firm performance, where evidence showed the direct and indirect contributions of the entrepreneur's opportunity, relationship, and innovative, human and strategic competencies in affecting the long-term performance of an SME via competitive scope and organisational capabilities. Within the Malaysian SME context, empirical evidence clearly show that ECs are indeed important for economic success, and that entrepreneurs must thus have the right competencies to undertake innovative projects (Mohsin *et al.*, 2017:96,97). Akinruwa, Awolusi and Ibojo (2013) conducted a study investigating the determinants of SMEs' in the Ekiti State Nigeria by means of a business survey approach. The results indicate that managerial skills, entrepreneurial competencies, funds, government policy, education and infrastructure are significantly related to the performance of SMEs at 5% level of significance. Empirically investigating twelve factors affecting the performance of SMEs in the retail sector in Windhoek, Namibia, Amwele (2013) found, among others, that entrepreneur characteristics, SMEs characteristics and innovation and training are all factors that affect business performance.

Sánchez (2012:167) argues that a closer relationship between firm performance and job skills suggests better management ability in order to maintain business performance. However, this approach addresses the need to consider durable individual characteristics which, rather than just abilities and capabilities, lead to success. These will inevitably allow entrepreneurs to face growing competitiveness and innovation. As discussed in Chapter 2, the model of person-entrepreneurship fit and entrepreneurial success developed by Markman and Baron (2003:293) suggests that becoming an entrepreneur places people in a situation where certain individual-difference factors will be instrumental to their success, where success is conceptualised as launching a new company into the marketplace (Markman & Baron, 2003:282). It is therefore of critical importance to look into the specific individual competencies of entrepreneurs. Findings of path analysis using variance-based SEM reveals that informal micro-entrepreneurs' self-efficacy and risk-taking propensity have a significant positive effect on micro-enterprise performance. Focusing on increasing micro-entrepreneurs' self-efficacy and risk-taking propensity will therefore assist entrepreneurs to take advantage of income-generating opportunities, particularly those in low-income settlements (Al Mamun *et al.*, 2016b:273). The SEM model proposed by Sánchez (2012:165,175) indicate that ECs, specifically opportunity, relationship, analytical, operational, strategic and personal strength, have a direct effect on firm performance, as well as an influence on competitive scope, and organisational capability. The study conducted by Sánchez (2012) also demonstrates the validity of the model of Man *et al.* (2002) in addressing the relationship between ECs and SME performance.

According to Brix (2019:21), IC being built within an organisation focuses on utilising existing knowledge and competencies as efficiently as possible. In a study conducted by Jasińska-Biliczak *et al.* (2016:1), hypotheses tested were in support of the notion that IT users in regional enterprises (SMEs) in Poland, support innovation processes by developing social competencies, knowledge and skills. An increase in the level of firm's capabilities through competent management, market linkages and marketing capabilities leads to enhanced SME performance. As ECs and firm capabilities are found to predict 30.4 percent of variance in Ugandian SMEs' performance, SME owners and managers, through their ECs, can use firm capabilities as tools to influence a firms' operations to enhance their performance (Abaho *et al*, 2016:105). In elucidating the link of dynamic capabilities upon the relationship between ECs and small firm performance, ECs and dynamic capabilities are perceived as the prospective solution for better performance of small firms (Hashim, 2018:1).

By clustering competencies, Mitchelmore and Rowley (2013:125) found four main clusters of competencies and identified: personal and relationship, business and management, entrepreneurial, and human relations competencies. In analysing the mediating effect of the competence categories; emotional, social and cognitive competencies, these competencies were found to predict entrepreneurial intent within students (Bonesso *et al*., 2018:215). Ryan *et al.*, (2009:859) added to the empirical literature related to the validity and practical utility of emotional, social, and cognitive competencies in the workplace in Europe, most predictive of performance.

The relationship between each of the EC categories and IC will be addressed in the next section. As discussed in Chapter 2, entrepreneurial competencies are divided into four categories: cognitive, social, functional and meta competencies.

4.2.1.1 Cognitive competencies and innovation capacity

Opportunity recognition, decision making, proactiveness, resilience, creative problem-solving and imaginativeness and innovation/innovating are categorised as cognitive competencies in this study as they all are based on the possession of appropriate work-related knowledge, skills (Ommi & Zeng, 2018:4) and the ability to put them into effective use (Cheetham & Chivers, 1996:24). By using pattern recognition, systems thinking and knowledge to measure cognitive competencies, zis (2006:127) is able to predict the performance of managers/leaders. Moreover, the relative importance of cognitive competencies are linked to workplace performance. The competency model developed in Boyatzis' study shows that it is still possible to apply statistical analyses/techniques to validate and refine competency models retrospectively (Ryan *et al*., 2009:859,874). In analysing the mediating effect of cognitive competencies (systems thinking and pattern recognition), Bonesso *et al.*, (2018:215) is able to predict students' entrepreneurial intent. In linking cognitive competencies and IC, ECs such as systems thinking, pattern recognition, opportunity recognition (Bonesso *et al.,* 2018:224; Sánchez, 2012:175) play a key role.

- Opportunity recognition and IC

Entrepreneurship literature has placed a specific focus on the cognitive process through which individuals decide to start a business (Audretsch *et al.*, 2005:72). As shown in the findings of Al Mamun, Nawi and Shamsudin (2016a:119), the ability to *recognise* income-generating *opportunities*, entrepreneurial training and skills, innovativeness, and information-seeking competencies has a significant effect on their entrepreneurial intentions. Botha and Taljaard (2019:9) found a significant bidirectional relationship with entrepreneurial intention. Baron and Ensley (2006:1331) suggest that business opportunities are identified when entrepreneurs use relevant cognitive frameworks between seemingly unrelated events or trends and then detect patterns in these connections suggestive prototypes of novice (first-time) and repeat (experienced) entrepreneurs. As predicted, the empirical evidence proves that the prototypes of experienced entrepreneurs are more clearly defined, richer in content, and more related to actually staring and running a business than the prototypes of novice entrepreneurs. Earlier studies show how the resource-based view is used to explain the effect of EC on enterprise performance (Peteraf & Barney, 2003). In his causal model which includes ten EC, Sánchez (2012:165) found opportunity as one of the specific ECs that predict firm performance. Results further indicate that organisational capability, which includes the constructs innovative ability, quality, cost effectiveness and organisity, has a direct effect on firm performance. Studies from Baum (1995); Chandler and Hanks (1994); and McClelland (1987) in (Man *et al.*, 2002a) have been validated on EC on firm performance.

Morris *et al.* (2013:358) define opportunity recognition as “the capacity to perceive changed conditions or overlooked possibilities in the environment that represent potential sources of profit or return to a venture”. By employing a Delphi study, pre- and post-measures demonstrate significant improvement on the competency opportunity recognition, as a competency necessary for entrepreneurial action. Krueger, Reilly and Carsrud (2000) found that the opportunity identification process is an intentional process, which offers a means to better predict and explain entrepreneurship. In a self-assessed measure of competence and venture performance, results from Chandler and Jansen (1992:223) indicate that effective performance in the entrepreneurial role requires the founder to have the ability to recognise business opportunities. The relationships evident in the study suggest some preliminary recommendations for potential entrepreneurs. However, the businesses previously initiated and the years spent as an owner manager are not strongly related to performance of the venture. Opportunity seeking and initiative were analysed and found to be two of the personal ECs crucial for success, and also what innovative organisations value in their employees (Santandreu-Mascarell *et al.*, 2013:1084). However, the empirical evidence found from systematic empirical testing of the model of the knowledge production function contradicted the assumption of the singularity between the organisation creating the opportunities and the organisation exploiting the opportunities. The empirical evidence particularly pointed to a much more vigorous contribution to small and new-firm innovative activity than would have been warranted from their rather limited investments in new knowledge, as measured by human capital and R&D (Audretsch, 1995). Dyer *et al.* (2008) developed a theory of opportunity recognition that explains why entrepreneurial behaviours increase the probability of generating an idea for an innovative venture. Dyer *et al.* (2008:317) contend that one's ability to generate novel ideas for innovative new businesses is a function of one's behaviours that trigger cognitive processes in order to produce novel business ideas.

- Decision making and IC

Decision making is the process of making choices by identifying a decision, gathering information, and assessing alternative resolutions to a problem (Grzybowska & Łupicka, 2017:251). The knowledgeable and skilled entrepreneurs play an important role in deciding vision and strategy, and communicating throughout an organisation (Lumpkin & Dess, 2001:430). The ability to make decisions and work in a team is found to play an important role for employees of the future. Independently from their position, this behavioural competency is critical to successfully working in I4.0 (Prifti *et al.*, 2017:55). In a comparative analysis, decision making was also found to be an important competency for contemporary managers to cope with new challenges in I4.0 (Grzybowska & Łupicka, 2017:250). Someone who has the competence to make decisions initiates action, gives direction and takes responsibility (Bartram, 2011:7). Assessing the inferential statistics of data gathered from SMEs, Wingwon (2012:137) found that once organisations apply innovation and strategic decision making to their intangible assets (organisation capital, information capital and human capital), they are able to drive the organisation to achieve success. The strategic decision factor therefore had a direct effect toward the innovation. Strategic decision making of entrepreneurs plays an important part in an enterprise's growth, as the entrepreneur has created vision and imagination to link with the expanding opportunity of the organisation (Porter, 1998:77). Strategic decision making is therefore the action to position the business enterprise ahead of competitors, such as introducing new innovative products or services to the market (Miller,1983, revised in (Miller, 2011:881).

- Proactiveness and IC

Scholars have argued that the strategic and entrepreneurial orientation of innovation occurs in concert with strategic orientations such as proactiveness and risk-taking (1García-Piqueres, Serrano-Bedia & Pérez-Pérez, 2019; Pérez-Luño, Wiklund & Cabrera, 2011:558). A proactive orientation reflects "proactive behaviour" in relation to participation in emerging industries, experimentation with potential responses to changing environmental trends and a continuous search for market opportunities (Miles, Snow, Meyer & Coleman Jr, 1978:546). Proactiveness is expected to be manifested by means of seeking new opportunities and introducing new products and brands ahead of competition (Venkatraman, 1989). It is also associated with striving for first-mover advantages. A proactive firm can be expected to devote efforts to environmental scanning and monitoring in order to spot new trends and stay abreast of the competition (Barringer & Bluedorn, 1999:421; Sciascia, Naldi & Hunter, 2006). Hierarchical regression analysis conducted by Seibert, Crant and Kraimer (1999:416) also proves evidence that a proactive personality predicts career success. Empirical evidence challenging traditional views shows that risk-taking reduces, not increases innovation speed and that proactiveness has inverted U-shaped effects on innovation speed. In contrast with current, literature results further show that higher proactiveness is associated with a higher level of taking initiatives in innovation and higher ability in identifying opportunities (Shan, Song & Ju, 2016:688). Similarly, the relationship between guanxi (a culturally-based, informal resource involving the building and use of interpersonal relationships) and innovation capability is significant for firms that exhibit high levels of proactiveness but not when proactiveness is low (Zhang & Hartley, 2018:75). Using a sample of innovative firms, Pérez-Luño *et al.* (2011:555) on the other hand found that proactiveness and risk taking influenced the number of innovations generated, therefore indicating that proactiveness and risk taking predict innovation adoption and generation. Regarding the moderating effect of proactiveness and risk-taking on knowledge management practices-innovation outcomes relationship, proactiveness negatively moderates the relationship between knowledge creation and product/process innovation of Spanish family SMEs (García-Piqueres *et al.*, 2019:1). Furthermore, data suggest that proactiveness related to internal social issues leads to greater internal innovation with external innovation mediating the relationship, but not for external social issues (Goldsby, Kuratko, Bishop, Kreiser & Hornsby, 2018:1).

- Resilience and IC

Morris *et al.* (2013:358) define resilience as the ability to cope with disturbances and stresses in such a way that one remains well, recovers, or even thrives in the face of adversity. From an organisational perspective, Robb (2000) defines a resilient organisation as one able to sustain competitive advantage through its capability to deliver excellent performance against current goals and effectively innovate and adapt to rapid, turbulent changes in the environment. Carayannis, Grigoroudis, Sindakis and Walter (2014:440) studied the role of different factors in the process of how organisation stability and resilience is achieved through business model innovation. Empirical validation provides some interesting insights into whether, when, how and why organisational sustainability, resilience and excellence is best served by business model innovation. Innovation has therefore been found as a documented resilience enabler (Edgeman & Eskildsen, 2012). Levinthal and Rerup (2006) argues that the commitment to resilience is likely to lead to an active awareness in organisations, which is regarded as an openness to new information.

Conducting a meta-analysis of Canadian communities, Dale, Ling and Newman (2010:228) argue that community vitality provides the resilience needed to weather social, economic, and environmental change, and provides a site for innovation where problems can be addressed interactively. From a resilience engineering approach, Pellissier (2011:145) shows how this approach provides space for innovation implementation and focuses on organisational and management innovation through complex adaptive systems. From a different point of view, using the Spearman's Rank correlation tool to test the hypotheses, Williams and Anyanwu (2017:1) reveal that product innovation is significantly related to adaptability and vulnerability, which concludes that organisational innovation has significant influence on resilience. It is therefore recommended that organisations create an enabling environment that encourages employee creativity and innovative capacities that will play a key role in building organisational resilience. One of the activities identified by Johnson-Lenz and Johnson-Lenz (2009) relating to resilient organisations is that "resilient organisations prepare themselves and their employees for disruptions" and "resilient organisations encourage innovation and experimentation". for example indicates that technological, business-model and new-to-the-world (radical) product innovations are all categories of disruptive innovations, which create different kinds of markets, pose radically different challenges for firms and have radically different implications for managers (Markides, 2006:19). Testing and presenting a model of strategic resilience, Morais-Storz, Platou and Norheim (2018:1184) posit that strategic resilience entails proactively and deliberately engendering change via innovation, because in a world of turbulence, complexity and uncertainty, effective change is a requisite of resilience.

- Creative problem-solving and imaginativeness and IC

In Morris *et al.* (2013:358,359), creative problem-solving is described as the ability to relate previously unrelated objects or variables to produce novel and appropriate or useful outcomes. All ventures begin with imagination (Seelig, 2015:56) and opportunities are ultimately determined through the creative imagination and social skills of the entrepreneur (Suddaby, Bruton & Si, 2015:3). Using a creative problem-solving approach, McMullen and Kier (2017:455) developed and tested a new scale that finds imaginativeness to predict new venture ideation over and above the effects of the usual suspect of attitude, knowledge, and evaluation. Creative problem-solving is sought to explain the creativity behind ideation as a function of attitude, knowledge, evaluation and imagination (Isaksen, Dorval & Treffinger, 2011). Creative imaginativeness is the cognitive skill to envision something that cannot be or is not currently being observed for the purpose of original, artistic, novel, or innovative creation (Kier & McMullen, 2018:2271). Kier and McMullen (2018) posit that creative imaginativeness fuels the innovative new combinations of resources that Schumpeter (1934) identified as the function of the entrepreneur and source of economic development. These include product innovation, process innovation, market innovation, input innovation and organisational innovation. Results from a quasi-experiment reveals that, creative imaginativeness play a more prominent role in the generation and selection of ideas for radically innovative ventures than for incrementally innovative or imitative new ventures.

Steiner (2009:5) introduced a "Plenetary Model of Collaborative Creative Problem Solving" as a conceptual framework oriented towards the generation of innovations.

However, it was found that concentrating purely on the creative problem-solving capabilities of individuals is seldom sufficient for creating successful innovations. With respect to the generation of innovation, creativity is a fruitful strategy in attaining new knowledge. The interplay among creative systems for releasing and making available the highest possible creative potential is of special interest in order to enhance the overall creative capability for generating innovations (Steiner, 2009:15).

- Innovation/Innovating and IC

Creativity is characterised by the ability to find hidden patterns, to perceive the world in new ways, to make connections between seemingly unrelated phenomena, and generate solutions (Grzybowska & Łupicka, 2017:250). Someone who is creative can transfer knowledge and ideas, has good visualisation skills and demonstrates a willingness to take chances (Dixon *et al.*, 2005). Creativity has been identified as a method through which entrepreneurs recognise and develop opportunities (DeTienne & Chandler, 2004). Barth (1993) argues that individuals with strong creativity or an innovative anchor have a need to create something new. Creativity is a common manifestation of entrepreneurship and is well established in the empirical literature (Becherer, Mendenhall & Eickhoff, 2008:5). Moreover, creativity reflects the capability to turn problems into new opportunities, and is an important ingredient for successful entrepreneurs (Oosterbeek, Van Praag & IJsselstein, 2008:8). It is also defined as the result of the process embodied in an invention. According to Antonites (2017:71), to discover or invent something new (novel product) is the outcome of the process of creativity. Collaborative creativity is in essence a prerequisite for the generation of innovation (Steiner, 2009:5). Innovation also relates to pre-empting outcomes of creativity (Antonites, 2017:102). Kruger, Millard and Pretorius (2005:56) postulate that creativity is part of the entrepreneurial skills required to successfully start a venture and is the origin of the entrepreneurial process. It is the process through which invention occurs and the enabling process by which something new comes into existence. According to Yusuf (2007), innovation springs from the creative application of knowledge, which consists of creativity and the stock of knowledge.

According to Grafström and Lindman (2017:179) technological progress is a process where invention, innovation and diffusion tend to take place simultaneously. Their estimation results demonstrate that the configuration of a technology learning model has empirical relevance as it supports a move away from a linear view on technological development. Further evidence is found of national and international knowledge spillovers in the invention model. In order to be classified as an innovation, an idea therefore has to be developed and transformed into a product, process or service and commercialised (Popadiuk & Choo, 2006:303).

In a meta-analysis of 52 empirical samples comprising of 10 538 observations, Smith, Courvisanos, Tuck and McEachern (2011b:105) and Sarooghi, Libaers and Burkemper (2015:714) finds a strong positive relationship between creativity and innovation, especially at the individual level. In addition, the authors find moderating effects in which the relationship between creativity and innovation is stronger for larger firms, process innovations, and low-tech industries relative to small firms, product innovations, and high-tech industries. Dyer *et al.* (2008:317) contend that one's ability to generate novel ideas for innovative new businesses is a function of one's behaviour that triggers cognitive processes to produce novel business ideas. More innovations and new technologies can be expected as the level of invention increases (Suarez-Villa, 2017:1). Innovation is also seen as new knowledge incorporated into products, services and processes (Afuah & Afuah, 2003); IC is conceptualised as the stock of all available inventive knowledge (Suarez-Villa & Hasnath, 1993:335).

4.2.1.2 Social competencies and innovation capacity

A positive attitude, networking and leadership are categorised as social competencies as they all comprise attitudes and behaviours in work-related situations (Cheetham & Chivers, 1996:24). Interpersonal competencies are often categorised as social competencies, such as people skills, which are useful in establishing and maintaining relationships with others (Bharwani & Talib, 2017:408). Using three "blocks" of competence categories; professional competencies, social competencies and personal competencies, the empirical findings suggest that managerial competencies, which includes all three categories, is associated with performance in SMEs (Veliu & Manxhari, 2017:59). Ameen, Hameed, Bashir, Bashir and Amin (2015:189) argue that when entrepreneurs integrate with strategic management actions such as innovation, social capital, networking, organisational learning combined with interpersonal skills, then they will gain competitive advantage.

- Positive attitude and IC

Many authors reporting on opportunities presented by neuroplasticity (brain development and associated learning) have drawn attention to the need for a number of important conditions to be fulfilled for desired neuroplastic changes to occur in response to experiences (learning) (Smith *et al.*, 2011a:57). One of the aspects concerned is having a positive attitude, commitment and enthusiasm for the activities involved in the experiences (and their outcomes). This draws attention to the way in which learning at work and learning in all sectors of education form part of a lifelong process that contributes to and helps shape innovation outcomes (Smith *et al.*, 2011a:57).

Liñán and Chen (2009:7) refer to “personal attitude” in the context of someone starting a business, as the degree to which the individual holds a positive or negative personal valuation about being an entrepreneur. *Positive attitude* had the highest mean score rating from the Delphi study and was therefore seen as a very important competency for entrepreneurs in I4.0. Suggestions have been made that personal attitude and perceived behavioural control are the most relevant factors explaining entrepreneurial intentions (Liñán, Rodríguez-Cohard & Rueda-Cantuche, 2011). Krueger *et al.* (2000:413) indicate that it seems evident that much of what we consider “entrepreneurial” activity is intentionally planned behaviour; for instance, “there are often indications of long-time interests and desire to be in business for one’s self.” While it is indicated that intentions predict behaviour, in turn it is said that certain specific attitudes predict intention. In a study focused on non-profit sports clubs, SEM results indicate that knowledge management has a positive effect on organisational performance through two different sequential mediators: attitude towards innovation and innovativeness, and open innovation and innovativeness (Delshab, Winand, Sadeghi Boroujerdi, Hoeber & Mahmoudian, 2020). A model of structural equations using Partial Least Squares applied on small business owners in Paraguay indicates that entrepreneurial attitudes, such as openness to change and self-transcendence, have a mediating role in the positive impact of values on innovation. Thus, suggesting an interaction between entrepreneurial attitudes and entrepreneurial personal values influence innovation (Sánchez-Báez, Fernández-Serrano & Romero, 2018:771).

According to Nieuwenhuizen (2008:14,15), one's thoughts shape behaviour, which is reflective of one's attitude. A *positive attitude* towards their business and themselves will therefore be reflected in entrepreneurs' behaviour. Developing a positive approach to conducting business and facing obstacles will enable them to accomplish seemingly impossible goals. In pairing innovation with the strategic thinking model, an organisation is directly delimited by senior management when it specifies the corporate philosophy that stimulates innovation (Manuel Martínez-López & Vargas-Sánchez, 2013:599). Anthony, Eyring and Gibson (2006:104) therefore argue that it is evident that senior management's positive attitude towards planning is essential to complying with the psychological model of strategic thinking, of which innovation affects a company's socio-organisational and economic areas (Anthony *et al.*, 2006).

- Networking ability and IC

Evidence from Hazlina Ahmad *et al.* (2010) suggests that entrepreneurs, especially in SMEs, engage in various tasks that demand possession of relevant competencies to enable them to manage their ventures effectively. Networking ability is also valued as an entrepreneurial characteristic that innovative ventures want in their employees (Santandreu-Mascarell *et al.*, 2013:1091). Hussler and Ronde (2009) empirically analysed the influence of firms' innovativeness of *networking abilities* in comparison with internal development of competences and spillovers available. The paper estimated the impact of different categories of innovative competences on innovative performance and aimed to identify the core competences firms should develop to become more innovative. The relational competences with economic partners (customers, suppliers or universities) are crucial in the innovation process, which confirms open innovation intuitions, indicating that external networking activities lead to higher innovative levels, rather than pure in-house development of innovative competences (Hussler & Ronde, 2009:6). Meta-case analysis results from Dale *et al.* (2010:228) on thirty-five Canadian communities indicate in many of the case studies that social capital and network formation appear to be key characteristics linked to the diffusion of innovation, since most people decide to adopt an innovation primarily on subjective values and social norms diffused through interpersonal networks. The capacity to integrate networks therefore appears to be a major dimension of SMEs' IC (Pierre & Fernandez, 2018:156). Findings from firms operating in New Zealand also shows that informal institutional distance positively moderates the effect of business networking on innovation whereas informal institutional distance negatively moderates the effect of business networking on innovation (Wang & Chung, 2020:152).

- Leadership and IC

The literature highlights top management support and commitment to innovation as being crucial for successful innovation (Baker, Green & Bean, 1986; Cooper *et al.*, 1988; Lee & Na, 1994). Leadership is regarded as even more important when innovation is concerned with radical change, as this requires a level of learning and change that is often disruptive, risky and costly (Prajogo & Ahmed, 2006:501). Dixon *et al.* (2005) describe someone with leadership skills as having the ability to minimise politics in the workplace, expect excellence from employees, demonstrate good people skills, share information with employees, and being a good coach or mentor. Empirical evidence suggest that leadership significantly affect performance, specifically hotels in Indonesia, either directly or indirectly through innovation and differentiation as an intervening variable. Leaderships does not however affect differentiation strategy directly, but it affects indirectly through innovation (Semuel, Siagian & Octavia, 2017:1152). One of the significant roles of leadership, in relation to innovation, is shaping a "fertile" environment to nurturing innovation (Jassawalla & Sashittal, 2002:43; Martensen, 1998). It is also argued that it is the far-sighted leaders who make the difference by making an aggressive exploitation of new technologies. Innovative companies usually have strong R&D activities and tend to be at the forefront of technological advances. However, taking advantage of these activities requires an enabling stimulus – factors such as leadership, organisational culture and managerial practices. Prajogo and Ahmed (2006:504) hypothesise a significant relationship between innovation stimulus factors (leadership, people management, knowledge management, creativity management) and IC factors of innovation management. Their results indicated that an excellent innovation stimulus is likely to be demonstrated in an excellent IC (Prajogo & Ahmed, 2006:509). Mokhber, Khairuzzaman and Vakilbashi (2018:108) investigated a sample of the top 100 Iranian companies and found a positive relationship between transformational leadership and organisational innovation. Leaders might not only promote innovative activity within the organisation, but also ensure the market success of the innovation.

4.2.1.3 Functional competencies and innovation capacity

Value creation is categorised as a functional competency, as it is based on the ability to perform a range of work-based tasks effectively to produce specific outcomes (Cheetham & Chivers, 1996:24). Based on a study of 306 women entrepreneurs of micro and small enterprises in Germany and Ireland, the analysis finds that ECs as a higher order latent construct have a major impact on entrepreneurial success. Schneider (2017:252) suggest that ECs can be operationalised by six first-order constructs, including functional tasks related to managerial skills, entrepreneurial characteristics of self-efficacy and orientations of competition, risk-taking and innovation, and the founder and innovator identity.

- Value creation and IC

Morris *et al.* (2013:358) define value creation as having capabilities of developing new products, services, and/or business models that generate revenues exceeding their costs and produce sufficient user benefits to bring about a fair return. Priem (2007:2020) defines the term from a consumer-demand side, as involving innovation that establishes or increases the consumer's valuation of the benefit of consumption. Greater value creation therefore depends on the firm's ability to innovate successfully (Adner & Kapoor, 2010:306). Nada and Ali (2015:390) uses service value creation capability in assessing service innovation capability of Danish and Turkish SMEs. The empirical data analysis reveals that there is a strong positive correlation between SME's service innovation capability and service value creation capability. Using a longitudinal data set on alliance portfolios and patents on manufacturing firms, Chung, Kim and Kang (2018:1) found that internal value creation capabilities in terms of routine and ability moderate the relationship between alliance portfolio diversity and innovation performance. In an inductive grounded theory study of innovative entrepreneurs, Dyer *et al.* (2008:317) traced the origins of innovative strategies by examining the attributes of innovative entrepreneurs. According to Vala, Pereira and Caetano (2017:479) innovation requires a combination of capabilities and competences that, together with appropriate routines, converges towards value creation through innovation activities and results. The hypotheses demonstrated that companies revealing innovation success develop routines that contribute to their economic and financial success.

4.2.1.4 *Meta competencies and innovation capacity*

Problem-solving and cognitive ability are categorised as meta competencies, as they facilitate learning (Cheetham & Chivers, 1996:22) and the ability to put the focus on the "know-how" and combine and relate a set of skills in different situations (Arisó *et al.*, 2016:51). In a literature review, combining bibliometric, network and content analysis Reis, Fleury and Carvalho (2020:179,196), proposes a meta-competence framework that clusters 33 core entrepreneurial competences previously identified. Nine clusters linked to meta-competencies evolved from applying the Unicet software which includes: learn with feedback, strategic foresight, flexible emotional stability, business passion, leadership, communication, facing innovation challenges, market forecasting, self-confidence with optimism and ambition.

- Problem solving and IC

According to Casper and Whitley (2004:3), where technological uncertainty is high, predicting which investments and skills will be effective becomes difficult, and firms have to be able to change direction at short notice. This leaves managers of radically innovative firms faced with the need to attract and motivate expert staff to work on complex problems. Radically innovative firms are typically project-based organisations where managers organise highly skilled staff into a series of teams focused on *solving complex problems* under very tight time constraints (Casper & Whitley, 2004:4). Not only can problem solving be valuable in new product development, but it can also be used to facilitate the introduction of existing products in new markets. Problem-solving competencies include visualisation, ordering, analogy, simplification, and framing, which facilitates your ability to create new solutions (Matthews & Brueggemann, 2015:59,60). The manufacturing of products in low maturity levels requires knowledge intensive non-conformance problem-solving, yet constitutes to be a major difficulty in industry (Burggräf, Wagner & Weißer, 2020:1,12). In their theoretical review of 52 articles, they conclude that shortening of product lifecycles, making time to market a competitive factor, demands increased problem solving capabilities during product development. It has also been proved that problem-solving increases performance (Botha *et al.*, 2015a:58). Problem-solving ability demonstrates good analysis skills, ability to prioritise problems and good critical thinking skills (Dixon *et al.*, 2005:33). In their focus on exploring managerial competencies of future managers and engineers, Grzybowska and Łupicka (2017:251) found in their comparative analysis that respondents from both the pharmaceutical sector and automotive sector consider problem solving to be very important as a competency for I4.0. The experts who participated in these specific industry sector included qualified managers employed in transnational companies. While innovative behaviours, such as problem solving, thinking and new knowledge are individually and collectively powerful tools, creativity is often known as the catalyst that brings innovation to light and life (Matthews & Brueggemann, 2015:64).

- Cognitive ability and IC

Cognitive ability is defined as “the ability to generate or use different sets of rules for combining or grouping things in different ways” (Gray, 2016). Cognitive ability is understood as being constructed over sets of measureable information-processing tasks (Hernández-Orallo, Dowe & Hernández-Lloreda, 2014:7). The authors Hernández-Orallo *et al.* (2014:16) argue that abilities are constructs while tasks are instruments; cognitive abilities can be inferred by the performance on tasks, though it is very difficult to find a set of tasks which corresponds uniquely with an ability, since a task usually involves several abilities. Scholars in entrepreneurship suggest that research in cognition can serve as a process lens through which to re-examine the “people side of entrepreneurship” by investigating the memory, learning, problem identification, and decision-making abilities of entrepreneurs (Mitchell, Smith, Morse, Seawright, Peredo & McKenzie, 2002b:93). Entrepreneurial cognition has therefore been defined as “the knowledge structures that people use to make assessments, judgement, or decisions involving opportunity evaluation, venture creation, and growth (Mitchell *et al.*, 2002a). Cognitive adaptability, on the other hand, is defined as the ability to be dynamic, flexible, and self-regulating in one’s cognitions, given dynamic and uncertain task environments (Haynie & Shepherd, 2009:695). In their findings, Pihie, Bagheri and Sani (2013:174) highlight the importance of understanding students’ knowledge of cognition capacity in Malaysia to improve their entrepreneurial learning and consequently their intentions to become entrepreneurs. Cognitive ability on individual level has been found to have a positive relationship with successful entrepreneurship (Hafer & Jones, 2015:284). Based on product innovation ability insights, Sheng, Hartmann, Chen and Chen (2015:94) examine the role of social cognitive ability as a minimizer of a negative relationship between subsidiary tacit-knowledge level and multinational corporations' product innovation ability. Applying PLS-SEM to test the hypotheses, results reveal that each of the multinational corporations' social cognitive capability components (i.e., task efficiency, organic structure, and affective trust) independently weakens the negative relationship. In Ahmed (1998:7), cognitive factors also appear to be associated with the ability to innovate, and a number of factors are associated with creativity. Cognitive parameters that affect idea production have been identified as: associative fluency, fluency of expression, figural fluency, ideational fluency, speech fluency, word fluency, practical ideational fluency, originality, fluency, flexibility, originality and elaboration (Ahmed, 1998:8). The empirical findings of Sarfraz, He and Shah (2020:45938) envisage the cognitive CEO (chief executive officer) as a promoter of corporate environmental responsibility. Meanwhile, innovation output is ascertained as a vigorous intensifier of corporate environmental performance as compared with innovation output. Building on a new concept of "cognitive collective engagement", which integrates engagement theory with knowledge-based view. Empirically testing this concept on a sample of 202 firms, evidence reveal that cognitive collective engagement mediates the relationship between the three organisational resources (knowledge-oriented leadership, knowledge management practices, and talent-based human resources management) and innovative performance (Fachrunnisa, Adhiatma & Tjahjono, 2020:743).

Based on the preceding literature provided, it is evident that there is a relationship between ECs and IC, of which specific competencies could be identified significant to innovation. Building on the Markman and Baron (2003) person-entrepreneurship fit theory, Figure 4.2 illustrates how this theory defines entrepreneurial success as IC, and identifies which ECs innovative entrepreneurs require for their capacity to innovate.

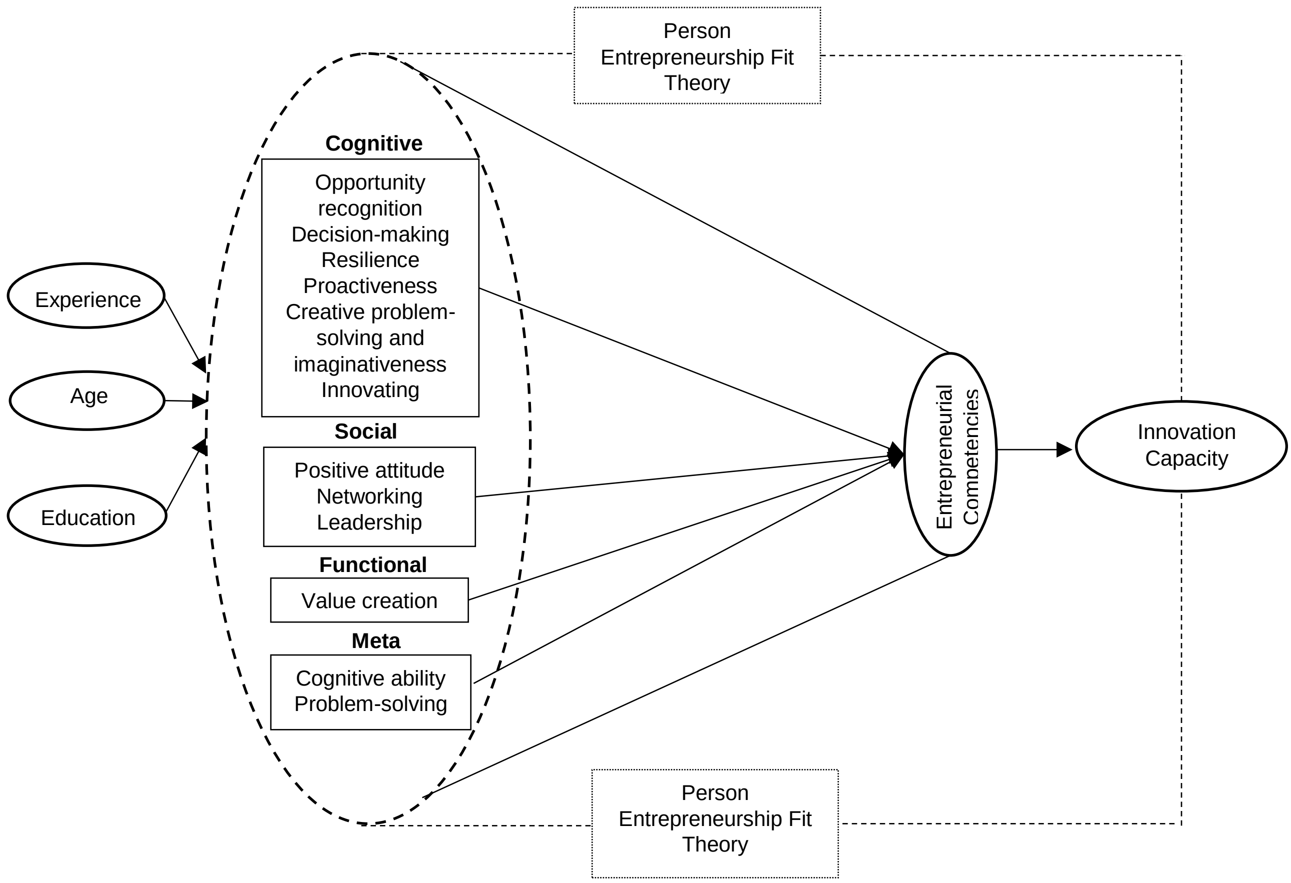


Figure 4.2: The relationship between entrepreneurial competencies and innovation capacity, grounded in Person Entrepreneurship Fit Theory

Source: Adapted from Markman and Baron (2003)

4.2.2 The relationship between entrepreneurial absorptive capacity and innovation capacity

From the primary objective, a secondary objective of the study was formulated, namely to determine whether entrepreneurial absorptive capacity enhances an entrepreneur's innovation capacity. In order to explain Hypothesis 2, the relationship between the constructs of EACAP and IC should be explained. From a micro-perspective point of view, there are specific innovations and factors that influence the nature and the success or failure of particular innovations. A number of theories in this perspective are used as an analytical tool to explain and predict the outcome of the innovation process. These theories also have value in the sense that they categorise and classify innovations. At the same time these theories can assist in identifying some factors that bring about successful innovations (Smith, 2015:56).

One of the greatest strengths of ACAP and the reason why it has been widely used by those researching the field is that it integrates and brings together a number of ideas. It includes ideas about technological evolution, the learning process and networking. ACAP is also known to be linked to IC to explain why absorbed knowledge can or cannot be transformed into successful innovation (Lukjanska, 2010:43). According to research conducted by Pierre and Fernandez (2018:158), the learning process appears to be a relevant dimension of SMEs' IC the ability to integrate external knowledge has been identified as a major factor in firms' IC. ACAP involves learning and acting on the scientific discoveries and technical activities occurring outside the boundaries of the firm, which is qualitatively different from technology development. The knowledge and information gathered outside the firm is then used to redirect scientific discovery and technology development activities (Deeds, 2001:32). It is for this reason that "diversity of experience" (Cohen & Levinthal, 1990) or "work experience" (Pierre & Fernandez, 2018:142) has been identified as a critical factor in developing ACAP and hence the ability to assimilate and apply new ideas, and in turn, lead to innovative performance (Cohen & Levinthal, 1990:128).

Pierre and Fernandez (2018:142) state that innovation is broadly influenced by the owner or the entrepreneur and can also be the initiator of innovation activities in SMEs. Fındıklı *et al.* (2015:377) posit that strategic human resources practices has an influence over organisational innovation (exploration and exploitation) and knowledge management capacity of firms (knowledge sharing and knowledge application) operating in Turkey. Regression analysis emphasises that certain practices in human resources do have a predictive power over organisational innovation and knowledge management capacity of firms. How organisations enhance their innovativeness has long been a question for scholars and practitioners. Research has pointed out the direct influence of learning-orientation on firm innovativeness (Calantone, Cavusgil & Zhao, 2002; Hurley & Hult, 1998). Keskin (2006:396) finds that a firm's learning-orientation positively influences firm innovativeness, and shows that firm innovativeness positively affects firm performance. ACAP seems to be one of the most important determinants of the organisation's ability to acquire, assimilate, and profitably utilise new knowledge to increase its innovation performance. Empirical evidence from high and medium technology manufacturing industries in Iran suggest that in the presence of ACAP, only collaboration with research organisations and competitors have a positive effect on product innovation capability. In the case of process innovation capability, collaboration with suppliers and research organisations are the most important factors (Najafi-Tavani *et al.*, 2018:1).

Looking at total quality management practices and knowledge management processes enhancing innovation performance of manufacturing companies in Malaysia, Yusr *et al.* (2017:955) finds a significant relationship between total quality management practices and knowledge management processes, as well as a relationship between knowledge management and innovation performance. In a longitudinal case study on an industrial district in Italy who has successfully introduced a radical innovation, the analysis supports that the meso (industrial district) and the micro (organisation) have to be considered together to understand to what extent the district might be able to sense, assimilate and apply ideas to transform the local knowledge base. The findings further highlights the role of the industrial district's functioning mechanisms in enabling the development of (radical) innovation (Molina Morales, De Marchi & Martínez-Cháfer, 2021:1,9). Organisations therefore need to raise their ACAP to acquire, assimilate, transform, and exploit knowledge which can lead to organisational innovations (Chen, Lin & Chang, 2009:154). Research further indicates that when ACAP is present, external research activities can complement in-house research, achieving potentially strong synergies and yielding the best results in terms of innovation and innovation appropriation (Arora & Gambardella, 1990; MacPherson, 1997). Using data from the American pharmaceutical industry to estimate generalised linear mixed models, results confirm known relationships between R&D capability, alliance network position and the development of radically new products, but reveals different sets of factors that influence differentiation and imitation (Skilton *et al.*, 2020). In an attempt to investigate how individuals inside a high-tech company use external knowledge to generate innovations, Tortoriello (2015:586) shows that the effects of external knowledge on individuals' innovativeness are contingent upon individuals' position in the internal social structure. Empirical results particularly indicate that the positive effects of external knowledge on innovation generation become more positive when individuals sourcing external knowledge span structural holes in the external knowledge-sharing network. ACAP offers synthesis that draws all these strands together, and in the process offers a powerful tool to analyse innovation (Smith, 2015:65).

Further research by Popadiuk and Choo (2006:311) suggests that knowledge creation is focused on the generation and application of knowledge that leads to new capabilities for an organisation. Innovation is therefore concerned with how these new capabilities may be turned into products and services that have economic value in markets. By using the analysis of SEM on a sample of company managers in the tourism sector, Yuwono (2020:1399,1401) found a significant positive effect of realised ACAP on innovation, but found potential ACAP to have no effect on innovation. This indicates on the one hand that merely acquiring and understanding knowledge relevant to a company’s core business, with the dimensions of acquisition and assimilation, will not result in innovation as with realised ACAP. Realised ACAP on the other hand is a company’s ability to use the knowledge that has been acquired to become useful knowledge, which consists of the transformation and exploitation of knowledge. Similarly, by dissociating the dimensions of ACAP (potential and realised) and corporate entrepreneurship, Jiménez-Barrionuevo *et al.* (2019:1) draws on a dynamic capabilities perspective and resource-based view. The empirical results from a sample of Spanish firms demonstrates that entrepreneurs must be able to enhance potential and realised ACAP at the same time in order to improve the end performance of their corporate entrepreneurial projects.

According to Smith (2015:65), the ACAP theory is more sophisticated than other theories of innovation, as it highlights the importance of external knowledge as a critical component in innovation. Evidence therefore suggests that the most prominent output of ACAP is innovation performance. This can be seen in Chapter 3, as research conducted by Hall and Andriani (2003:149) indicates that the amount of knowledge to be acquired and applied links to the nature of new knowledge, which indicates what the innovation will lead to (minor incremental innovation, major incremental innovation, minor radical innovation, major radical innovation). Building on models of innovation by Zahra and George (2002), Löwik (2013:113) clearly illustrated in Figure 3.7 that the outcome of individual ACAP is individual innovative performance. The successful absorption of knowledge (effective ACAP) therefore leads to competitive advantage in the form of innovation performance (the ability to generate innovative outputs), illustrated in Figure 3.10 (Smith, 2015:64). For the purposes of this study, building on models of Zahra and George (2002) and Löwik (2013), Figure 4.3 illustrates the relationship between EACAP and IC grounded in ACAP theory, therefore justifying the hypothesis statement that there is a relationship between EACAP and IC, which is grounded in ACAP theory.

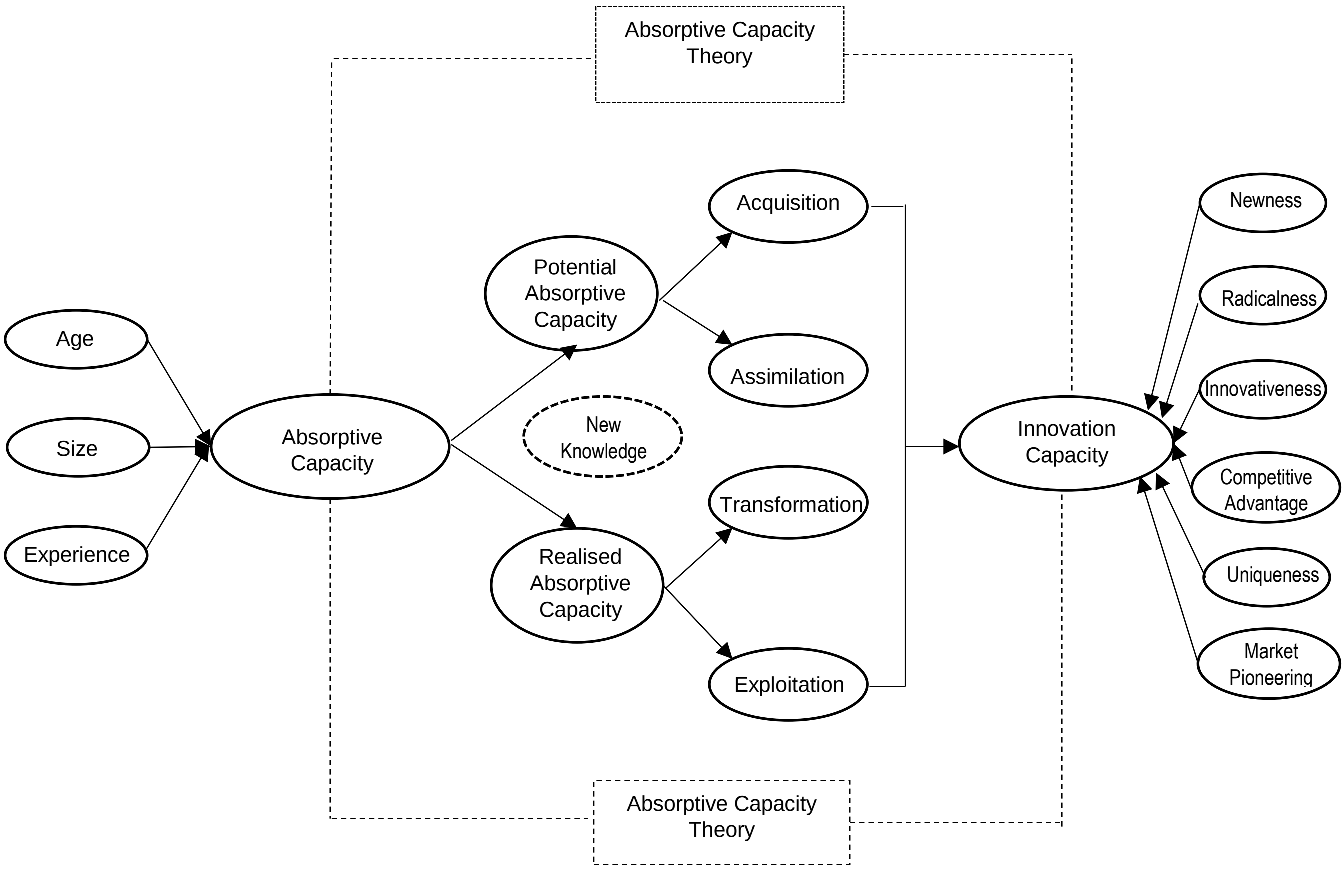


Figure 4.3: The relationship between entrepreneurial absorptive capacity and innovation capacity grounded in Absorptive Capacity Theory

Source: Adapted from Löwik (2013); (Zahra & George, 2002)

4.2.3 The relationship between entrepreneurial competencies and entrepreneurial absorptive capacity that leads to innovation capacity

From the primary objective, a secondary objective of the study was formulated, namely to determine whether specific cognitive, functional, social and meta competencies enhances ones entrepreneurial absorptive capacity. In order to explain Hypothesis 3, the relationship between the constructs of EC and EACAP that leads to IC should be explained. Most revolutionary new business ideas can be argued to have been, and are likely to continue to be, provided by the independent entrepreneur. One explanation that gives individual entrepreneurs a radical innovation advantage may be that opportunities to create radical innovation depend more on individual knowledge and initiative than on organisational processes (Marvel & Lumpkin, 2007:809).

4.2.3.1 ACAP theory supporting the relationship between EC and ACAP that leads to IC

The new ACAP theory of knowledge spillover entrepreneurship, illustrated in Figure 3.1 by Qian and Acs (2013), provides insights into the relationships between new knowledge, knowledge embodied in people (i.e. human capital), and entrepreneurship (Qian & Acs, 2013:186). Not only is human capital a predictor of new knowledge, as suggested by the Knowledge Production Function, but also the key determinant of EACAP that involves knowledge and skills of entrepreneurs to understand a new technology, recognise its market value, and bringing it into commercialisation (Qian & Acs, 2013:193). In existing ACAP literature, an individual's ACAP is conceptualised as a set of competences consisting of individuals' prior knowledge and experience (Hayton & Zahra, 2005; Jane Zhao & Anand, 2009), values and beliefs, technical skills (García-Sánchez, García-Morales & Martín-Rojas, 2018; Matusik & Heeley, 2005) and motivation (Minbaeva *et al.*, 2003). Of course these competences mainly relate to the knowledge-processing function of individuals for organisational ACAP (Löwik, 2013:106).

Skills are widely recognised as central to ACAP, but the identification of the specific levels of education and skills that contribute most to the development of ACAP is often hampered. By drawing on a cross-country industry-level dataset, Mason *et al.* (2020:223), retain separate measures of key components of ACAP, namely skills, R&D investments and openness to foreign trade investment. In order to determine the extent to which different levels of skills contribute to innovative output (measured by growth in patenting), SEM was applied. Strong support is provided that high-level skills have positive effects on each country/industry's ability to convert opportunities for external knowledge sourcing into innovative output. However, only partial support is provided regarding the indirect effects of intermediate skills on innovative output. Contributing to responsible management literature by integrating ACAP and organisational learning, findings demonstrate that managers who are able to recognise and acquire external knowledge, develop environmental competences. At the same time, organisations capable of assimilating, transforming and exploiting knowledge, develop environmental capabilities. As such, results show that environmental competences have a positive direct effect on environmental performance, and an indirect effect as a mediator between environmental capabilities and performance (Dzhengiz & Niesten, 2020:881). According to García-Sánchez *et al.* (2018:345), the capacity to absorb new knowledge and technological skills can generate new, advanced technological processes. Positive relationships are found between these factors using a sample of 160 European technology firms.

The ACAP theory of knowledge spillover entrepreneurship, with endogenously created new knowledge and endogenously developed entrepreneurial ACAP, becomes a two-phase process, as illustrated earlier in Figure 4.1. As mentioned, the theory provides insights into the relationships between new knowledge, knowledge embodied in people (i.e., human capital), and entrepreneurship. It is therefore evident that the knowledge economy in Silicon Valley, for example, is driven by a multiplicity of high-level skills as well as effective models of knowledge sharing (DA, 2013:4). Empirical evidence supporting the knowledge spillover theory of entrepreneurship provides evidence that the greater the investment in new knowledge, the higher the start-up rates (Audretsch, 1995), and ultimately greater innovation and economic growth (Audretsch *et al.*, 2005:70). In order to develop the notion of ACAP, Camisón and Forés (2011:66) indicate that the diffusion of shared competences requires a firm's internal learning effort to better absorb localised knowledge spillovers.

4.2.3.2 Human capital supporting the relationship between EC and ACAP that leads to IC

Many scholars have empirically studied human capital in opportunity research (Bayon, Lafuente & Vaillant, 2016; Lim & Xavier, 2015) and examined knowledge exclusively, as knowledge influences the entrepreneur's ability to comprehend, extrapolate, interpret, and apply new information (Hajizadeh & Zali, 2016; Marvel & Lumpkin, 2007:810; Mostafiz & Goh, 2018). When exploring the combinations of general and human capital linked to higher levels of innovation radicalness, the characteristics associated with radicalness were education and experience depth (knowledge based on years of experience) (Marvel & Lumpkin, 2007:821). Interestingly, the specific configuration of human capital knowledge revealed that, of the different knowledge types for opportunity recognition, only technology knowledge was greater for those entrepreneurs who created radical innovations. This indicates that technology knowledge is a prerequisite for recognising opportunities with radical innovation outcomes and should be included in future knowledge frameworks (Marvel & Lumpkin, 2007:821). Empirical evidence suggest that prior knowledge, cognitive characteristics, entrepreneurial alertness and social network have a positive impact on opportunity recognition (Hajizadeh & Zali, 2016:63; Lim & Xavier, 2015:105). Furthermore, results demonstrate that both entrepreneurial alertness and learning partially mediate the relationship between prior knowledge and opportunity recognition (Hajizadeh & Zali, 2016:63).

Professional capacities developed over years are one of the two factors found by Pierre and Fernandez (2018) to influence an SME's IC. They are known to be a combination of personal knowledge, experience, activities and training that allows the owner or entrepreneur to efficiently manage innovation within an organisation. The related professional capacities further rely on the personality of the owner, particularly his attitude towards risk and capacity for taking risks (Pierre & Fernandez, 2018:142-143). Although research conducted by Prajogo and Ahmed (2006) did not show any direct effect of technological and human capital factors (innovation stimulus factors) on innovation performance, the results did demonstrate that there is a link between stimulus factors implemented at the enterprise level and the development of the "innovation capacity" of the enterprise (Smith *et al.*, 2011a:105). Furthermore, SMEs hold knowledge, and so the capabilities, training and experience, of which human capital represents the basis for their ACAP (Valentim, Lisboa & Franco, 2016:722).

Lichtenthaler (2009:822) postulates that the process-based conception of innovation (or absorptive) capacity, linking technological and human capital stimuli, highlights the role of learning in the innovation process. As studies on the human factors of innovation within an organisation began to appear (Kanter, 1983), the need arose to link the human factors into an overall macro-perspective of the complete innovation process. This builds on the macro framework developed by Prajogo and Ahmed (2006), known as the stimulus capacity performance approach, in which human capital and technological capital are the stimulus factors that develop IC. The human capital factors are underpinned by the internal learning and development within an organisation and the external tertiary education system, which supports internal learning and development. In effect, these bring together internal and external training, individual career development and organisational development, to embed in employees the learnt ability to recognise and use stimuli, thus building IC (Smith *et al.*, 2011a:105).

4.2.3.3 Knowledge and competence supporting the relationship between EC and ACAP that leads to IC

When it comes to innovative performance, Danneels (2002:1096) argues that product innovation ultimately drives organisational renewal, which involves the building and expansion of organisational competences over time, by exploiting and exploring firm competences. He examined the reciprocal interplay of product innovation with firm competences over time by basing his theoretical framework on literature regarding product innovation, organisational resources and competences, organisational learning and path dependency. In articulating the dynamic and reciprocal relation between a firm's product innovation efforts and its use and development of competence, the findings show how product innovation functions as a tool for organisational learning, and thus contributes to firm renewal (Danneels, 2002:1097).

Popadiuk and Choo (2006:311) suggest that knowledge about markets is another critical component of the innovation process that is determined by this continuous interaction between technical knowledge and market knowledge that will define an organisation's capacity to innovate. The knowledge configuration and the negatively correlated betas of prior knowledge of ways to serve markets and prior knowledge of customer problems found by Marvel and Lumpkin (2007:822) provide evidence that these knowledge types may stifle creativity and ability to recognise more radical opportunities. Looking further into customer and competitor dimensions, empirical findings support the notion that knowledge competencies are indeed mediators of the positive relationship between orientations and market-based innovations (Ozkaya, Droge, Hult, Calantone & Ozkaya, 2015:309). While assessing IC, Lukjanska (2010:43) identified knowledge and competence as one of the important internal determinants for IC, as such linking ACAP to innovative capacity in a way that absorbed knowledge can or cannot be transformed into successful innovations, as part of the ACAP process. Knowledge and competence are therefore determinants of IC on the level of which SMEs always raise problems to be delivered. Based on the evidence, the relationship between ECs and EACAP can lead to IC.

Building on Qian and Acs (2013) schematic description of the ACAP theory of knowledge spillover entrepreneurship with endogenously created knowledge, Figure 4.4 illustrates how the relationship between EC and EACAP that leads to IC is grounded in the Knowledge Spillover Theory.

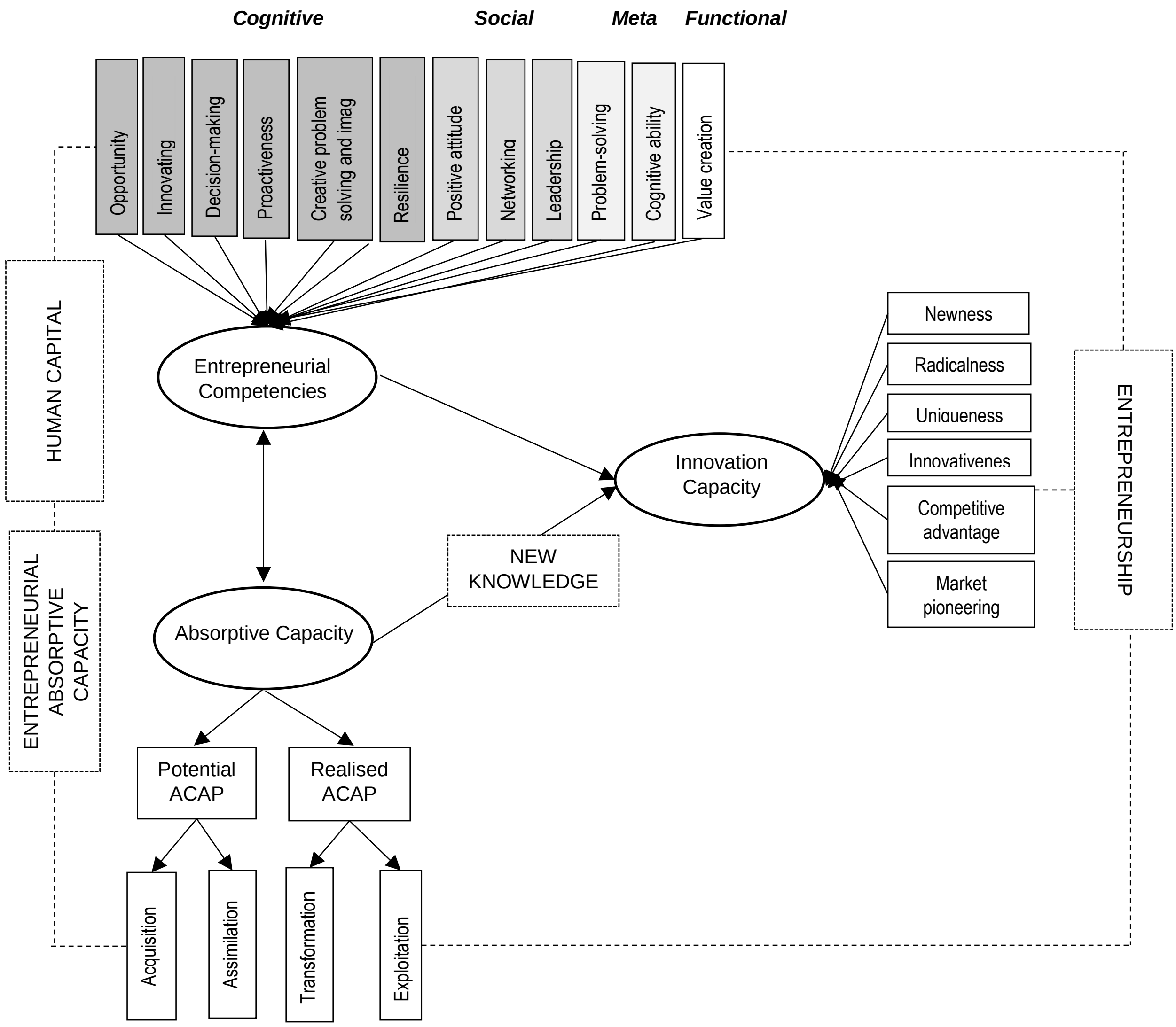


Figure 4.4: The relationship between entrepreneurial competencies and entrepreneurial absorptive capacity that leads to innovation capacity grounded in Knowledge Spillover Theory

Source: Own compilation

4.3 CONCEPTUAL FRAMEWORK 2

This study hypothesises that EACAP mediates and moderates the relationship between EC and IC. This is illustrated in Figure 4.5 below.

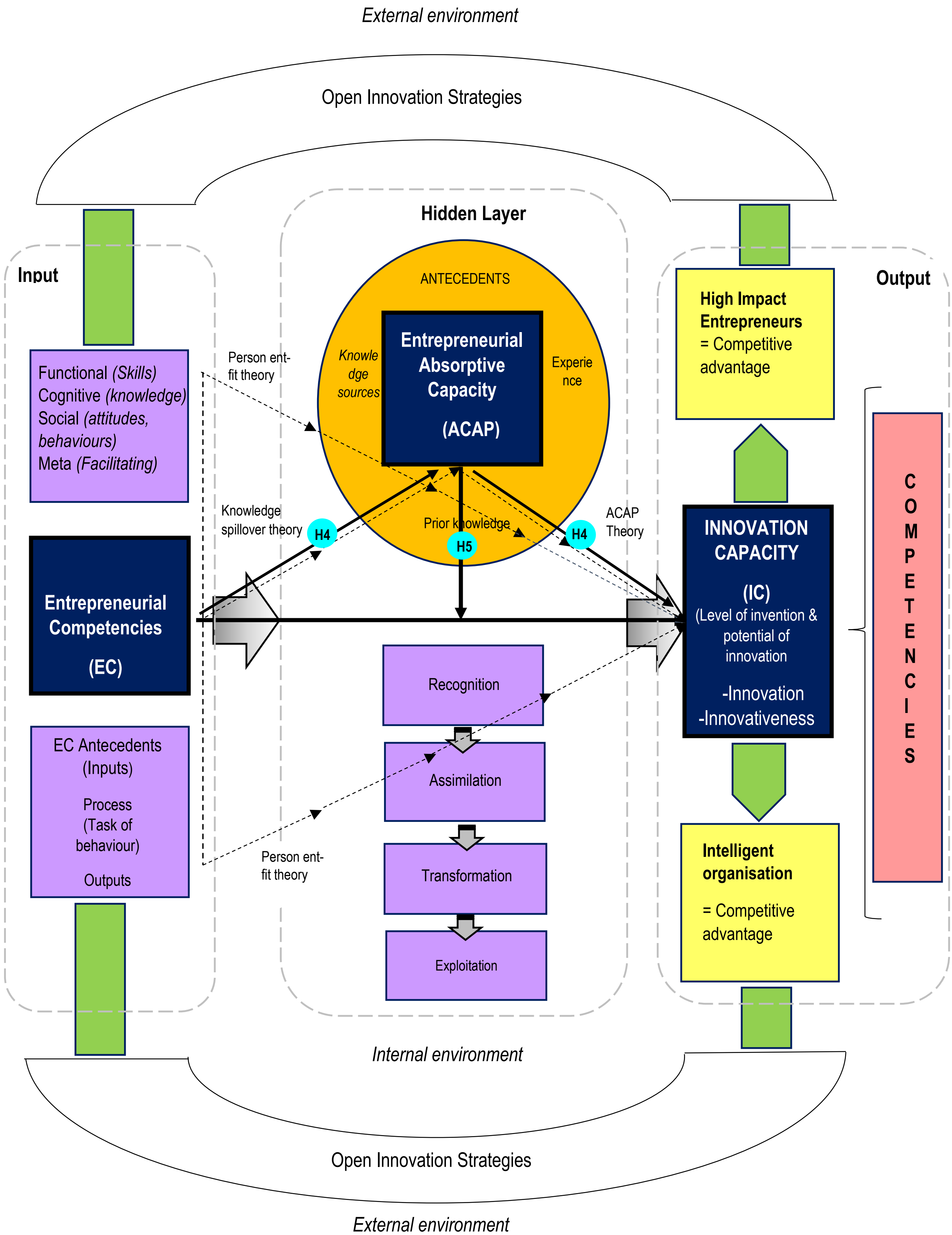


Figure 4.5: Conceptual framework 2: EACAP as moderator and mediator (Hypotheses 4 & 5)
Source: Own compilation

4.3.1 Entrepreneurial absorptive capacity as mediator between entrepreneurial competencies and innovation capacity

From the primary objective, a secondary objective of the study was formulated, namely to determine whether entrepreneurial absorptive capacity has a mediating effect on the relationship between the four categories of entrepreneurial competencies and innovation capacity In order to explain Hypothesis 4, the mediating effect of EACAP between the constructs of EC and IC should be explained. Many scholars have found ACAP playing a mediating role in its relationship between information system integration and firm performance (Francalanci & Morabito, 2008:297), information technology (IT) capabilities and firm performance (Liu, Ke, Wei & Hua, 2013), knowledge acquisition and innovation capability (Liao, Wu, Hu & Tsuei, 2009) as well as entrepreneurial orientation and IT project success (Khan, Bhatti, Zaman & Hussain, 2020:529). Kostopoulos, Papalexandris, Papachroni and Ioannou (2011:1335) extended their research on ACAP and its role as mediator in the relationship between external knowledge inflows and innovation. The study demonstrated that external knowledge inflows are directly related to ACAP and indirectly to innovation. The same findings resulted from Moilanen, Østbye and Woll (2014:447), whose study was based on SMEs. These studies offered empirical evidence of the mediating role of ACAP in the relationship between external knowledge flows and innovation performance (Kostopoulos *et al.*, 2011:1340; Moilanen *et al.*, 2014:447). Chen *et al.* (2009:152) utilised structural equation modelling (SEM), which showed that relationship learning and ACAP positively influence innovation performance and have positive effects on competitive advantages of companies. According to Kahn (2020:529), the lack of absorptive capacity touch points, limits the organisational potential to cope with innovation-based project challenges. Employing a deductive approach, evidence suggests the importance of aligning project management practices with organisation's entrepreneurial orientation that empowers members to maximise on successful project outcomes with the timely consumption and application of new knowledge. Using a sample of 111 industrial organisations, contradictory findings also shows that ACAP fosters the creation of knowledge, but does not significantly influence organisational innovation (Costa & Monteiro, 2016:207).

Organisations can acquire and simulate knowledge but not have the capability to transform and exploit this knowledge. A high potential absorptive capacity (PACAP) does not necessarily imply enhanced performance. Realised absorptive capacity (RACAP), on the other hand, involves transforming and exploiting the assimilated knowledge by incorporating it into the organisation's operations. Realised ACAP therefore fully mediates the influence of the PACAP on innovation outcomes (IO), which is positively conditioned by relational learning (Leal-Rodríguez, Roldán, Ariza-Montes & Leal-Millán, 2014b:1,6). Therefore, this evidence suggests that EACAP can play a mediating role in the relationship between ECs and IC.

4.3.2 Entrepreneurial Absorptive Capacity as moderator between Entrepreneurial Competencies and Innovation Capacity

From the primary objective, a secondary objective of the study was formulated, namely to determine whether entrepreneurial absorptive capacity has a moderating effect on the relationship between the four categories of entrepreneurial competencies and innovation capacity. In order to explain Hypothesis 5, the moderating effect of EACAP between the constructs of EC and IC should be explained. According to Bonache and Brewster (2001:159), the knowledge transfer perspective on expatriation suggests that expatriates represent a means of transferring knowledge to subsidiaries. One indicator of knowledge transfer success is the amount of knowledge received by a subsidiary from expatriates which, Chang, Gong and Peng (2012:929) argue, is influenced by expatriate competencies (ability, motivation and opportunity-seeking) in transferring knowledge. They proposed that the three dimensions of expatriate competencies will increase the knowledge received by the subsidiary, which in turn will enhance subsidiary performance. The empirical results supported their hypotheses, with subsidiary ACAP as moderator, which indicated that the indirect effect of expatriate competencies in knowledge transfer on subsidiary performance can be strengthened when subsidiary absorptive capacity is greater (Chang *et al.*, 2012:927). In recent studies, attention has been given to "the green economy" (Zhao *et al.*, 2019) and "green absorptive capacity" (Pacheco, Alves & Liboni, 2018), where in both cases ACAP is found to play a moderating role. The results indicate that ACAP positively moderates the relationship between knowledge spillover and the green economy (Zhao *et al*., 2019:25312) as well as the relationship between environmental factors and green innovative performance (Pacheco, 2018:1502), Escribano, Fosfuri and Tribó (2009:96) attempted to test the impact of ACAP on innovation performance, with the focus on how such an influence moderates the degree to which external knowledge flows affect innovation input. The results suggest that ACAP is indeed a source of competitive advantage, and therefore pays dividends in terms of innovation performance to invest in enhancing absorptive capacity (Escribano *et al.*, 2009:104). Absorptive capacity was also found to have a positive moderating effect between technology sourcing mix and performance. Furthermore, using a sample of 324 SMEs in China, ACAP positively moderates the relationship between entrepreneurial orientation and technological innovation performance (Zhai *et al*., 2018:314). Higher levels of ACAP will therefore allow a firm to more fully capture the benefits resulting from ambidexterity in technology sourcing. Therefore, this evidence suggests that EACAP can play a moderating role in the relationship between ECs and IC.

4.4 CONCEPTUAL FRAMEWORK 3

This study suggests (Hypothesis 6) that EC has a moderating effect on the relationship between EACAP and IC.

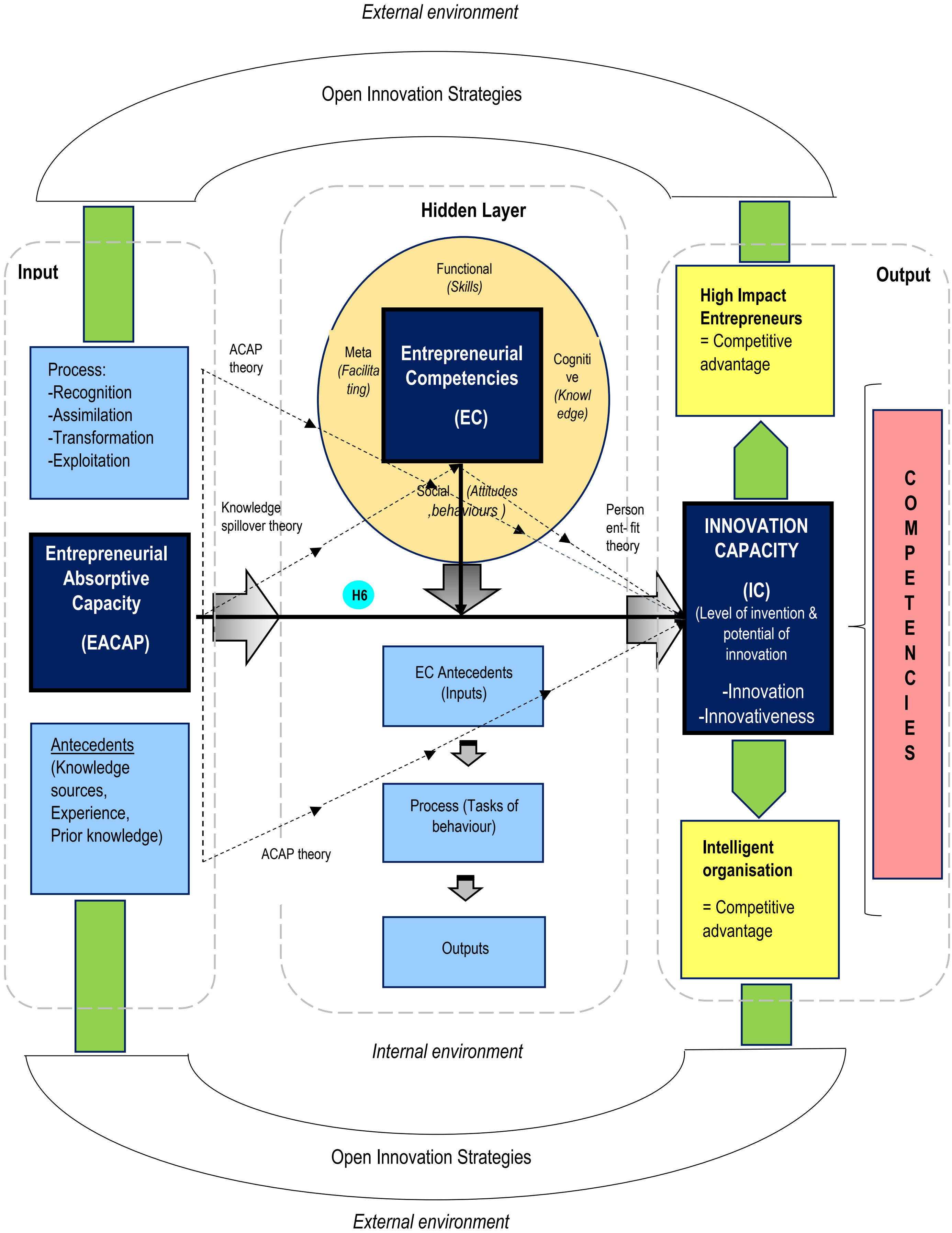


Figure 4.6: Conceptual framework 3: EC as moderator (Hypothesis 6)
Source: Own compilation

4.4.1 Entrepreneurial competencies as moderator between entrepreneurial absorptive capacity and innovation capacity

From the primary objective, a secondary objective of the study was formulated, namely to determine whether the four categories of entrepreneurial competencies have a moderating effect on the relationship between entrepreneurial absorptive capacity and innovation capacity. Due to the lack of existing research focusing specifically on the four EC categories as moderators in the relationship between EACAP and IC, this section includes evidence of ECs as moderators in other relationships. In order to explain Hypothesis 6, the moderating effect of EC (cognitive, social, functional, meta) between the constructs of EACAP and IC should empirically be tested. Noting the radical changes in today's business environment, entrepreneurs are made aware of important competencies that may have causal connections to their business success (Ahmad *et al.*, 2010:73). Chandler and Hanks (1994:77) presented a parsimonious model of venture performance that incorporates the founder, firm and environmental characteristics. It specifically examined the moderating effect of founder competencies on venture performance; the results indicated that individual level competencies moderate the relationships between the quality of the opportunity and firm performance.

Several studies have also focused on professional competencies compatible with outcomes (Cheetham & Chivers, 1996; Winterton *et al.*, 2006) and a holistic approach in aligning education and learning with the development of professional competencies (Le Deist & Winterton, 2005). Managerial competencies are assessed in terms of actual behaviour observed in the workplace. These competencies are usually defined in terms of underlying personal characteristics such as traits, knowledge, skills and attitudes of the individual manager. Research on EC show that competencies directly correlate with job performance (Bryant & Poustie, 2001:73; Morris *et al.*, 2013:353) and firm performance. A theoretical framework was developed by Ahmad *et al.* (2010:71) to link ECs and business success by taking into consideration the various roles held by entrepreneurs in managing their own business. Sánchez (2012:165) studied the influence EC has on firm performance and built a causal model. The results indicate that entrepreneurial competence plays an influential role in organisational capability and competitive scope. It also has a direct effect on firm performance (Covin

& Miles, 1999; Sánchez, 2012:165). Botha (2020:11) found that ECs, leadership, innovativeness, curiosity, self-efficacy and motivation are all statistically significant moderators in the relationship between prior entrepreneurial exposure and entrepreneurial action for woman entrepreneurs. Investigating a sample of 400 SME's, results confirm that ECs strongly moderate the relationship between entrepreneurial climate and venture performance (Lawal *et al.*, 2018:1). Focusing on innovation competencies, Kobarg, Stumpf-Wollersheim and Welpe (2018:1697) investigate the potential influence of ACAP and innovation competencies on the relationship between university-industry collaboration and innovation performance. Using moderated multiple regression, results reveal that ACAP is indeed a moderator in this relationship.

Based on the foregoing, this study sought to confirm whether an entrepreneur's capacity to innovate (demonstrating high levels of invention and innovation) can be achieved with higher levels of competency (cognitive, social, functional meta) and ACAP.

4.5 CONCLUSION

In general the purpose of this study is to investigate existing literature on the interrelationships between EC, EACAP and IC and to empirically study the relationships between these variables in the context of innovative entrepreneurs in South Africa. In order to achieve this purpose, the investigation revolved around three conceptual frameworks. The conceptual frameworks illustrated in Figures 4.1, 4.5 and 4.6 endeavours to unfold a deeper understanding of the entrepreneur for this emerging industrial revolution and what is needed for successful innovation – translating research outputs into commercially viable products and services. It has been centred on the gaps in existing literature, mainly on the understanding of why entrepreneurs invent the way they do, in particular with the fourth industrial revolution in mind. The individual's capacity to innovate and how EACAP and EC play a role in this relationship are of particular importance.

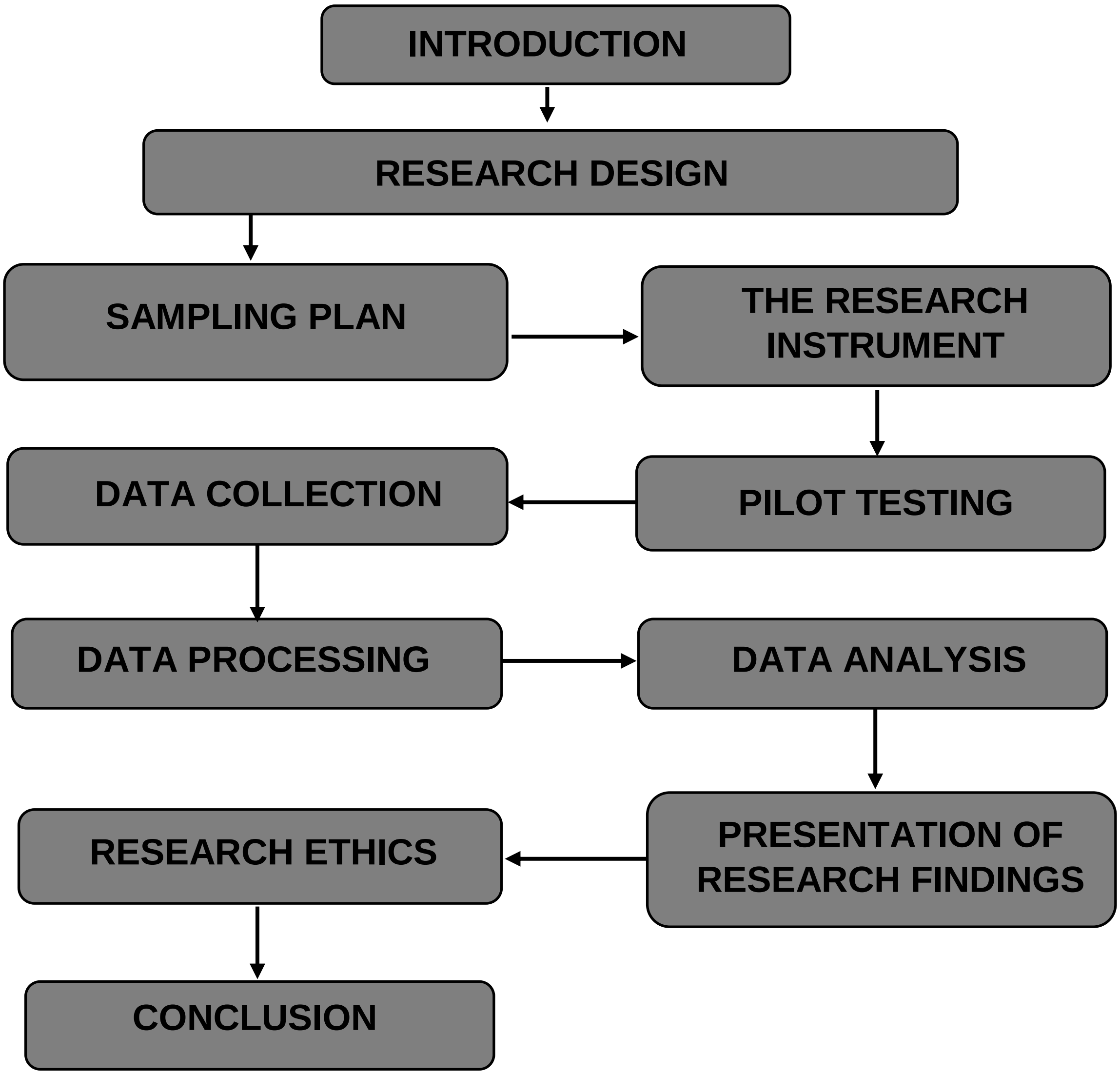
The specific ECs that evolved from the Delphi study and IC elements are other variables that are examined in the course of this study. In order to achieve this, the study will adopt a chronological approach in the investigation.

The first part of this study utilised a qualitative approach designed to provide insights into the competencies required for entrepreneurs for I4.0. In the process this addressed the gap in the literature pertaining to I4.0 competencies of entrepreneurs. The second part of this study adopted a quantitative approach that examined the three frameworks as suggested to explore which empirical relationships exist. Analysing the relationships between EC, EACAP and IC will enhance our understanding of why the I4.0 entrepreneurs invent the way they do. Based on the results, a proposed ECs framework was also presented, specifically for the 14.0 entrepreneurs, as illustrated in conceptual frameworks 2 and 3.

CHAPTER 5:

RESEARCH METHODOLOGY

DIAGRAMMATIC SYNOPSIS



5.1 INTRODUCTION

While theoretical grounding for the study was provided in chapters 2 to 4, this chapter focuses on the next step of the study by focusing on the research methodology. This chapter discusses the practical steps that were followed in providing information needed to conduct the proposed empirical study. The chapter therefore details the process in the form of research objectives and hypotheses to be tested, research design, sampling plan, measurement instrument and data collection, data processing and data analysis. The chapter elaborates on the postulated model for Innovation Capacity (IC) and the structural relationships, operationalises all the constructs of interest while indicating the items for the respective subscales comprising the overall measurement instrument. It also provides a basis for assessment of both the measurement and structural model components of the postulated SEM models. This chapter further explains the research design and research method applied to this study in order to provide answers to the research objectives that were established to achieve the primary objective.

The research was conducted in five phases, as illustrated in Figure 5.1.

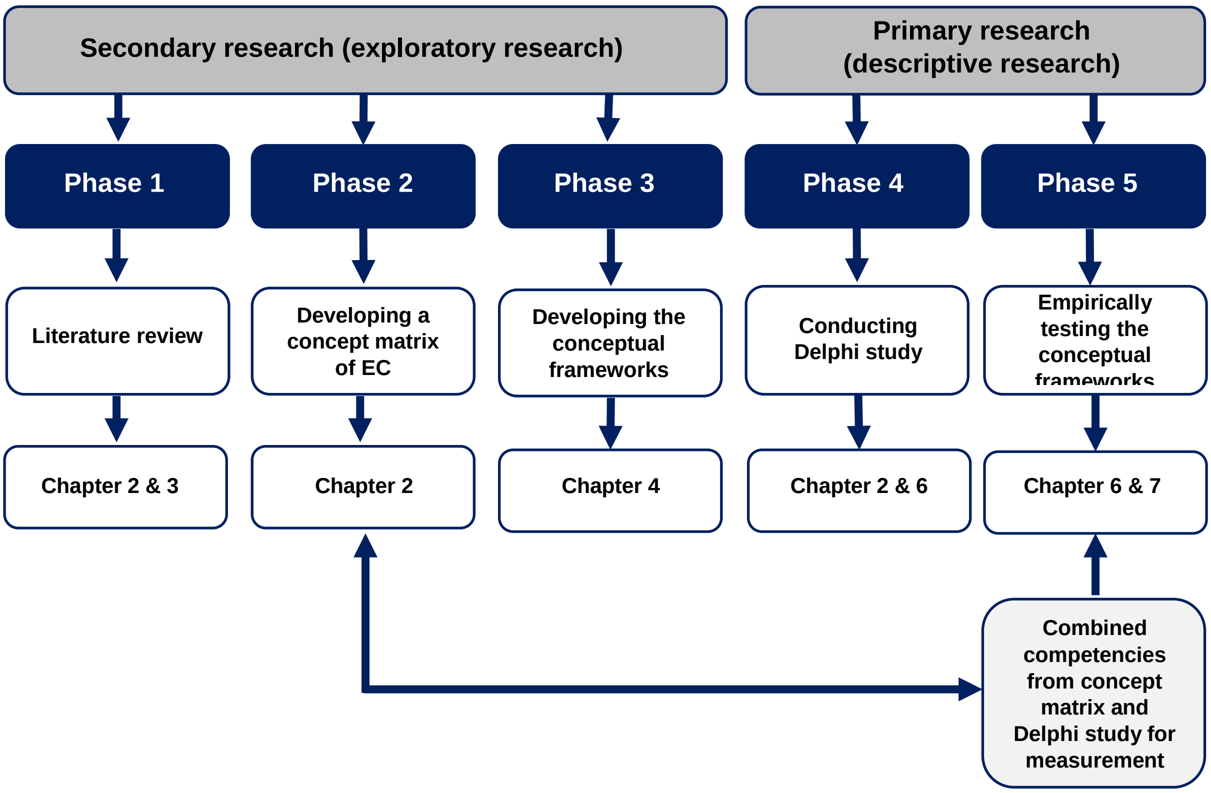


Figure 5.1: Methodological procedure of this study (including chapter outline)

The first three phases, illustrated in Figure 5.1, represent the secondary research (exploratory research) conducted for this study. *Phase 1* provided a detailed literature review of entrepreneurial competencies (EC), entrepreneurial absorptive capacity (EACAP) and innovation capacity (IC) in Chapters 2 and 3, constituting the theoretical aspects of the study. Exploratory research is of particular use in order to discover what is happening and to gain insight into a topic of interest (Saunders *et al.*, 2016:174). The literature review indicated the need to conduct an empirical study to identify fourth industrial revolution (4IR) ECs and competencies significant for innovation, and investigate the relationship between EC, EACAP and IC. In the first step of the exploratory research, secondary literature was obtained from previous research studies, as recommended by Cooper and Schindler (2014:130). In Chapter 2, competencies from the literature were conceptualised into a concept matrix, and the results of the Delphi study were used to present twelve competencies for measurement. In *Phase 3*, presented in Chapter 4, ideas from the literature review were consolidated into three conceptual frameworks. The last two phases, *4* and *5*, represent the primary research (descriptive research) conducted for this study.

Descriptive research was used to answer the "who, what, when, where and how" questions of the present study (Tustin, Ligthelm, Martins & Van Wuk, 2010:86). Descriptive statistics is therefore more structured, with clearly stated hypotheses, research objectives or investigative questions (Cooper & Schindler, 2014:134). The study was partly descriptive in that one of the objectives was to identify ECs that are required for the 4IR, and it is partly explanatory in that it sought to identify EC for the 4IR and innovation, specifically in a South African context. A Delphi study was conducted in order to get primary input on the most appropriate competencies that should be included in the study. In *Phase 5*, the relationships in the conceptual literacy frameworks for EC, EACAP and IC, were empirically tested.

This chapter focuses mainly on the primary research conducted. The research design was mixed method, which included a Delphi study and concept matrix, before commencing with the empirical study, reflecting a positivist paradigm. The steps of the primary research process followed for the empirical research are illustrated in Figure 5.2.

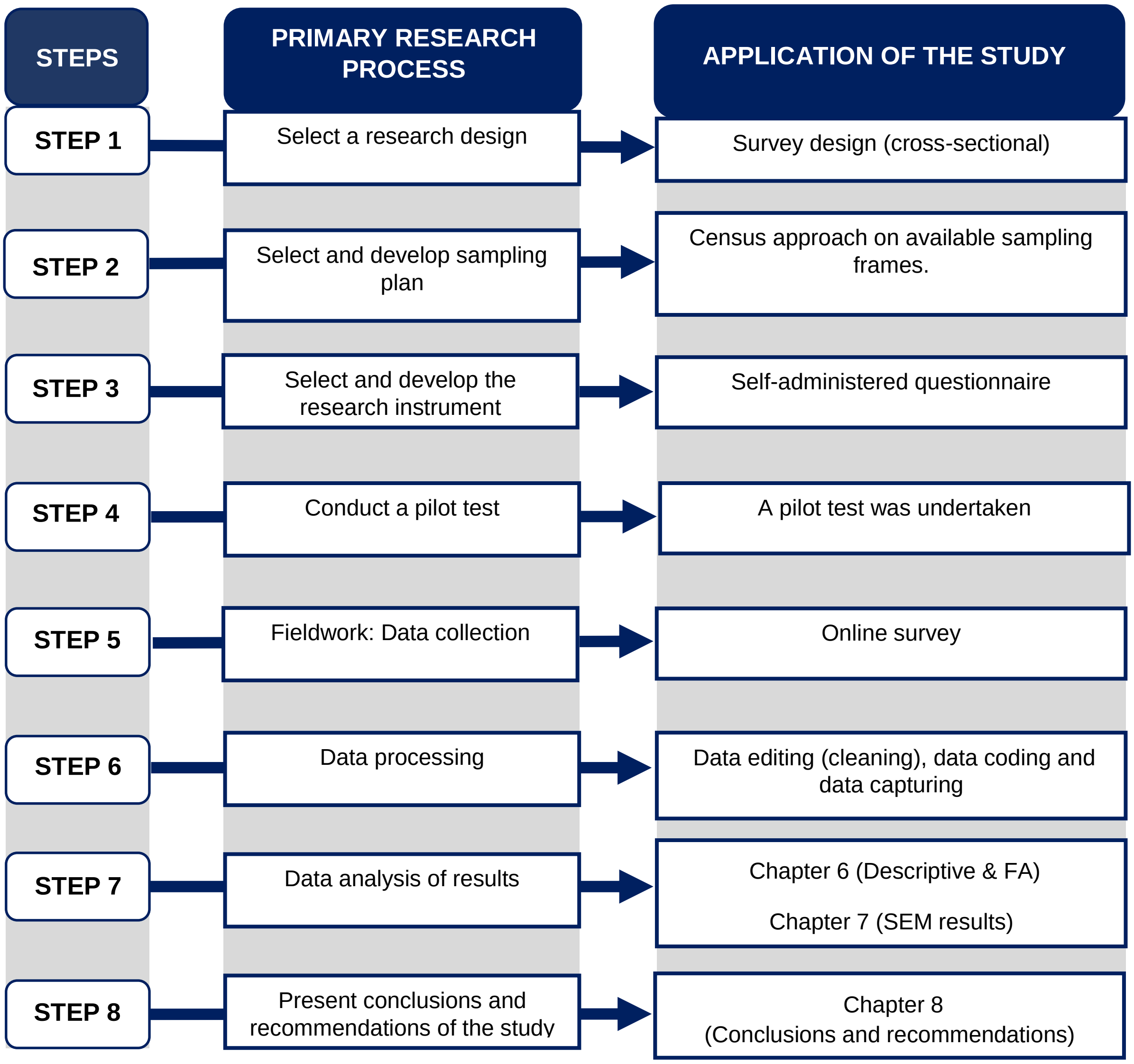


Figure 5.2: The primary research process

Source: Own compilation

Each step, as illustrated in the primary research process and its application to the current study, is discussed, starting with Step 1, the research design.

5.2 RESEARCH DESIGN

The research design is based on this study's research problem, objectives and hypotheses. It is a master plan that specifies the methods and procedures for collecting and analysing the needed information and provides a framework or plan of action for the research (Zikmund *et al.*, 2013:64). In Table 5.1 clearly outline why specific research methods were used for data collection and analysis with reference to each research objective. Each of the research methods, the data collection used and analysis applied are discussed in the sections that follow.

Table 5.1: Research methods, data collection and analysis with reference to each research objective

Research objective	Research method	Data collection	Data analysis
Primary research objective: To determine whether there is a significant positive relationship between entrepreneurial competencies (within the four categories), entrepreneurial absorptive capacity and innovation capacity of innovative entrepreneurs in South Africa.	Quantitative	Survey	SEM, Neural networks
To determine the specific Entrepreneurial Competencies significant for innovation within the 4IR context in South Africa.	Qualitative	Delphi study	
To determine whether these specific Entrepreneurial Competencies enhances an entrepreneur's Innovation Capacity.	Quantitative	Survey	SEM, Neural networks
To determine whether Entrepreneurial Absorptive capacity enhances an entrepreneur's Innovation Capacity.	Quantitative	Survey	SEM, Neural networks

To determine whether specific cognitive, functional, social and meta competencies enhances ones Entrepreneurial Absorptive Capacity.	Quantitative	Survey	SEM, Neural networks
To determine whether Entrepreneurial Absorptive Capacity has a mediating effect on the relationship between the four categories of Entrepreneurial Competencies and Innovation Capacity. To determine whether Entrepreneurial Absorptive Capacity has a moderating effect on the relationship between the four categories of Entrepreneurial Competencies and Innovation Capacity.	Quantitative	Survey	SEM, Neural networks
To determine whether the four categories of Entrepreneurial Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity.	Quantitative	Survey	SEM, Neural networks

Source: Own compilation

When choosing the research method for this study, the nature of the research questions was considered (Morse & Richards, 2002). The research onion, as applied to the present study (Saunders *et al*., 2016:124), is illustrated in Figure 5.3.

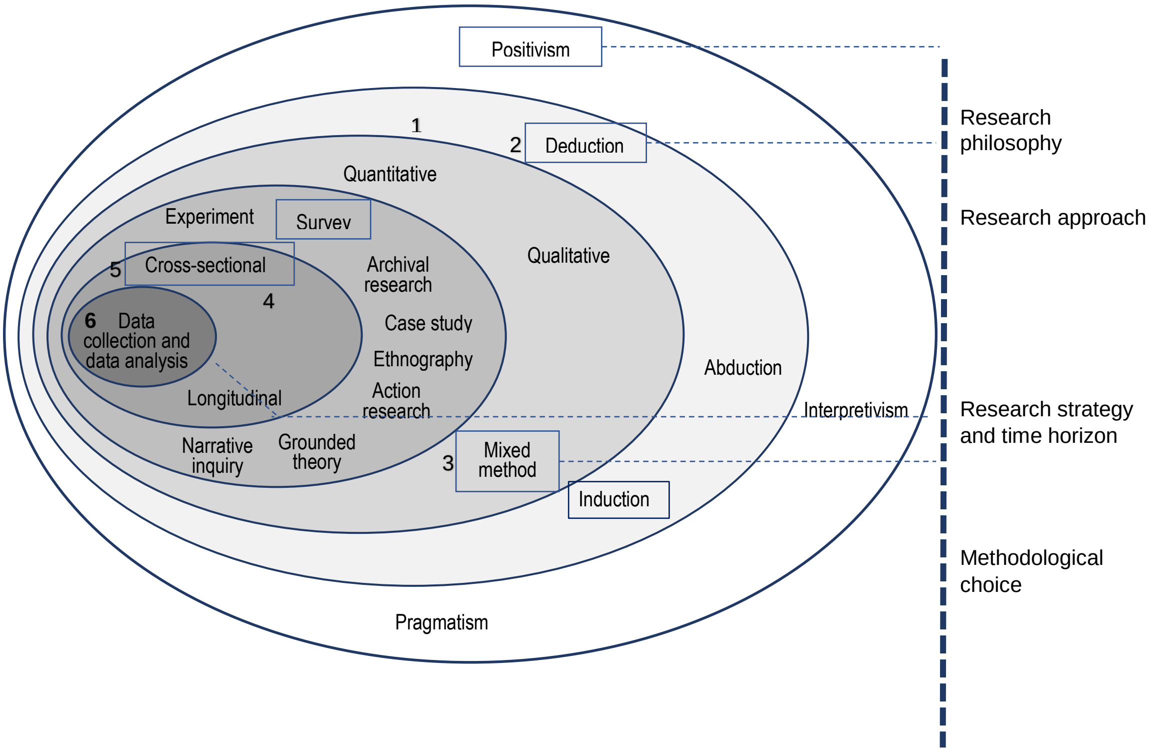


Figure 5.3: The research "onion" underlying the research choices made in the current study

Source: Adapted from Saunders (Saunders *et al.*, 2016:124)

A paradigm is a set of assumptions about the world, and involves a philosophy regarding the relevant topics and techniques for inquiry into that world (Punch, 2014:17). The research philosophy by Saunders *et al.,* (2016) is briefly discussed as:

- Positivism is the epistemological position that advocates working with an observable social reality. The emphasis is on highly structured methodology to facilitate replication. The end product can be law-like generalisations similar to those produced by the physical and natural sciences (Saunders *et al*., 2016:598).

- Interpretivism concentrates on the episternological position that advocates the necessity to understand differences between humans in their role as social actor (Saunders *et al*., 2016:593)
- Pragmatism is a position that argues that the most important determinant of the research philosophy adopted is the research question, arguing that it is possible to work within both positivist and interpretivist positions. It applies a practical approach, integrating different perspectives to assist in collecting and interpreting data (Saunders *et al.*, 2017:598).
- Constructivism assumes that realities are local, specific, and constructed. Since experiences are socially and experientially based, it argues that findings cannot be generalised because realities on the individuals or groups holding them (Punch, 2014:17).

As illustrated in Figure 5.3, the research philosophy used in this study reflects the principles of positivism. The researcher therefore approaches the study from the ontological view which assumes that the world out there is real and measureable, and that it exists independently of our subjective perception of it (Creswell & Creswell, 2018). Studies conducted from a positivistic paradigm further aim to provide an objective reality against which the researcher can compare claims and ascertain truth. As such, it is assumed that there are general patterns of cause and effect that can be used as a basis for predicting and controlling natural phenomenon (Creswell & Creswell, 2018). In line with this view, the study was designed to discover the predictive patterns in terms of how ECs and EACAP relates to IC. To achieve this, the study will test hypotheses that were derived from existing body of knowledge (Refer to chapters 2 to 4). Deductive conclusions will then be drawn from the quantitative analysis of data obtained using a representative sample of innovative entrepreneurs (Mouton & Marais, 1996:145). It further assumed that the research will be free of subjective bias and objectivity will be achieved, if strict protocol is followed (Creswell & Creswell, 2018).

Quantitative research is interested in the frequency, quantity, or magnitude of a phenomenon (Schindler, 2018:76), which forms the basis of this part of this chapter. Positivism seeks to identify details with propositions that can be tested by identifying causal relationships present in a data set with some degree of probability (Lin, 1998:163). This approach involves trying to decipher which pieces of information in the data sets are associated and assesses the strength of the association by counterfactual thinking and problems of reliability and representativeness. However, this approach cannot easily explain how the mechanism implied by the causal relationship interacts or works (Saunders *et al.,* 2016). The positivist element of qualitative research entails the development of the elements that went into the design of the questionnaire for stage 4: the quantification of the study, as illustrated in Figure 5.3. It attempts to document practices that lead to one set of outcomes rather than another, to identify characteristics that are commonly related to a problem or to find strategic patterns that hold across different venues and with different actors (Lin, 1998:162).

Interpretivism, on the other hand, seeks to understand what general concepts mean: to uncover the conscious and unconscious explanations people have for what they do or believe. It produces detailed examinations of causal mechanisms in specific cases and explains how particular variables interact (Saunders *et al*., 2016). Therefore, step 1 in Figure 5.1 involves qualitative research that is at least partially interpretivist in orientation in that it is the actual experience of the research participants that the research seeks to explore. A qualitative research approach uses interpretive techniques to translate, describe, decide, and otherwise come to terms with the meaning of certain phenomena (Schindler, 2018:76). The qualitative study was undertaken to identify competencies required of entrepreneurs for the fourth industrial revolution, through a Delphi study, but followed by an empirical statistical study to further test the ECs in different conceptual frameworks (Schindler, 2018:76). These results were used to operationalise the different competencies already mentioned in the literature, with the possibility of the emergence of new competencies through the concept matrix. The combination of both modes of logic adds more functional content which neither interpretivism or positivism can produce alone, and gives more additional confidence to conclusions (Lin, 1998:137).

The research approaches as indicated in Figure 5.3 includes: deduction, abduction and induction. A *deductive research* approach occurs when the research starts with theory, developed from reading academic literature, and designing a research strategy to test the theory (De Vos, Delport, Fouché & Strydom, 2012:48; Saunders *et al.*, 2016:145). An inductive approach is where one would collect qualitative data and develop theory as a result of the data analysis (Saunders *et al.*, 2016:145). The Delphi study therefore applied an inductive approach resulting in twelve competencies from expert opinions. Quantitative research is deductive, objective and attempts to measure something precisely (Cooper & Schindler, 2011:146). The current study applied deductive logic, as the literature review *(Phase 1)* was used to develop three conceptual frameworks (*Phase 3)* (see Chapter 4), which were tested empirically *(Phase 5)* (see Figure 5.1).

In *Phase 3 of the study,* a sequential exploratory mixed method design was conducted. A sequential exploratory strategy entails the collection and analysis of qualitative data, followed by the collection and analysis of quantitative data. Equal priority is given to the two phases, though priority can be given to either. It is used primarily to explore a phenomenon by the development of instrumentation, for example by using a small group to create instrumentation and then collecting quantitative data based on the instrumentation (Terrell, 2012:264). The methodological choice (3) of the current study (in *Phase 3*) was therefore a *mixed method* design. Mixed methods research is known as quantitative and qualitative methods that are combined. It is increasingly recognised as valuable, since it can potentially capitalise on the respective strengths of quantitative and qualitative approaches (Östlund, Kidd, Wengström & Rowa-Dewar, 2011:369). The mixed method approach of this study combined elements of qualitative and quantitative research for studying phenomena.

Mixed methods research provides an opportunity to develop novel theoretical perspectives by combining the strengths of qualitative and quantitative methods and results in “meta-inferences” (Venkatesh, Brown & Sullivan, 2016:436). The two primary types of research method that significantly influence the design of the research are: qualitative and quantitative. In general, qualitative research is research dominated by, but not exclusively based on, constructive paradigms and focused on analysing narrative data, while quantitative research is research dominated by positivist paradigms and focused on analysing numerical data. Mixed methods research is research dominated by other paradigms, such as pragmatism, critical realism, and transformative-emancipatory research and is focused on analysing both narrative and numerical data (Venkatesh *et al.*, 2016:437). Studies that use a mixed methods approach gain a deeper, broader understanding of the phenomenon than studies that do not utilise both a qualitative and quantitative approach (McKim, 2017:203). Three advantages of this method are that: 1) it enables researchers to simultaneously address confirmatory and explanatory research questions and, therefore, evaluate and generate theory at the same time; 2) it enables researchers to provide stronger inferences than a single method or worldview; and 3) it provides an opportunity for researchers to produce a greater assortment of divergent and/or complementary views (Venkatesh, Brown & Bala, 2013).

Firstly, in this study, a qualitative approach to data collection was taken due to the exploratory nature of the preliminary research questions in this study. In order to address the research questions outlined in Chapter 1, the competencies needed for measurement needed to be determined. The Delphi method was utilised as an effective and reliable data collection method that is particularly useful when there is uncertainty or little knowledge surrounding the area being investigated (Crisp *et al.*, 1997; Dalkey & Helmer, 1963; McKenna, 1994; Reid *et al.*, 1990). After the Delphi study, a concept matrix was developed, enabling the researcher to conduct a critical comparative literature review (Klopper, Lubbe & Rugbeer, 2007:262), to incorporate all the possible competencies for further testing. According to Miles, Huberman, Huberman and Huberman (1994:240-241), there are no correct matrices, only functional matrices. One should keep in mind that researchers will have to modify their matrices according to their understanding of the research topic.

In *Phase 1*, a classical Delphi method was used, where data are collected from the participants in a series of rounds and the results are fed back to the participants until stability in responses among the participants has been achieved. The results and consensus of the Delphi study were then incorporated in the survey for empirical testing. Measures were developed for a pilot study involving innovative entrepreneurs. SEM and NN were used for further statistical testing to determine the directional relationships between EC, EACAP and IC.

The qualitative part of the study (Delphi study and concept matrix) was therefore used to develop consensus on the EC with the Delphi technique. A communication study is where the researcher questions the participants and collects their responses by means of personal or impersonal means (Schindler, 2018:78). Linstone and Turoff (1975:37) further highlight the “reality” of collecting assumptions as a suitably secure basis on which to formulate future predictions.

The Delphi technique is employed in cases where judgemental information is indispensable, and typically uses a series of questionnaires interspersed with controlled opinion feedback (Okoli & Pawlowski, 2004:2). It is also defined as a quantitative methodology structure to support group communication forecasting and consists of rounds of structured questions designed to collect and analyse knowledge from a panel of experts (Hasson, Keeney & McKenna, 2000; Kennedy, 2004; Stewart, 2001; Williams, Boone & Kingsley, 2004; Yang, 2003). The experience and knowledge of the panel of expert principals provided the underlying premise from which group consensus was built. A key advantage of this approach is that it avoids direct confrontation with experts (Okoli & Pawlowski, 2004:2). The Delphi method is an effective and reliable data collection method that is particularly useful when there is uncertainty or little knowledge surrounding the area being investigated (Crisp *et al.*, 1997; Dalkey & Helmer, 1963; McKenna, 1994; Reid *et al.*, 1990).

The purpose of this part of the study was to develop consensus among expert principals regarding the EC considered most essential for the 4IR. What distinguishes the Delphi from other procedures is the process of feedback and the refinement of views that occurs between rounds. The number of rounds completed varies; however, the point at which consensus is achieved is largely determined by the researcher and the study purpose (Holmes & Scaffa, 2009:82). For this study, two rounds were conducted before consensus was achieved. The size of the panel and criteria for selection varies widely by the application method and is not reliant on statistical applications for its determination. Even small groups between 10 and 15 individuals could produce good results depending on the intended application (Okoli & Pawlowski, 2004:15; Ziglio, 1996:3).

A survey (the research strategy) was used in the current study, as it is a popular, common strategy used in business management research (Saunders *et al.*, 2016:181). The current study was a *cross-sectional* study, which involves the analysis of data that have been collected at a particular time and are sociological in nature, but not longitudinal or experimental. Using a cross-sectional design, taking the research objectives into consideration, will enable the researcher to study multiple actions and does not differentiate between cause and effects or the sequences of events. A *self-administered questionnaire* was developed for the purpose of this study. The Delphi process is discussed in the next section.

5.2.1 Delphi study

The Delphi method facilitated the structured communication of participants (in this case academics, industry experts and entrepreneurs), often geographically dispersed, for the purpose of gathering knowledge or arriving at a consensus on a topic (Holmes & Scaffa, 2009:82). The inclusion of expert participants, commonly called a panel, is key to the Delphi study. They provided their expertise anonymously on the selected topic in order to meet the objectives of the study. The starting point for the application of the Delphi method is to identify the problems and then select experts to be on the Delphi panel based on the expertise required for the problem defined. A questionnaire is developed and distributed to the panel members in the various rounds. The data are then collected after each round for consensus in responses. If the responses have reached consensus after a specific round a report is developed based on them, if not, a new questionnaire is developed based on the results of the previous round and fed back to the panel. The process is repeated until consensus is reached, based on which a final report is developed (Linstone & Turoff, 1975:6).

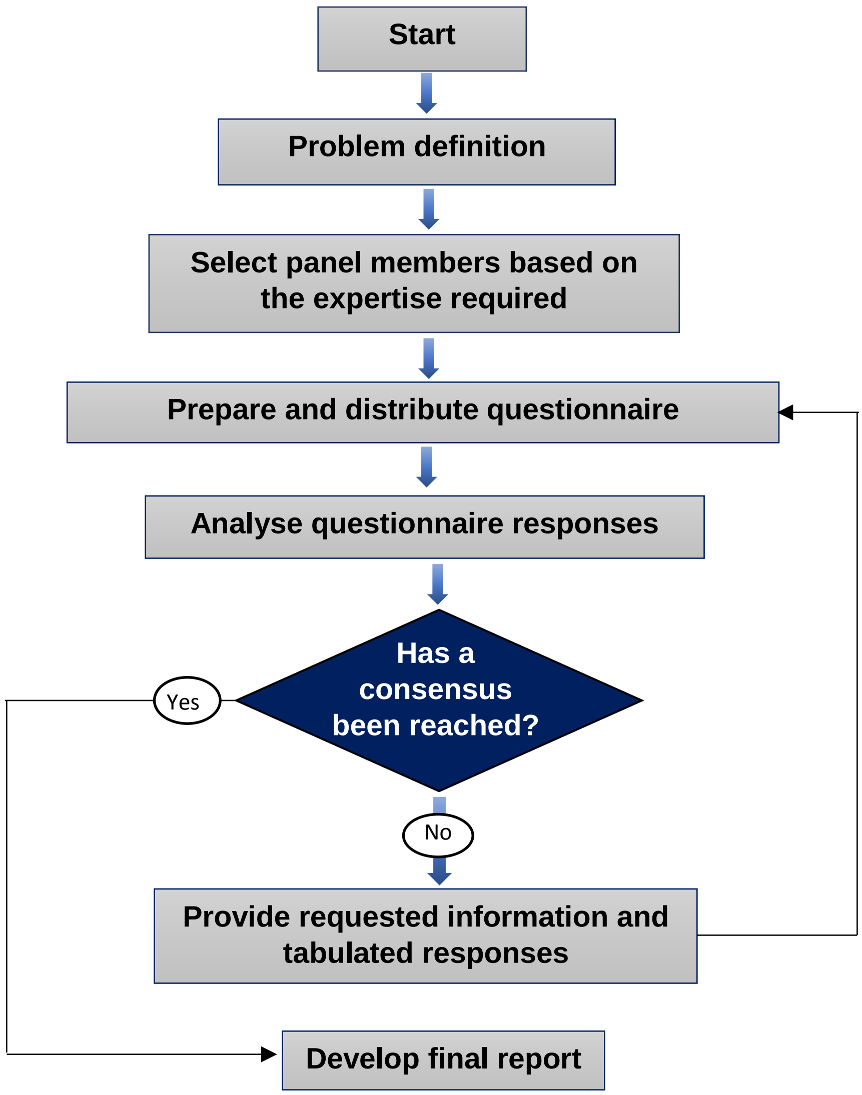


Figure 5.4: Flowchart for the Delphi method

Source: Hjarnø, Syed and Aro (2007:3)

In addition to the Delphi study, a systematic literature review was conducted, which offered a rigorous view of research results of competencies identified in existing literature (Vom Brocke *et al.*, 2009:2208). A concept-centric approach was used (Webster & Watson, 2002:16) to compile the organising framework of competencies into a concept matrix. The matrix method is known as a process and structure for systematically reviewing the literature and a system for bringing order out of the chaos of too much information spread across too many sources in too many places (Goldman & Schmalz, 2004:6). The matrix is a tabular format that collects and arranges data for easy viewing in one place, permits detailed analysis, and sets the stage for later cross-case analysis with other comparable cases or sites (Miles *et al.*, 1994:111). This approach also enables the researcher to conduct a critical comparative literature review of all references listed under each concept (Klopper *et al.*, 2007:270). Using a matrix method protects the reviewer against ignorant assumptions about the research theme at a stage when he or she is the most vulnerable due to lack of knowledge about the topic under investigation, especially in the early stage of a study (Klopper *et al.*, 2007:263). It is also useful in building a case for the empirical part on the study (Klopper *et al.*, 2007:272). This method was chosen to ensure that all the required competencies needed to be included for measurement had been considered, based on the Delphi results, and those competencies identified and tested in previous research studies, which could not simply be ignored. The research design using the Delphi method versus a traditional survey is outlined in Appendix E.

5.2.1.1 Population of interest

The Delphi study population was set out to attract experts in the field of entrepreneurship, which included academics, entrepreneurs and industry experts.

5.2.1.2 Sample frame

Although no single sample frame exists, the following sources were used as the sample frame.

- Academics situated at eleven different institutions (University of Cincinnati, University of Pretoria, University of Cape Town, University of South Africa, University of Stellenbosch, University of Johannesburg, Nelson Mandela University, University of the Free State, Wits University, North West University and Warrington College of Business) with a minimum of an Honours degree. These academics ranged from lecturers to professors with a speciality in the field of entrepreneurship.
- Entrepreneurs who had at least five years' experience as an entrepreneur and who themselves were innovators in their respective fields such as automation, strategic innovation and corporate venturing and data analytics.
- Industry experts who had experience in working with innovative entrepreneurs or who had specialised in the field of entrepreneurship or 4IR.

5.2.1.3 Sampling method

The purposive sampling technique was chosen for its simplicity. Purposive sampling, a non-probability sampling method, enables researchers to select cases that will best enable them to achieve their research objectives (Saunders *et al.*, 2016:301), where the researcher selects sample members to fit some criterion (Cooper & Schindler, 2014:359). Since the potential total target population size was not known to the researcher, it was decided to follow a census approach allowing all the potential respondents in the sampling frame to complete the survey.

5.2.1.4 Sample size

Delphi consultations have been conducted with as few as 4 and as many as 904 participants (Smith, 1995). For this Delphi study, the targeted panel size was between 10 and 25 industry experts, academics and entrepreneurs. A minimum of 10 panellists were necessary to ensure that the study results represented the views and opinions of a valid number of experts within the profession. A total of 12 panellists completed all rounds. Thirty-eight experts were initially identified through using purposive sampling to participate in the Delphi study, of whom eighteen agreed to participate in the Delphi study. The panel members can be categorised as: academic lecturers specialising in entrepreneurship (8) industry experts (4) and entrepreneurs (3). It was anticipated that participants would drop out of the exercise over time and thus a final sample of 10–18 individuals were desired, as recommended by Okoli and Pawlowski (2004). The 12 final participants/panellists who completed round 1 and round 2 had between 9 and 36 years of work experience, with their field of expertise mainly in entrepreneurship and qualifications ranging from honours degree to doctoral degree and professorships.

5.2.1.5 Data collection

This Delphi study made use of a survey method to collect data. The constructs indicated in the theoretical frameworks (Figures 4.1, 4.5 and 4.6) and their measured variables formed the study’s measurement and structural model, as elaborated on in Chapter 4. Analysis methods using statistical and mathematical procedures were used, and conclusions drawn from the research setting would be used to provide evidence to support or reject hypotheses generated, therefore by means of deduction rather than induction. The emphasis would be on measurement of EC and its associated dimensions (cognitive, functional, social and meta), individual ACAP and IC through the use of a questionnaire. The major descriptors are classified in Table 5.4 according to the descriptors used by (Cooper & Schindler, 2014:126).

The primary data from the Delphi study were collected over a period of three months (March to May, 2018).

Pre-testing the measurement instrument for the Delphi study

The first round of the Delphi study questionnaire was sent to three industry experts for pilot testing. No changes were deemed necessary based on the comments received.

Round 1: Data collection

The distribution and collection of the questionnaire to the experts was done via email (some replies were received as paper format from the respondents by email). Thirty-eight email invitations were sent to individuals requesting their participation, of whom 21 agreed to participate, but only 14 completed the questionnaire.

Round 2: Data collection

Seven participants did not complete round 1 from the 21 who had agreed to participate, and thus the sample size for the second round was 14. The online survey for the second round was based on the results and comments of the participants in the first round.

Twelve of the fourteen participants completed round 2, of which two did not complete the survey, representing an 86% completion rate in round two. The efforts yielded 108 competencies after round one, which were used for further analysis in round two.

5.2.1.6 Measures for the qualitative study

Qualitative research aims to achieve an in-depth understanding of a situation and includes an

> "array of interpretive techniques which seek to describe, decode, translate, and otherwise come to terms with the meaning of certain more or less naturally occurring phenomena in the social world" (Cooper & Schindler, 2011:144).

The qualitative approach for this part of the study (Delphi study) enabled the identification of competencies relevant for 4IR and innovation, since the topic is new and little research has been done in the field of EC for 4IR. Nonetheless, this research did not advance only on the grounded theory of EC, but also aimed at collecting data to validate existing competencies relevant to innovation and identify new competencies that are 4IR specific. For the purpose of this research study, 12 panel members participated in the Delphi study over a period of three months (March to May, 2018).

Delphi Method: Round 1

In round 1, members of each panel were sent an initial survey via email in a Word document asking to generate a complete list of ECs they believed to be required for the Fourth Industrial Revolution – they were not limited to an amount, but were requested to identify no less than 10 ECs. They were provided a column to list the identified competencies and another column for respondents to fill in a definition or description of the competency.

They were then asked to use the identified ECs and classify them under one of the four categories (domains): cognitive, functional, social or meta-competencies. These categories were based on Winterton *et al.* (2006:40) unified typology of knowledge skills and capabilities model, Cheetham and Chivers (1996:27) provisional model of professional competence and Le Deist and Winterton (2005:40) holistic model of competence using cognitive, functional, social and meta-competence as domains. The description of each category was given to the participants before answering the question, as illustrated in Table 5.2.

Table 5.2: 4IR entrepreneurial competency categories

Categories	Description
1. Cognitive competencies (Knowledge)	The possession of appropriate work-related knowledge and the ability to put it into effective use. Including underpinning theory and concepts, as well as informal tacit knowledge gained experientially. Knowledge (know-that), underpinned by understanding (know-why), is distinguished from competence.
2. Functional competencies (Skills)	The ability to perform a range of work-based tasks effectively to produce specific outcomes. Also known as skills or know-how. Things that a person who works in a given occupation area should be able to do and be able to demonstrate.
3. Social competencies (Attitudes and behaviours)	The ability to adopt appropriate, observable behaviours in work-related situations. Known as behavioural competencies (knowing how to behave), defined as a relatively enduring characteristic of a person, causally related to effective or superior performance in a job.
4. Meta competencies (Facilitating learning)	Described as meta-qualities, i.e. creativity, mental ability, and balanced learning skills, which are reinforced by other qualities. The ability to cope with uncertainty, as well as with learning and reflection. Individuals' knowledge of their own intellectual strengths and weaknesses, how to apply skills and knowledge in various task situations and how to acquire missing competencies.

Source: Adapted from (Winterton *et al.*, 2006:40)

The qualitative from round 1 were used to generate a total list of 152 items. The compilation included a couple of items that appeared to be similar and were combined as one (such as ability to learn continuously and life-long learning; and conveying a compelling vision and visualisation) which resulted in a list of 108 competencies. As described earlier, the SHL, Universal Competency Framework is composed of three hierarchical levels. This was used to further confirm proper identification of the individual competencies and the process of clustering was conducted. For the purpose of this study, this framework was adapted for the second round of the Delphi Study, by using the "Great Eight" competencies' main competence areas as the first level and the 20 competency dimensions as the second level, as can be seen in Appendix F. The competencies of the behavioural level as third level were adapted based on the results from the first round of the Delphi Study. In this way, the framework was built on a well-known framework from practice and research and adapted for the 4IR and specifically entrepreneurs.

Delphi Method: Round 2

In round 2, an email was sent to the participants where the Delphi was conducted through an online survey link, including a list of 87 competencies and definitions or meanings that resulted from round 1 (see Appendix C). Some participants did not provide a definition, so the definition or meaning were sourced from existing sources. The participants were asked to rate their level of agreement for each competency on a 7-point Likert scale ranging from 1 = Strongly Disagree, 2 = Disagree, 3 = Slightly Disagree, 4 = Neutral, 5 = Slightly Agree, 6 = Agree and 7 = Strongly Agree. Questions 2 and 3 (description and classifying) were dropped for round 2 due to the number of competencies that resulted from round 1, keeping in mind the time constraints of the questionnaire.

The data from round 2 were analysed to determine those items that received a mean importance rating of above 4.0. The top 48 competencies had a mean score of 6.00 and above and 28 competencies had a mean score of 6.33 and above. The top 5 competencies had a mean score of 6.67 (see Table 2.3 in Chapter 2).

The top 48 competencies resulting from round 2 were further analysed through determining their relationships by using Spearman correlation coefficients. Strong correlations (above 0.8) between competencies were evaluated to eliminate any competencies seen as similar, if their definition confirmed this. If the correlation was very strong and above 0.8, but the meaning differed, the competencies remained independent.

The detailed process followed in identifying the final 12 ECs for further testing is discussed in Chapter 2 (section 2.6) where a literature study was conducted and a concept matrix compiled from the results.

5.2.1.7 Validity and reliability of the Delphi study

The success and validity of the Delphi process is dependent on concepts of “common reality”, so it becomes important to ensure that any study using this approach seeks to identify these realities. Seeking reality views, exploring agendas and gestalts, identifying latent opinions and issues, explaining and extracting from the collected views, and from this collecting data and generating a common or consensus reality picture then forms part of the process (Winzenried, 1997:336). To ensure consistency in the process of coding, the researcher clearly described the coding scheme as illustrated in Appendix F. The competencies identified from the Delphi study were classified into one of the eight categories, based on the existing framework of Bartram (2011), initially developed from the SHL Universal Competency Framework by CEB Inc. (Bartram, 2011), which is widely used in competency modelling in practice. Prifti *et al.* (2017:56) used the same framework as basis for their 4IR competency modelling from a behavioural orientation perspective.

5.3 SAMPLING PLAN DESIGN

The steps in designing the sampling plan used in the quantitative study are shown in Figure 5.5 and are discussed in this section.

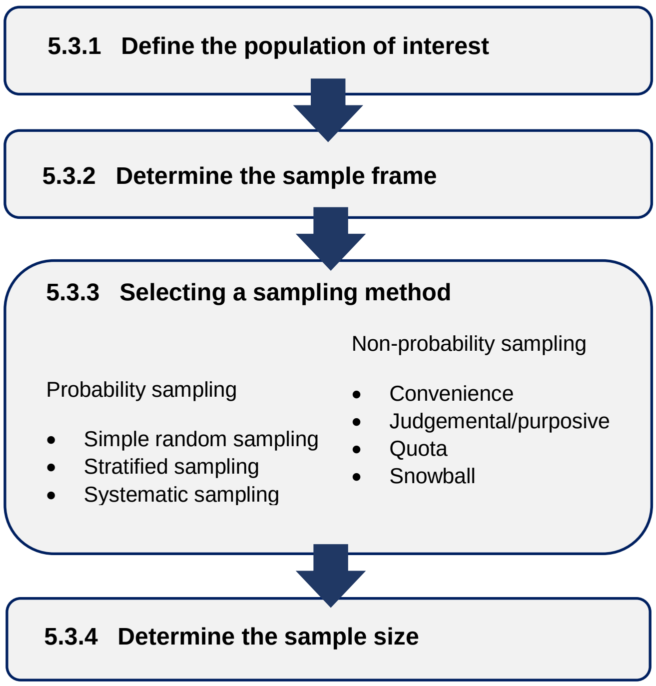


Figure 5.5: The steps in designing the sample plan

Source: Adapted from Aaker, Kumar, Day and Leone (2011:336), Malhotra (2015:272) and Tustin *et al.* (2010:339)

The sampling plan for the Delphi study and quantitative study is discussed according to the steps illustrated in Figure 5.5 (section 5.2.1). The sampling plan for the quantitative part of the study is discussed next.

5.3.1 Define the population of interest

A target population is the collection of elements that possesses the information sought by the researcher, from which the sample is selected and about which he or she wishes to make some inferences (Babbie, 2015:193; Kumar, 2019:174; Malhotra, 2015:272).

The primary study's target population is respondents who are the owner of a business. The entrepreneur or business owner had to have an innovative business of some sort, which could be technology-orientated, an incremental or radical invention or operating within the 4IR industry, therefore, bringing something new and original into existence. For the current study, a sample was planned based on the following criteria:

- The sample should represent South African based businesses with their main business operations based in South Africa.
- Respondents had to be entrepreneurs of the age of 18 years and older.
- Both male and female respondents should be included in the sample.
- Respondents had to be the owner of the business.
- Respondents had to have an innovative business of some sort, which could be technology-orientated, an incremental or radical invention or operating within the 4IR industry, therefore, bringing something new and original into existence.
- The respondents had to understand English, which was the language used in the questionnaire.

5.3.2 Identify the sample frame of the final phase

A sampling frame is a representation of the elements of the target population and consists of a list or set of directions for identifying the target population (Malhotra, 2015:272). It is also the identification of all population elements from which the sample will be drawn. How well a sample frame represents the characteristics of the population it purports to represent is therefore an indication of a good sample (Cooper & Schindler, 2011:338).

The initial sampling frame for the final phase consisted of a combination of several sources, namely incubated entrepreneurs situated at technology business incubators Small Enterprise Development Agency (SEDA), the Innovation Hub and 4IR incubators and accelerators (Sw7 Accelerate, MLab), entrepreneurs at government-supported entrepreneurship centres (Shanduka Black Umbrellas and the CSIR), entrepreneurial entrants for innovation summit (SA Innovation Summit) and innovation competitions (FNB Endeavour) in South Africa and groups of business owners or entrepreneurs who potentially had an innovative business or business related to the 4IR (Black IT Forum, Koi Strategy and 4th Industrial Revolution group). Due to a lack of responses after utilising the sampling frame above, either as a result of the qualifying questions and/or the general rate of response normally experienced for online surveys, two general business databases were included as well as replies to an advertisement that was placed on Facebook with the survey. For both these databases, the email had to be sent to the owner or director of the business. One of the databases used was a solutions marketing company with business data offering target email marketing for business. The business leads contain company information that is updated daily in order to provide relevant and updated information. The database consists of the business records of key decision-makers from micro to large enterprises in South Africa, including 25 key business sectors.

In order to ensure that only business owners who formed part of the target population responded to the survey, two qualifying questions were added to the survey in order to disqualify those who fell outside the target population. The qualification conditions were:

- A business owner or entrepreneur who currently owns or actively runs/operates a business
- One who has developed an innovative product/service over the last three years (in other words, has created and subsequently introduced a good or service that is either new, or an improved version of previous goods or services)

Disqualified participants were not able to complete the survey since they had failed the qualifying conditions. During the data collection process it was observed that the second qualifying question might seem limiting, due to some participants perhaps failing to meet the specific criterion. The criterion was simplified to:

- Are you an innovative entrepreneur? (Innovativeness: “the act of bringing something new and original into existence) (Boyles, 2012).

The researcher thus ensured that the realised sample met the study’s objectives. This was achieved by:

- Collecting the data from innovative entrepreneurs. If by some rare occurrence a survey was sent to a participant who was not a business owner, a disqualification question was added into the survey to ensure that they did not complete the survey. Once they had been disqualified, even if they attempted to complete the survey again, the tool did not allow them to do so, since it linked a unique identifier to a specific email address. The unique identifier was not linked to the IP address so they could not attempt to complete the survey again from another device.
- The participants came from all nine South African provinces.
- The researcher ensured that mailing list used had no invalid emails, no duplicates and no blanks.

5.3.3 Select a sampling method

The sampling method depends on the knowledge of the population in question, the available financial resources, the objectives of the study, time limits and the nature of the research problem (Blaxter, 2010:165; MacDaniel & Gates, 2013:276). Due to the known low response rates on online surveys, as well as the fact that the qualifying number of innovative entrepreneurs for the total sample frame, thus the potential total target population size, was not known to the researcher, it was decided to rather follow a census approach allowing all the potential respondents in the sampling frame to complete the survey. Although quota sampling appears to be an option, it could not be considered, as the set of qualifying criteria furthermore had to be met in conjunction with each other and not separately. Thus it was highly likely that the total population could be, for example, very young and mostly male, therefore pre-planning proportional representation of, for example, all age categories or gender within a quota context was not meaningful.

For the purposes of the study, each participant could not complete the survey more than once. The tool which was used to collect the data generated a unique identifier for each email address (recipient). Once the participant had completed the survey to the end, they were not allowed to repeat the survey. They were only allowed to continue the survey from where they had left it off on their previous attempt.

5.3.4 Sample size requirements for data analysis

The sample size refers to the "number of elements to be included in a study" (Malhotra, 2015:274). Recommendations regarding the sample size necessary for the statistical data analysis to be used were however considered in order to ensure that the realised sample achieved was large enough. McQuitty (2004:167) suggests that it is important to determine the minimum sample size required in order to achieve a desired level of statistical power with a given model before data is collected. Although the needed sample size is affected by the normality of the data and method of estimation used by the researcher, it is generally agreed that a sample size of 10 participants for every free parameter estimated is ideal (Schreiber, Nora, Stage, Barlow & King, 2006:326). However, according to Sivo, Fan, Witta and Willse (2006), there seems to be little consensus on the recommended sample size for SEM, although Garver and Mentzer (1999) as well as Hoelter (1983) and Kline (2015:16) propose a critical sample size of 200. However, when conducting factor analysis, a larger sample size is recommended in general (Pallant, 2011:18). Tabachnick, Fidell and Ullman (2007:613) suggest at least 300 cases for factor analysis. The realised sample size of the current study (n = 452) can therefore be considered suitable for factor analysis. Structural Equation Modelling (SEM), in general, requires a larger sample size than multivariate approaches (Hair, Black, Babin & Anderson, 2014:573).

According to Hair, Anderson, Babin and Black (2010a:661-664) the minimum sample size for a particular SEM model depends on several factors. These additional factors are indicated in Table 5.3 below. Hair *et al.* (2010a:662) further suggests that there are additional circumstances that may require a sample size to be increased:

- Deviations of data from multivariate normality
- Use of sample-intensive estimation techniques
- When missing data exceed 10%
- Need for group analysis (each group should meet the sample size requirements)
- Need for sample size to adequately represent the population of interest.

Table 5.3: Sample size specifications for SEM

Type of Model	Minimum sample size
Models containing five or fewer constructs, each with more than three items (observed variables), and with high item communalities (0.6 or higher).	100
Models with seven or fewer constructs, modest communalities (0.5), and no under-identified constructs.	150
Models with seven or fewer constructs, lower communalities (below 0.45), and/or multiple under identified (fewer than three items) constructs.	300
Models with a larger number of constructs, some of which have fewer than three measured items as indicators, and multiple low communalities.	500

Source: (Hair *et al.*, 2010a:664)

Each SEM model was investigated in terms of sample adequacy and the sample was found to be adequate in each case.
After the sampling was considered, the next step involved the development of the research instrument.

5.3.4.1 Non-respondent bias

One main concern with a research survey is the degree to which non-response bias could compromise the validity of the results. Insufficient detail on non-respondents presents a challenge in testing this bias. The survey for this study was sent to all respondents in the sampling frames identified. As the demographic characteristics and size of the target population is not known, this study could not establish the extent of non-response bias.

5.4 THE RESEARCH INSTRUMENT

Step 3 in the primary research process was to select and develop the research instrument. A two-stage qualitative approach (Delphi study and concept matrix) in the form of a questionnaire enabled the researcher to identify EC required for the 4IR (*phases 2 and 4*). Some were existing competencies and some were newly identified ECs, providing a “fresh” outlook of what competencies are perceived and found to be important for innovation.

An online survey for entrepreneurs was developed to answer the research objectives and aim of the study, and to form the basis for the research findings and conclusions of the study (Kumar, 2019). The Delphi study and concept matrix results were used to develop section B of the survey instrument, to measure EC. The questionnaire was developed to measure the four competence categories, namely EC: 1) cognitive competence (decision-making, proactiveness, creative problem-solving and imaginativeness, innovation, resilience and opportunity recognition); 2) functional competence (value creation); 3) social competence (leadership, networking and positive attitude); 4) meta competence (cognitive ability and problem-solving); AC: 5) recognition, 6) assimilation, 7) transformation, 8) exploitation; IC: 9) newness, 10) radicalness, 11) uniqueness and superiority, 12) innovativeness, 13) competitive advantage, and 14) market pioneering.

As discussed in Chapter 2, the SHL Universal Competency Framework (UCF) can be used as a generic foundation for building competency models (Bartram, 2011). For the purpose of this study, this framework was adapted for the second round of the Delphi study, by using the “Great Eight” competencies as the first level and the 20 competency dimensions as the second level, to categorise competencies according to their meaning or definition, as illustrated in Appendix F and G. This was done in order to prevent repetition of competencies identified. The competencies of the behavioural level as third level were adapted based on the results from the first round of the Delphi

Study. This way, the competencies identified are built on a well-known framework from practice and research. However, this framework was only used in order to refine the 108 competencies identified after round 1 of the Delphi study, and assisted in categorising competencies identified from the concept matrix, as the four main competence domains. The four main competence domains were not used as yet, as they merely form an over-arching framework in developing a typology of knowledge, skills and competence. Skills are captured by functional competence, knowledge is captured by cognitive competence, attitudes and behaviours are captured by social competence, while meta-competence is concerned with facilitating the acquisition of the other substantive competences (Winterton *et al.*, 2006:41). The final 12 competencies were placed into the four categories (domains): cognitive, functional, social and meta competence, for empirical testing. The categorised competencies, according to their meaning and definition, are illustrated in Appendix G and H and illustrate the conceptual and operational definitions of EACAP and IC.

5.4.1 Measures for the quantitative study

The questionnaire was developed to measure the three main identified components (constructs), namely EC, EACAP and IC.

The full questionnaire (Appendix D) consisted of 113 items which were divided into four sections (Section A, B, C and D). The first section (Section A) contained biographical questions which consisted of gender, age, race, education level of the entrepreneur and specialisation field, industry sector, age of business, number of employees, annual turnover and geographical area of business.

Table 5.4 summarises the constructs EC, EACAP and IC, sections B-D in the questionnaire, number of items, measuring scale and Cronbach alphas used to construct the final questionnaire.

Table 5.4: Construction of the EC, EACAP and IC literacy questionnaire

Research construct	Section of questionnaire	Number of items	Measuring scale	Cronbach alpha values of previous research
1 Entrepreneurial Competencies	B	**62**		
Cognitive competencies	B	25		
○ Decision-making capability		*4*	Self-developed, guided by definitions from Bartram (2011); Candidate, (2013)	N/A
○ Proactiveness		*4*	Adapted from Bateman and Crant (1993)	Sample 1: 0.89 Sample 2: 0.87 Sample 3: 0.87
○ Creative problem-solving/Imaginativeness		*5*	Morris *et al.* (2013)	0.968 0.803
○ Innovation/Innovating		*4*	Adapted from Antonites (2017)	Not given
○ Resilience		*4*	Adapted from Morris *et al.* (2013)	0.914 0.841
○ Opportunity recognition		*4*	Adapted from Morris *et al.* (2013)	0.794 0.867
Functional competencies	B	5		
○ Value creation		*5*	Adapted from Morris *et al.* (2013)	0.898 0.761 0.904 0.878
Social competencies	B	12		
○ Leadership		*4*	Adapted from Candidate (2013)	(Based on SHL competency framework)
○ Networking		*4*	Adapted from Morris *et al.* (2013)	0.867 0.973 0.867
○ Positive attitude		*4*	Adapted from Liñán and Chen (2009)	0.897
Meta competencies	B	20		
○ Cognitive ability		*16*	Adapted from Schraw and Dennison (1994)	0.91
○ Problem-solving		*4*	Adapted from Dixon *et al.* (2005)	Not given

2 Entrepreneurial Absorptive Capacity	C	**14**		
• Recognition		4	Adapted from Löwik (2013)	0.78
• Assimilation		3	Adapted from Löwik (2013)	0.77
• Transformation		4	Adapted from Löwik (2013)	0.82
• Exploitation		3	Adapted from Löwik (2013)	0.71
3 Innovation Capacity	D	**25**		
• Newness		7	Adapted from Cooper (1979); Cooper and De Brentani (1991)	0.724
• Radicalness		2	Adapted from Souder and Song (1997)	Not given
• Uniqueness and superiority		6	Adapted from Cooper (1979); Cooper and De Brentani (1991)	0.750
• Innovativeness		4	Adapted from Cooper and De Brentani (1991)	0.710
• Competitive advantage		3	Adapted from (More, 1982)	Not given
• Market pioneering		1	Adapted from Ali *et al.*, 1995	Not given
Total		101		

The questionnaire was mostly based on previous research instruments, as discussed in the literature review (see chapters 3 and 4). Each section (section B-D) in the questionnaire which measured the three main constructs EC, EACAP and IC, is now discussed.

5.4.1.1 Questionnaire Section B: Measures for entrepreneurial competencies

Section B contained questions on the respondent's EC. This section used a 7-point Likert scale where 1 = Strongly Disagree and 7 = Strongly Agree, with 62 items measuring the set of 12 ECs. If a statement was worded negatively, the assigned numerical values were reversed to ensure consistent results (Cooper & Schindler, 2011:278). The four competency categories consisted of: Cognitive competencies: 1) Decision-making, 4-items; 2) Proactiveness, 4-items, 3) Resilience, 4-items; 4) Creative problem-solving and imaginativeness, 5-items, 5) Innovation/innovating, 4-items, 6) Opportunity recognition, 4-items; Functional competencies: 7) Value creation, 5-items; Social competencies; 8) Positive attitude, 4-items, 9) Networking, 4-items, 10) Leadership, 4-items; and Meta competencies: 11) Cognitive-ability, 16-items, 12) Problem-solving, 4-items. Some of the scales were adapted from existing scales and some scales had to be developed based on the definitions of each competency based on the lack of existing measures. Table 5.5 indicates the measures for EC.

Table 5.5: Measures for entrepreneurial competencies

	EC categories and individual ECs	Variable numbers in the questionnaire
1	Decision making	Q11-14
2	Proactiveness	Q15-18
3	Creative Problem- Solving / imaginativeness	Q47-51
4	Innovation / innovating	Q52-55
5	Resilience	Q61-64
6	Opportunity recognition	Q69-72
7	Leadership	Q19-22
8	Networking	Q23-26
9	Positive attitude	Q65-68
10	Cognitive ability	Q27-42
11	Problem-solving	Q43-46
12	Value-creation	Q56-60

1. Decision making (Cognitive)

To measure decision making, questions were developed based on research from Candidate (2013:4,7) and the SHL universal competency framework (Bartram, 2011). In categorising “decision making”, it was coded under the category “Leading and deciding – deciding and initiating action” and measured as a cognitive competence. Decision making is known to be the process of making choices by identifying a decision, gathering information, and assessing alternative solutions to a problem (Grzybowska & Łupicka, 2017:251). It is activated by someone with the competence to make decisions who initiates action, gives direction and takes responsibility (Bartram, 2011:7). Refer to the questionnaire in Appendix D.

2. Proactiveness (Cognitive)

To measure proactiveness, the scale from Bateman and Crant (1993) was used for measuring proactive behaviour. In categorising “proactiveness”, it was coded under the category “Leading and deciding – deciding and initiating action” and measured as a cognitive competence. According to Bateman and Crant’s formulation, people who are highly proactive identify opportunities and act on them, show initiative, and persevere until they bring about meaningful change. They define an individual with a prototypical proactive personality as one who is relatively unconstrained by situational forces and who effects environmental change (Seibert *et al.*, 1999:417). Refer to the questionnaire in Appendix D.

3. Leadership (Social)

To measure leadership, the measurement scale of Candidate (2013:3) was used. Minor changes were made to the statements such as changing the words “rarely” to often and “unlikely” to likely. This was done in order to avoid negative statements and reverse coding. In categorising “leadership”, it was coded under the category “Leading and deciding – leading and supervising” and measured as a social competence. The SHL universal competency framework (Bartram, 2011) defines a leader as someone that has the ability to provide others with clear direction, motivates and empowers others, recruits staff of a high calibre, provides staff with development opportunities and coaching and sets appropriate standards of behaviour (CEB, 2013:7). Refer to the questionnaire in Appendix D.

4. Networking (Social)

To measure networking ability, the 17-item scale from (Morris *et al.*, 2013) was used and minimalised with viewer items. The 5-item Likert-type response scale that Morris used was adapted to fit the 7-item Likert-type response scale for this questionnaire. Networking was coded under the category “Interacting and presenting – relating and networking” and measured as a social competence. Networking ability is defined as using deliberate strategies to influence or persuade others, using key people as agents to accomplish objectives and acting to develop and maintain business contracts (Santandreu-Mascarell *et al.*, 2013). Networking ability is applied by someone who easily establishes good relationships with customers and staff, relates well to people at all levels, builds wide and effective networks of contracts and uses humour appropriately to bring warmth to relationships with others (CEB, 2013:7). Refer to the questionnaire in Appendix D.

5. *Cognitive Ability (Meta)*

To measure cognitive ability, scale items from Schraw and Dennison (1994) were used from their 8-category metacognitive awareness questionnaire. Cognitive ability was coded under the category "Analysing and interpreting – analysing" and measured as a meta competence. Cognitive ability is defined as "the ability to generate or use different sets of rules for combining or grouping things in different ways" (Gray, 2016). Refer to the questionnaire in Appendix D.

6. *Problem solving (Meta)*

To measure problem solving, statements from Dixon *et al.* (2005:33) were used from their problem-solving skills cluster, such as "is a problem solver" and "demonstrates good analysis skills" . Problem solving was coded under the category "Analysing and interpreting – analysing" and measured as a meta competence. It is applied by someone with the ability to solve problems, who demonstrates good analysis skills, has the ability to prioritise problems and has good critical-thinking skills (Dixon *et al.*, 2005). Refer to the questionnaire in Appendix D.

7. *Creative Problem-Solving / imaginativeness (Cognitive)*

To measure creative problem-solving/imaginativeness, the measuring scale from Morris *et al.* (2013) was used. Creative problem-solving and imaginativeness was coded under the category "Creating and conceptualising – creating and innovating" and measured as a cognitive competence. It is defined as "the ability to relate previously unrelated variables or objects to produce novel and appropriate or useful outcomes" (Morris *et al.*, 2013). Refer to the questionnaire in Appendix D.

8. *Innovation / Innovating (Cognitive)*

To measure innovation, the measurement scale from Antonites (2017) was used for measuring the ability to create new innovations. Innovation/innovating was coded under the category "Creating and conceptualising – creating and innovating" and measured as a cognitive competence. The term innovation is defined as the introduction, establishment, commencement, novelty, departure from the old, introduction of new improved methods and things, modernisation, drastic change and breaking of precedents (Antonites, 2017:102). Refer to the questionnaire in Appendix D.

9. Value-creation (Functional)

To measure the competency value-creation, the measuring scale developed by Morris *et al.* (2013) was used. The statements/questions were reduced from 15 to 5. Statements were chosen that would be the easiest for participants to understand and answer and were the most relevant in terms of how the concept is defined by Morris *et al.* (2013). Morris's intention was to measure the construct value creation in terms of new products, services and business models. Value creation was coded under the category "Creating and conceptualising – creating and innovating" and measured as a functional competence. Value creators are defined by Morris *et al.* (2013) as having capabilities of developing new products, services, and/or business models that generate revenues exceeding their costs and produce sufficient user benefits to have a fair return. Refer to the questionnaire in Appendix D.

10. Resilience (Cognitive)

To measure resilience, the measuring scale developed by Morris *et al.* (2013) was used. The statements/questions were reduced from nine to four in consideration for participants to complete the questionnaire. Only the most straightforward and understandable statements were chosen based on the most relevant statements in terms of its definition. Resilience was coded under the category "Adapting and coping – adapting and responding to change" and measured as a cognitive competence. Resilience is defined as " the ability to cope with disturbances and stresses in such a way that one remains well, recovers, or even thrives in the face of adversity" (Morris *et al.*, 2013). Refer to the questionnaire in Appendix D.

11. Positive attitude (Social)

To measure positive attitude, the measures for personal attitude for entrepreneurial intention from Liñán and Chen (2009:40) were used. Positive attitude was coded under the category "Enterprising and performing – achieving personal work goals and objectives" and measured as a social competence. Refer to the questionnaire in Appendix D.

12. Opportunity Recognition (Cognitive)

To measure opportunity recognition, the measurement scale of (Morris *et al.*, 2013) was used. Items were reduced from six statements to four. Questions that were deemed similar were not included (e.g., "I am an avid information seeker" was included, whereas "I am always actively looking for new information" was not included). Opportunity recognition was coded under the category "Enterprising and performing – entrepreneurial and commercial thinking" and measured as a cognitive competence. Opportunity recognition is defined as" the capacity to perceive changed conditions or overlooked possibilities in the environment that represent potential profit or return to a venture (Morris *et al.*, 2013). Refer to the questionnaire in Appendix D.

5.4.2.2 Questionnaire Section C: Measures for Entrepreneurial Absorptive Capacity

In order to understand the knowledge absorption process, four inter-related routines of ACAP and flow of knowledge absorption were measured by using the existing measurement scale developed by (Löwik, 2013). The conceptualisation of individual EACAP mainly consists of four routines/dimensions: recognition, assimilation, exploitation and transformation.

Section C held a 14-item four-dimensional, 7-point Likert-type response scale adapted from Löwik (2013) measuring EACAP, which included: 1) Recognition, 4 items; 2) Assimilation, 3 items; 3) Transformation, 4 items and 4) Exploitation, 3 items. This section also included a question indicating the field one had most experience in and total number of years of work experience.

1. Recognition

Recognition is concerned with the recognition of the value of new external knowledge and an individual's recognition activities such as searching for new knowledge, identifying it and evaluating it as opportunities for potential beneficial use (Löwik, 2013:106). Refer to the questionnaire in Appendix D.

2. Assimilation

Assimilation is concerned with exploiting the new knowledge; a portion of the prior knowledge should be related to the new knowledge to facilitate assimilation. Assimilation is conceptualised as routines and processes that allow an individual to analyse, process, interpret, and understand the information obtained from external sources (Zahra & George, 2002:189). Assimilation activities include interpretation, articulation and codification by the individual acquiring knowledge (Löwik, 2013:107). Refer to the questionnaire in Appendix D.

3. Transformation

Transformation is concerned with the generation of new ideas in collaboration with others (Löwik, 2013:108). Transformation capability is the ability to recognise two apparently incongruous sets of information and combine them in order to arrive at a new schema (McGrath *et al.*, 2000:1). It further relates to the capability to develop and refine routines that facilitate the combining of existing knowledge and newly acquired and assimilated knowledge (Zahra & George, 2002:190). Refer to the questionnaire in Appendix D.

4. Exploitation

Exploitation is concerned with the activities to internalise the knowledge in one's own work routines (Nonaka, 1994) and activities to apply new knowledge in one's own work routines (Löwik, 2013:108). Refer to the questionnaire in Appendix D.

5.4.2.3 Questionnaire Section D: Measures of Innovation Capacity

Invention is viewed as the simple outcome of individual creativity. Therefore, as the level of invention increases, the more innovations and new technologies can be expected. Measuring the level of invention therefore provides an important indicator of the potential IC and the introduction of new technologies.

As previously defined, IC is viewed as: "the level of invention and potential for innovation". One of the key focus points of this study is the fact that knowledge and competence are viewed as internal determinants of IC (Lukjanska, 2010:43).

The last section, Section D, consisted of 25 items, measuring IC. The first four constructs were measured on a 7-point Likert-Type scale in the form of: 1) Newness, 7 item scale, adapted from Cooper (1979) and Cooper and De Brentani (1991); 2) radicalness, 2 item scale, adapted from Antonites (2017) and Souder and Song (1997); 3) uniqueness and superiority, 6 item scale, adapted from Cooper (1979) and Kleinschmidt and Cooper (1991); and 4) innovativeness, 4 item scale, adapted from Cooper and De Brentani (1991). Competitive advantage was measured by a 3 item scale from More (1982), where a rating scale form 1-7 was used (1 = low, 4 = moderate and 7 = high); 5) market pioneering was measured with one yes/no question, adapted from Ali, Krapfel and LaBahn (1995). The last question gave an option to select an answer from 1-6 measuring the type of radical or incremental innovation, adapted from Antonites (2017).

1. Newness

To measure newness, the measurement scale of Cooper and Brentani (1991) was used. The study used seven items as shown in Table 5.4. In order to know how new and different something has to be in order to make it an innovation, this depends on the degree and novelty. Two particular aspects of "newness" are 1) is it new to the market, implying that it is a product or service not previously offered in the market; and 2) is it new to a company, meaning that the product or service is not offered by another company. Products or services that are new to the market and company have a high degree of innovation (Smith, 2010:7). Refer to the questionnaire in Appendix D.

2. Radicalness

To measure radicalness, the measurement scale of Sounder and Song (2009) was used for the first two statements on a 7-item Likert-type response scale; and Antonites (2017) was used, where respondents had to select all options that applied. The study used four items as shown in Table 5.4 to measure radicalness. A radical innovation calls for a whole new design; "a radical innovation establishes a new dominant design, and hence a new set of core design concepts embodied in components that are linked together in a new architecture" (Smith, 2010:32). In terms of the degree of novelty, radical innovations involve a high level of novelty since they employ a new design with new components integrated into a new system architecture. A new architecture with new components often results from the introduction of a new technology (Smith, 2010:33). Refer to the questionnaire in Appendix D.

3. Uniqueness and Superiority

To measure uniqueness and superiority, the measurement scale of Cooper and Brentani (1991) was used. The study used six items as shown in Table 5.4. One way of defining “uniqueness” is that the object or product must be “different” from all others of its kind. A unique product is also “one of a kind” and it may be considered “unusual” or “novel” in some way (Jaeger, Cardello, Jin, Hunter, Roigard & Hedderley, 2017:60). However, developing a unique and highly differentiated product that has a high potential for market success includes the caveat that the characteristics of the product that highly differentiate it from other products must deliver “positive value” to the customer (Carpenter, Glazer & Nakamoto, 1994:339). Refer to the questionnaire in Appendix D.

4. Innovativeness

To measure innovativeness, the measurement scale of Cooper and Brentani (1991) was used. The study used four items as shown in Table 5.4. Inventive thinking by definition involves the act of bringing something new and original into existence (Boyles, 2012:46). It also requires sound higher-order thinking skills, allowing the application of analysis, comparison, inference and interpretation, evaluation, and synthesis to develop new solutions to complex problems (Lemke *et al.*, 2003). It is therefore a combination of intelligence and creativity that leads to the ability of entrepreneurs to evaluate multiple ideas to determine the true opportunities (Hills & Shrader, 1998:125; Keh *et al.*, 2002). Refer to the questionnaire in Appendix D.

5. Competitive advantage

To measure competitive advantage, the measurement scale of More (1982) was used. The study used three items as shown in Table 5.4. According to Porter (1985:60), technological innovations can have important strategic implications for individual companies, in which technological change is one of the principal drivers of competition. For the purpose of this study, competitive advantage was measured as the extent of patent protection, licence protection and ease of competitive duplication. The three conditions to show that an invention is new, before a patent is granted, are: novelty; it must have an inventive step; and the invention has to be capable of being used in some kind of industry (Smith, 2010:133). Licensing, on the other hand, is where the intellectual property rights associated with an invention have been legally established through a patent, the holder of which can then permit someone else to produce the invention in return for a fee (Smith, 2010:144). Refer to the questionnaire in Appendix D.

6. Market pioneering

To measure market pioneering, the measurement scale of Ali *et al.* (1995) was used. The study used one item. This was not a Likert-type response scale but a Yes/No question. Being a market pioneer means being first or being a first entrant into the market with a product or service (Ali *et al.*, 1995). Refer to the questionnaire in Appendix D.

5.5 PILOT TESTING

Pre-testing, or pilot testing, is an integral part of instrument construction (Kumar, 2019). For the purposes of this study, the following approach was followed.

5.5.1 Pre-testing the research questionnaire (survey)

In questionnaire design, there is always a chance that some questions could cause problems and questionnaire testing is needed to identify and eliminate these problems (Sudman & Blair, 1998:300); Hair, Black, Babin, Anderson and Tatham (2010b:664) recommend that when a model has scales borrowed from various sources reporting other research, a pre-test should be considered using respondents similar to those from the population to be studied in order to screen items for appropriateness.

The research questionnaire was pretested during the pilot phase to ensure face validity and content validity of the questionnaire. Whereas face validity evaluates whether the questionnaire measures what it intends to measure, content validity, on the other hand, deals with whether the content of the instrument accurately assesses all fundamental aspects of the topic (Nunnally & Bernstein, 1994; Rattray & Jones, 2007). However, face validity deals with subjective judgement, and is concerned with the extent to which the researcher believes the instrument is appropriate (Frankfort-Nachmias & Nachmias, 1996). Content validity in this study was largely guided by theory pertaining to the proposed conceptual framework.

The questionnaire (for pre-testing) was sent to 33 innovative entrepreneurs in South Africa via Qualtrics, of whom 17 started the survey, 11 completed the survey and five did not start or complete the survey. Qualtrics is a web-based electronic survey which is the fastest route for pilot testing. The questionnaire had a cover letter containing instructions for the completion of the questionnaire and a deadline was given via email. Face validity showed that all the subscales were generally deemed appropriate. Minimal changes were suggested by the respondents and the general feedback was positive. Some items for the EC and IC were dropped due to duplication and time considerations. Two items from the initial 16 items were removed from the construct "cognitive ability": ("I ask myself if there was an easier way to do things after I finish a task" and "I ask myself how well I accomplished my goals once I'm finished"). Minor modifications were made towards clarifying certain questions and words, such as "I have the ability to demonstrate good analysis skills" was simplified by "I have good analysis skills", for measuring the construct "problem solving". A statement measuring "creative problem-solving and imaginativeness" was divided into two separate statements as they seemed to measure two different things. "Freedom to be creative and original is extremely important to me" was changed to ""Freedom to be creative is extremely important to me" and "Originality is very important to me". The same was experienced with a statement measuring value creation: "I love to experiment to understand how things work and to create new ways of doing things", where the statement was simplified and shortened based on more than one concept being measured. No changes were made under section B (ACAP). In section C (IC), statements such as "In terms of quality, it has a faster or more efficient service", were changed from "it" to "the product/service". The results of the pilot study confirmed that the instrument was fit for use in the intended study.

5.6 DATA COLLECTION

Step 5 in the research process was to conduct the data collection for the study.

The method of data collection for the research was based on communication in that responses were collected by personal and impersonal means (Schindler, 2018:78). Data were collected through a self-administered survey (drop-off, email and web surveys). The final questionnaire was carefully developed to adequately capture all the relevant research questions as well as facilitate testing of the hypotheses.

Due to the large sample size required, the collection of data was done through Qualtrics and Survey Monkey over a one-year period. Qualtrics and Survey Monkey was the preferred choice for this study because it is suitable for large sample sizes and the results can be analysed continuously. Qualtrics and Survey Monkey offers high levels of customisation and sophistication, which were needed for this study.

Based on the two qualifying questions, there were a total of 1569 participants who answered "yes" to both questions and were able to continue ("qualified") to participate in the survey (343 from Qualtrics and 1226 from Survey Monkey). The disqualifying responses are excluded in the calculation since they did not qualify to take the survey. A total of 1117 questionnaires were incomplete/partially completed (221 from Qualtrics and 896 from Survey Monkey) and could not be used in the data analysis. A total of 452 respondents who "qualified" completed the survey (122 from Qualtrics and 330 from Survey Monkey).

The questionnaire included an introductory letter from the University of Pretoria containing explanations of what is meant by ACAP and IC (see Appendix D). A simplified definition and explanation of the constructs ACAP and EC were provided, ensuring that all respondents had at least some basic understanding of the phenomenon in order to assist them to complete the questionnaire. Two exclusion criteria questions were included before participants could start and continue with the survey. Once they had been disqualified, even if they attempted to complete the survey again, the tool did not allow them to access since it linked a unique identifier to a specific email address. The unique identifier was not linked to the IP address since they could attempt to complete the survey again from another device. A question regarding how long they had been in business was also included to make the distinction between nascent, start-up and established entrepreneurs.

The participants were from South Africa. Details such as gender, age, race, education level and industry were not known in advance. The mailing lists which were used had no invalid emails, no duplicates and no blanks. The entire data set (primary data) was collected over a period of 12 months (November 2018 to November 2019). Taking into consideration that the ideal target audience was 4IR entrepreneurs, one has to keep in mind that South Africa has only recently joined the force in focusing on Industry 4.0.

The tool (Survey Monkey and Qualtrics) which was used to collect the data generated a unique code for each participant. A participant who had completed the survey to the end was not allowed to repeat the survey. Two disqualifying questions were added into the survey to ensure that only the people who fell within the target group completed the survey (see in Appendix D). If a participant replied with “no” to any of these questions, they were immediately disqualified from completing the survey.

For the purpose of this study, various data collection methods were utilised: the email survey and the web survey. A total of approximately 2050 surveys were distributed at the Innovation Summit that took place from September 11 to 13 2019 to entrepreneurs, where the survey link was posted on the summit’s application (mobile app). A further 2900 were sent to entrepreneurship incubators or entrepreneurship centres; 7867 were sent on social media to entrepreneurship or 4IR groups, and 245 428 email surveys were sent from two databases containing business owners or directors of companies. The second databases were only sourced in the tenth month of data collection, after only 120 responses had been received. These numbers are based on the third party’s distributor information received. These third parties acted as gatekeepers in the distribution of the survey, which the researcher did not have access to.

The first database of 12 519 emails was sent to businesses (the director) through an email campaign (response rate unknown). The second database from Cwaninga Research was therefore used with a total of 232 909 email contacts of business owners in South Africa. The survey was emailed through Survey Monkey. The researcher did not know in advance the field of business of the respondents, hence the invitation to participate in the survey was sent to the entire contact list. The completion rate from this database was 27%, of which 332 respondents completed the survey and 896 partially completed the survey.

A total of 452 completed surveys that met the qualifying criteria were received from both Survey Monkey and Qualtrics.

5.6.1 Limitations of the data collection method used

While the initial data collection (Qualtrics) was aimed at ensuring a relatively high response rate, the minimum respondent rate was not achieved. For this study a major limitation of the Qualtrics data collection method therefore is that although the researcher had personal assurance from institutions with databases of entrepreneurs, a low response rate was achieved. Web-based surveys are good for large sample sizes as they allow contact with otherwise inaccessible participants and rapid data collection (Cooper & Schindler, 2011:225). However, low response rate in some modes also appears to be a problem. After a very low response was achieved during the first ten months, a second database of business owners for the survey was administered through Survey Monkey. An administrator was appointed to assist with the administration and procurement of the tool for the period of the survey. Web-based surveys exclude individuals who do not have access to email. For those who have email addresses, respondents are asked to follow a web link to a site that allows for the completion of the survey. Some respondents may find this cumbersome and opt out. Perhaps the most common reason for the non-responsive sample, however, was the behaviour of the respondents (Berg, 2005:7) towards the lengthiness of the questionnaire.

5.7 DATA PROCESSING

Data processing (Step 6 in the research process) entails editing, coding and capturing data. Data editing involved examining all completed questionnaires in order to identify and minimise errors, incompleteness and misclassification, as recommended by Cooper and Schindler (2014:377).

Data coding (pre-coding) involved the assignment of receptive codes to categories, and these were built into the design of the questionnaire (Cooper & Schindler, 2014:379; Denscombe, 2007:258). Data in this format were then ready for capturing. The data capturing process happens automatically through the online survey platforms, Qualtrics and Survey Monkey. This automatically converts the information gathered into a medium suitable for viewing and manipulation (Cooper & Schindler, 2014:380).

Once the data collection for the study had been captured and cleaned, the data were analysed using a Statistical Package (SPSS 25.0), a statistical computer package and AMOSv25. The statistical data analysis used in the study is discussed in the next section.

5.8 DATA ANALYSIS

Data analysis (Step 7 in the research process) means the ordering, categorising manipulating and summarising of the data to an interpretable form in order to study and test relations and draw conclusions (De Vos *et al.*, 2012:249). Based on the order of data analysis, a sequential qualitative-quantitative data analysis strategy was used to analyse the qualitative data then the quantitative data. The data analysis practice used in the Delphi study was conversion or transformation, where the qualitative data was converted into numerical codes that one can represent statistically (quantised) (Teddlie & Tashakkori, 2009).

The statistical analysis is outlined in the following order:

- Cleaning and validation of the data
- The profile of the data obtained through descriptive statistics
- The validity and reliability of the research instrument
- Statistical methods used in the study

5.8.1 Cleaning and validation of the data

Data cleaning is aimed at identifying omissions, ambiguities, and errors in the responses (Cooper & Schindler, 2011; Diamantopoulos & Winklhofer, 2001:39).The level of measurement and types of variables dictate the statistical techniques used in analysing the data (De Vos *et al.*, 2012:250). The level of measurement, its description, method of validation and application to the questionnaire is depicted in Table 5.6.

Table 5.6: Level of measurement and method of validation – online survey

Measurement level	Description	Method of validation	Application to questionnaire
Nominal	Classify into categories	Calculate frequencies	Section A Section C (C-73) Section D (D-111)
Ordinal	Order by rank or magnitude	Calculate frequencies	Section B-C
Interval	Rank categories on a scale Distance between values is meaningful, but without an absolute zero	Calculate means, standard deviations, skewness and kurtosis Determine maximum and minimum values	Question C-5
Ratio	Categories exist on a scale Distance between values is meaningful, and there is an absolute zero point	Calculate means, standard deviations, skewness and kurtosis Determine maximum and minimum values	Question A-2 & A-7

Source: Cooper and Schindler (2014:250)

Frequencies in the case of nominal and ordinal data, and distributions in the case of interval or ratio data were checked for any discrepancies in the data. Cleaning the data involved determining whether valid numbers appeared (such as the age of business: yy/mm). A cleaned database was created and stored for data analysis. The descriptive statistics used are discussed in the next section.

5.8.2 Descriptive statistics

Descriptive statistics are used to describe the characteristics of the sample taken (Leedy & Ormrod, 2013:187). The measures of spread (standard deviation), presentation of frequencies and measures of location are used to describe the outcome of the study (Collis & Hussey, 2013; Cooper & Schindler, 2014:401). Standard deviation, means and frequency were used to describe characteristics in the present study. Graphs and tables were created and are interpreted in Chapter 6. The validity and reliability of the questionnaire are discussed next.

5.8.3 Validity and reliability of the research instrument

The internal reliability and validity of the data collected and the response rate achieved depend, to a large extent, on the questionnaire design and structure. Reliability has to do with accuracy and precision of a measurement procedure and validity is the extent to which a test measures what it is supposed to measure (Cooper & Schindler, 2011:280; Leedy & Ormrod, 2010:28). In the current study, content analysis and statistical evidence were used to establish the trustworthiness of the results. The questions were based on literature and previous measurement scales used. To establish construct validity with statistical evidence, factor analysis was performed. Factor analysis is a measure used to describe variability among variables in terms of fewer unobserved variables, called factors (Diamantopoulos & Winklhofer, 2001) Factor analysis was performed per section of the questionnaire. Both exploratory and confirmatory factor analysis were conducted. EFA was conducted on each individual construct to determine the dimensionality of each construct given changes in wording, constructs created from more than one instrument and reduced set of items. This was followed by a measurement model (confirmatory factor analysis) for each category of competencies, IC and EACAP. In the case of EACAP, the distributional result of the items related to the EACAP; Weighted Least Square (WLS) estimation was conducted.

Reliability is the extent to which the measuring instrument yields stability and consistency of results, to the degree to which the research can be repeated while obtaining consistent results (Leedy & Ormrod, 2010; Quinlan, Babin, Carr & Griffin, 2019:93). This study used internal consistency, which represents "a measure's homogeneity or the extent to which each indicator of a concept converges on some common meaning" (Quinlan *et al.*, 2019) to measure the reliability of each construct.

The most widely used index for determining the reliability of a measurement scale is Cronbach's alpha, with a commonly accepted reliability threshold of coefficient alpha (α) $\geq$ 0.70 in the case of established instruments. The Cronbach's alpha value was established for the results of the EFA conducted on each individual construct.

In the context of SEM (overall causal or CFA) models, acceptable reliabilities lower than the usually cited classic reliability of 0.70 may be obtained when model fit is achieved (Bagozzi & Yi, 2012). Standardised loadings are used to measure individual indicator reliability with at least 0.50, that is, at least 50% explained variance (Bagozzi & Yi, 2012). For complex models with many latent variables and indicators, satisfactory model fitting could in fact be obtained even with loadings as low as 0.50. However, Bagozzi and Yi (2012:17) are of the view that focus should be placed more on the hypotheses under test, and goodness-of-fit.

This study used measures of reliability in the context of SEM, that is, squared multiple correlations (SMCs), factor loadings, and error variances. According to Hooper, Coughlan and Mullen (2008), items that have SMCs less than 0.20 should be considered for deletion, as such levels of SMC are an indication that the item is measuring something else. However, the study used Cronbach's alpha to confirm the measurement reliability obtained with the CFA procedures.

5.8.4 Statistical methods used in this study

The multivariate statistical analysis used in this study included both factor analysis and modelling, as illustrated in Figure 5.6.

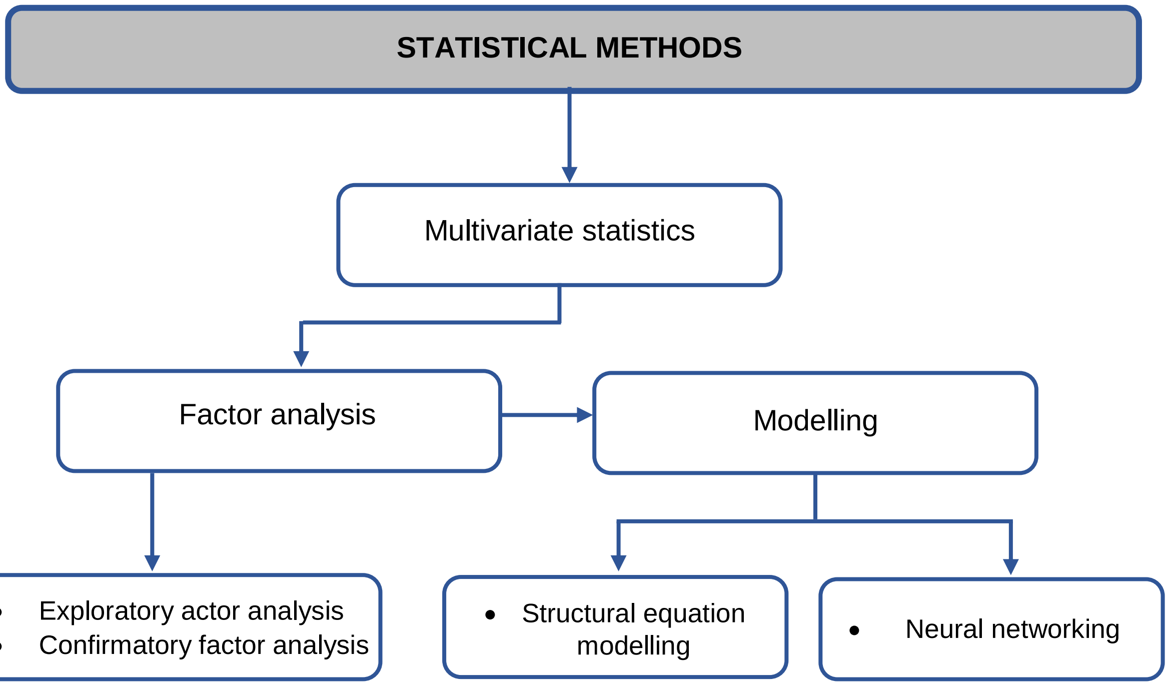


Figure 5.6: Multivariate statistics used in the study

Although SEM is known as the most appropriate multivariate procedure for testing interrelationships among variables such as EC, EACAP and IC (Hair, Black, Babin, Anderson & Tatham, 2019:627), it is a causal inference method testing linear relationships, but not non-linear relationships. Neural networking, on the other hand, offers additional advantages over traditional statistical procedures in developing pattern recognition (non-linear) models (John, Balakrishnan & Fiet, 2000:1084), which has not been done in the field of entrepreneurship. The statistical methods, EFA, CFA, SEM and NN as applied in this study, are discussed in the paragraphs below.

a. Exploratory factor analysis

Exploratory factor analysis (EFA) is used to explore the data and provides the researcher with information on how many factors best represent the data. The factors are therefore derived from statistical results and not from theory (Hair *et al.*, 2014:603). They can therefore only be named after the factor analysis has been performed (Hair *et al.*, 2014:603). EFA can therefore be conducted without knowing how many factors actually exist, or which variables belong with which factors (Hair *et al.*, 2014:603). EFA was conducted, using principal axis factoring extraction and promax rotation, to determine the unidimensionality of each of the constructs followed by measurement models (CFA) on each category of ECs, ACAP and IC. The minimum acceptable level of internal consistency required is 0.7 for all reported reliability coefficients (Nunnally, 1978). However, in exploratory research, 0.6 is considered acceptable (Bagozzi & Yi, 1988; Hair, Black, Babin & Anderson, 2010b). The procedure that was followed in performing the EFA in the present study is illustrated in Figure 5.7.

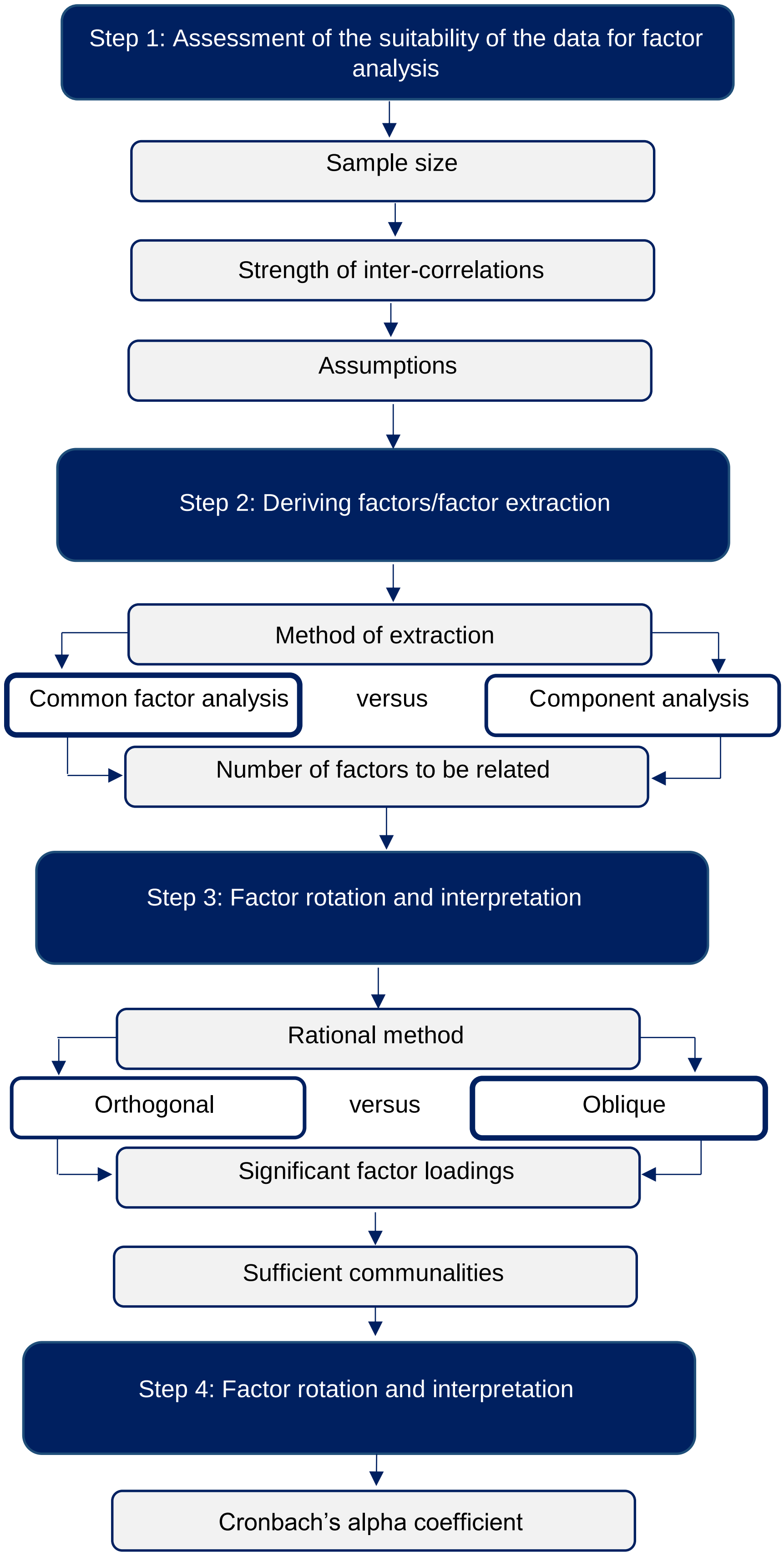


Figure 5.7: The process of EFA

Source: Adapted from Field (2013:657) and (Hair *et al.*, 2014:106)

Figure 5.7 illustrates the four steps involved in the EFA decision-making process. The first step is assessment of suitability of the data for factor analysis. The strength of the relationship among variables and sample size are two main issues to consider in determining whether this particular data set was suitable for factor analysis. A large sample size is generally recommended (Pallant, 2011:18), having at least 300 cases (Tabachnick *et al.*, 2007:613). The sample size of the current study is 452 and can therefore be considered suitable for factor analysis. In order to determine the strength of the inter-correlations among items, Pearson product-moment correlation coefficients were applied (Hair *et al.*, 2010a:103; Tabachnick *et al.*, 2007:613). In addition, two statistical measures, the Bartlett's test of sphericity and the Kaiser-Olkin (KMO) measure of sampling adequacy were used to aid in diagnosing the factorability of the correlation matrix.

The second step comprises deriving factors, which involves determining the smallest number of factors that can be used to best represent the interrelationships among the set of variables (Pallant, 2011:183). Patterns of correlation among the variables were examined by subjecting the set of items to common factor analysis, more specifically, principal axis factoring (PAF), using SPSS version 25.0. Factors with Eigen values greater than 1.0 were retained, as enough factors met the specified percentage of variance explained, usually 60% or higher, and factors shown by the screen test to have substantial amounts of common variance (factors before inflection point), were retained (Hair et al., 2010:111; Pallant, 2011:184).

The third step is performing factor rotation and interpretation. Factor rotation is the process of manipulating or adjusting the factor axes to achieve a simpler meaningful factor solution (Hair *et al.*, 2014:90). Promax with Kaiser Normalisation rotation was performed. As $n > 350$, factor loadings of 0.30 and greater were considered significant and used for the interpretation, as recommended by Hair *et al.* (2014:115). Thereafter, each variable's communality was also examined to identify whether there were variables that were not adequately accounted for by the factor solution (Hair *et al.*, 2014:117).

The last step in the EFA process was to assess the reliability of the factors, which is an assessment of the degree of internal consistency between multiple measurements of a variable(Hair *et al.*, 2010a:127). The internal consistency of each extracted factor was determined by calculating Cronbach's alpha-coefficient. The generally agreed upon limit for Cronbach's alpha-coefficient is 0.70, although it may decrease to 0.60 in exploratory research (Hair *et al.*, 2010a:127). Lastly, descriptive statistics were calculated for each of the factor-based variables created.

The results of the EFA are provided in Chapter 6.

b. Confirmatory factor analysis

CFA allows the evaluation of the hypotheses' construct validity by testing whether a theoretical model of what a test is supposed to measure is consistent with the observed co-variances (Kline, 1998a:343). CFA is therefore an enabling tool that either confirms or rejects the preconceived theory (Hair *et al.*, 2014:603; Reinard, 2006:428).

The measurement models (CFA) were employed to confirm fit for the social, meta and cognitive competencies groups, as well as for ACAP and IC. The analysis of moment structures (AMOS) (SPSS 25.0) was used as the statistical software for conducting the CFA. The models were then evaluated on the basis of goodness-of-fit indices to test whether the proposed measurement models fitted the data.

A number of goodness-of-fit indices, which reflect the extent to which a model can be considered an appropriate means of data representation, are suggested. The following goodness-of-fit indices were used in this study (Hair *et al.*, 2014:576-580; Raykov & Marcoulides, 2000:35-41).

- **Chi-square value (CMIN):** A test statistic of the goodness-of-fit model used when testing the null hypothesis to establish whether the model fits the analysed covariance matrix perfectly. The model is rejected when the p-value is smaller than a pre-set significance value.

$$T = (N - 1)\ F_{\mathrm{min}}$$

  - Chi-square value = T
  - N = sample size
  - F_{min} = minimal value of the fit function for the parameter estimation method used
- **Root mean square error of approximation (RMSEA):** This takes model complexity into account, with less rigid requirements for degree of fit. Its primary principle is that it evaluates the extent to which the model fails to fit the data. It

is generally recommended that the RMSEA should be less than 0.05 for the fitted model to indicate a good approximation. Values between 0.05 and 0.08 indicate acceptable fit, values between 0.08 and 0.10 marginal fit, and values above 0.1 poor fit.

- **Incremental fit index (IFI):** This also compares *T* (chi-square value) against a baseline model or the independence model, which assumes that all the covariances are zero. IFIs should ideally be greater than 0.9 for acceptable fit. TLI and CFI are the most widely resorted incremental fit measures (Hair *et al.*, 2019:638).
- **Comparative fit index (CFI):** This compares a proposed model with the null model, assuming no relationships between measures. A CFI that ranges between 0 and 1 is also recommended to be greater than 0.09 to indicate good fit. This index is one of the measures least effected by sample size and still performs well even when sample size is small (Hooper *et al.*, 2008:55).
- **Trucker-Lewis index (TLI):** This compares *T* (chi-square value) against a baseline model or the independent model, which assumes that all the covariances are zero. TLI should ideally be greater than 0.90 for acceptable fit.
- **Discriminant validity** is the extent to which a variable or construct is truly distinct from other variables or constructs. High discriminant validity thus provides evidence that a construct is unique and captures some phenomena other measures do not (Hair *et al.*, 2019:676). The term further refers to the relationship of the off-diagonal terms **R***xx* and **R***yy* with **R***xy*. This is because the *x* variables and *y* variables are indicators of different constructs; discriminant validity is exhibited only if all the correlations in **R***xx* and **R***yy* (measurement) are statistically significant and each of these correlations is larger than all correlations in **R***xy* (Fornell & Larcker, 1981:41). Fornell and Larcker (1981:47) indicate that the average variance extracted (AVE) is sensitive to a lack of convergent validity and can be used to assess discriminant validity where, if AVE is larger than the squared correlation, discriminant validity can be assumed (Hair *et al.*, 2019:676), where AVE is defined as follows:
- **Average Variance Extracted (AVE)**: This is the average percentage of variation explained (variance extracted) among the items of a construct. It is a summary measure of convergence among a set of items representing a

reflectively measured latent construct. An AVE of less than 0.5 indicates that, on average, more error remains in the items than variance held in common with the latent factor upon which they load.

- **Heterotrait-monotrait ratio** of the correlations **(HTMT):** This is the ratio of the between-trait correlations to the within-trait correlations. An HTMT value of above 0.9 suggests a lack of discriminant validity. When the constructs in the path model are conceptually different, a lower threshold value of 0.85 is suggested (Henseler, Ringle & Sarstedt, 2015).

c. Structural equation modelling (SEM)

The term SEM describes a large number of statistical models that are used for empirically evaluating the validity of substantive theories. This technique is the most appropriate multivariate procedure for testing both construct validity and theoretical relationships between a set of concepts represented by variables that are measured with multiple items, as well as interrelationships among a set of variables (Hair *et al.*, 2010b:627; Pallant, 2011:105). SEM is defined as a procedure for estimating a series of multiple, interrelated dependence relationships between concepts or constructs represented by multiple measured variables (latent constructs) and incorporated into an integrated model (Hair *et al.*, 2014:547; Malhotra, 2015:710; Raykov & Marcoulides, 2000:1). Other terms such as covariance structure modelling, covariance structure analysis or analysis of covariance structures are also used in the literature. According to Ullman in (Tabachnick *et al.*, 2007), SEM is a collection of statistical techniques that allow a set of relationships between one or more IVs, either continuous or discrete, and one or more DVs, either continuous or discrete, to be examined. SEM is also an overarching term that includes causal modelling, causal analysis, simultaneous equation modelling, analysis in covariance structures, path analysis, or confirmatory factor analysis Ullman in Tabachnick *et al.* (2007:676).

Models analysed in SEM generally assume probabilistic causality, which allows for changes to occur in outcomes at some probability < 1.0.

SEM can therefore be distinguished by the following characteristics:

- *Estimation of multiple and interrelated dependence relationships.* Firstly, the researcher draws upon theory, prior experience and the research objectives to distinguish which independent variables predict each dependent variable (Hair *et al.*, 2014:547). The proposed relationships are then translated into a series of structural equations for each dependent variable, which sets SEM apart from other techniques.

- *Incorporating latent variables not measured directly.* SEM has the ability to incorporate unobserved or latent constructs in these relationships, and account for measurement error in the estimation process. Latent constructs are measured indirectly by examining consistency among multiple measured variables that were gathered through various data collection methods, such as surveys. Therefore, latent constructs improve the statistical estimation of the relationships between the concepts by accounting for measurement error in the concepts. They also better represent theoretical concepts by using multiple measures of a concept to reduce measurement error (Hair *et al.*, 2014:547). Furthermore, distinguishing between endogenous and exogenous latent constructs is of importance, since the dependence of endogenous constructs is visually represented by a path (one-headed arrows) from one construct to another. Exogenous constructs, on the other hand, do not have any paths from other constructs or variables, given that they are independent (Hair *et al.*, 2014:549).
- *Defining a model.* A model can be described as "a systematic set of relationships providing a consistent and comprehensive explanation of phenomena", and can be described as a representation of theory (Hair *et al.*, 2014:549). The visual portrayal of a complete SEM model, known as a path diagram, indicates the relationships that employ specific conventions for both the constructs (indicated by ovals or circles) and the measured variables (indicated by rectangles or squares), as well as the relationships between them (Hair *et al.*, 2014:550). A relationship, depicted by a straight arrow, between the latent construct and the measured variables, or a structural relationship between constructs, for example, can either be dependence relationships (single-headed directional arrows) or a correlation relationship (two-headed arrows) (Hair *et al.*, 2014:550). Lastly, the researcher has to accept or reject the entire model, determining whether overall model fit is acceptable (Hair *et al.*, 2014:552). SEM will therefore assess how well the theory fits reality as

represented by the data of the study (Hair *et al.*, 2014:565). The process that was followed in performing SEM in this study is illustrated in Figure 5.8.

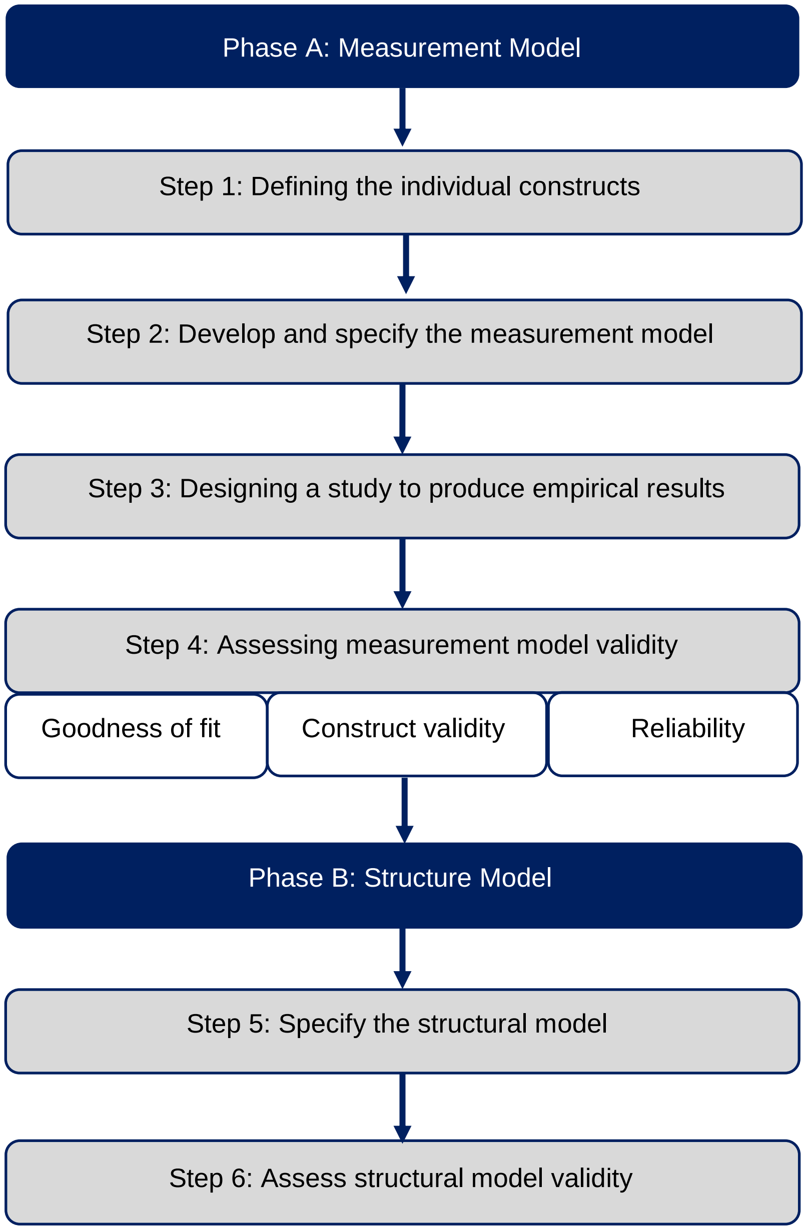


Figure 5.8: The SEM process

Source: Adapted from (Hair *et al.*, 2014:566; Hair *et al.*, 2019:626)

The six-step decision process reflecting the procedures of SEM is illustrated in Figure 5.8. SEM is represented by two components: 1) the measurement model and 2) the structure model.

Phase A: Measurement model:

A measurement model is defined as a "SEM model that specifies the indicators for each construct and enables an assessment of construct validity (Hair *et al.*, 2019:605). In this study, the researcher was interested in developing and testing six measurement models, namely: 1) Absorptive Capacity, 2) Innovation Capacity, and the four competence categories: 3) Cognitive, 4) Functional, 5) Social, and 6) Meta Competence. Functional competence consists of only one competency, namely value creation.

Step 1: Define the individual constructs: The constructs associated with each of the six measurement models were therefore theoretically defined (see Chapters 2 and 3). The constructs were then operationalised by selecting their measurement scale items and the scale type (section 5.x) (Hair *et al.*, 2019:627). In addition, the constructs were subject to EFA, as discussed in section 5.8.4. Once the constructs were defined and operationalised, the measurement model was developed and specified, as discussed in Step 2.

Step 2: Develop and specify the measurement model: In order to develop and specify the measurement model, each latent construct to be included in the model was identified and the measured indicator variables (items) were assigned to the latent constructs (Hair *et al.*, 2019:627). The visual diagrams depicting the measurement models of the current study are illustrated in the results section (see Chapter 7).

In this study, the majority of latent constructs were initially indicated by more than three indicators and were therefore over-identified, as indicated in the questionnaire. According to Kline (2015:201), it is better to have at least three to five indicators per factor in order to avoid technical problems, especially with small samples. The competence category "Functional competence" was represented by only one factor (value creation), but had five indicators. The latent constructs that had two indicators or were reduced to two indicators were leadership (social competency), competitive advantage (under IC) and radicalness (under IC).

The minimum required indicators per factor is two for CFA models with multiple factors (Kline, 2015). Therefore, even though a unidimensional two-item construct CFA is under-identified on its own, if it is integrated into a CFA model with other constructs, the overall model may be over identified (Hair *et al.*, 2019:668).

Step 3: Design a study to produce empirical results: Three issues were considered at this stage, namely (1) the sample size, (2) the approach taken regarding missing data and (3) model estimation. Even though a sample size of n = 452 was obtained for the current study, model complexity and communalities were also investigated. Model complexity is evident in the number of constructs being measured that require more parameters to be estimated. It was concluded that the sample size was appropriate to conduct four different postulated SEM models. As only completed responses were included, there were no missing data. After the model is specified (Step 2), the model estimation techniques are considered. In this study, the maximum likelihood estimation (MLE) technique is a procedure that iteratively improves parameter estimates to maximise a specified fit function (Hair *et al.*, 2019:632). The current study applied the statistical programme AMOS version 25.

Once the measurement model is specified (Step 2), a SEM model is estimated to provide an empirical measure of the constructs and associated indicators as well as the covariances between them, represented by the measurement theory (Step 3). In Step 4, the most fundamental question, SEM testing of "Is the measurement model valid?" is answered.

Step 4: Assess measurement model validity: The validity of the measurement model depends on (1) acceptable levels of goodness of fit and (2) construct validity (Hair *et al.*, 2019:635). Goodness-of-fit indicates how well the user-specified model mathematically reproduces the observed covariance matrix among the indicator items. The fundamental measure of statistical differences between the observed and estimated covariance matrices is the chi-square (Hair *et al.*, 2019:635). However, this measure is sensitive to sample size and as such is not considered when samples are large (above 200 cases). For the goodness-of-fit indices used in this study, refer to section 5.8.3 (CFA).

Rules of thumb suggest that standardised indicator loadings should be at least 0.5 and ideally 0.7 or higher. Loadings of this size confirm that the indicators are strongly related to their associated constructs, which indicates construct validity (Hair *et al.*, 2019:674). In addition, the statistical significance of each estimated coefficient was assessed. A loading can be significant at impressive levels (i.e., $p < 0.01$), but if the loading estimate is low (< 0.5), it does not qualify as a good item (Hair *et al.*, 2019:675).

Furthermore, CFA provides additional diagnostic information that may suggest modifying the measurement model to improve the model fit (Hair *et al.*, 2019:678). Model fit could therefore be improved with modification indices. The practice of adding relationships purely to increase model fit is a dangerous one and should only be added if it can be theoretically justified. For the current study, modification indices were studied and were theoretically justified, and additional covariances between measurement errors were included.

Phase B: Structural model:

In Phase B, the measurement scales are integrated into the estimation of the relationships between dependent and independent variables in the structural model (Anderson, Babin, Black & Hair, 2010:19). The structural model for the current study was operationalised following the last two steps (step 5 and 6) of the process of SEM.

Step 5: Specify the structural model: The structural model component of this study represents proposed theory with a set of structural equations specifying relationships (Hair *et al.*, 2019:700). When specifying the structural model, relationships are assigned from one construct to another based on the proposed theoretical model. This implies using single-headed, directional arrows to show dependence relationships that represent structural hypotheses of the researcher's model (Hair *et al.*, 2019:643). In step 5, the structural theory defined and structural path diagram displaying the relationships are expressed visually (see Figure 7.1) for the initial structural equation model of the present study.

The hypothesised models for the study, as shown in Figure 1.2, Figure 1.3 and Figure 1.4 (Chapter 1) is based on the conceptual frameworks presented in Chapter 4 (Figure 4.1, Figure 4.5 and Figure 4.6). The models depict the hypothesised theoretical relationships. The research hypotheses for the conceptual models are presented in the next section.

Table 5.7: Summary of the research hypotheses

H1:	There is a significant positive relationship between Entrepreneurial Competencies and Innovation Capacity
H1a:	There is a significant positive relationship between Cognitive Competencies and Innovation Capacity
H1b:	There is a significant positive relationship between Functional Competencies and Innovation Capacity
H1c:	There is a significant positive relationship between Social Competencies and Innovation Capacity
H1d:	There is a significant positive relationship between Meta Competencies and Innovation Capacity
H2:	There is a significant positive relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity
H3:	There is a significant positive relationship between Entrepreneurial Competencies and Entrepreneurial Absorptive Capacity
H3a:	There is a significant positive relationship between Cognitive Competencies and Entrepreneurial Absorptive Capacity
H3b:	There is a significant positive relationship between Functional Competencies and Entrepreneurial Absorptive Capacity
H3c:	There is a significant positive relationship between Social Competencies and Entrepreneurial Absorptive Capacity
H3d:	There is a significant positive relationship between Meta Competencies and Entrepreneurial Absorptive Capacity
H4:	Entrepreneurial Absorptive Capacity mediates the relationship between Entrepreneurial Competencies and Innovation Capacity
H4a:	Entrepreneurial Absorptive Capacity mediates the relationship between Cognitive Competencies and Innovation Capacity
H4b:	Entrepreneurial Absorptive Capacity mediates the relationship between Functional Competencies and Innovation Capacity
H4c:	Entrepreneurial Absorptive Capacity mediates the relationship between Social Competencies and Innovation Capacity

H4d:	Entrepreneurial Absorptive Capacity mediates the relationship between Meta Competencies and Innovation Capacity
H5:	Entrepreneurial Absorptive Capacity moderates the relationship between Entrepreneurial Competencies and Innovation Capacity
H6:	Entrepreneurial Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity
H6a:	Cognitive Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity
H6b:	Functional Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity
H6c:	Social Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity
H6d:	Meta Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity
H7:	Neural Networking (through testing non-linear relationships) provided an improved model fit to that provided by Structural Equation Modelling (SEM) through linear relationships

Source: Own compilation

Chapter 7 deals with the hypothesis testing procedures for this study, where a summary of the statistical hypotheses, whether rejected or not rejected are given in Chapter 8. The chosen level of significance (0.05) determines statistical significance; where the null hypotheses would be rejected if the calculated significance probability was less than 0.05 (Cooper & Schindler, 2011:438). H1-H3 are directional hypotheses. Directional hypotheses describe a positive or negative relationship between two or more constructs/concepts. In this study, each hypothesis therefore describes a significant positive relationship that is tested between two or more constructs by using correlation or regression analysis. H4 to H6 are seen as causal hypotheses in this study, as certain variables such as EC have effects on other variables such as IC.

With causal hypotheses, one variable being studied is assumed to cause a specific effect on another variable (Schindler, 2018:16).

Step 6: Assess structural validity: The final stage involves efforts to test the validity of the proposed theoretical structural model. The emphasis was firstly on SEM model fit and secondly on whether the structural relationships were consistent with theoretical expectations, as recommended by Hair *et al.* (2019:644). Goodness-of-fit indices used in the current study were explained in the previous section (see section 5.8.4). Based on the results of the SEM, the hypotheses that were set (see Table 5.7) were evaluated and are presented in Chapter 7. The testing for mediation is now discussed.

d. Testing for mediation

A mediating effect is created when a third variable/construct intervenes between two other related constructs. The application of mediation can potentially explain why a relationship between two constructs exists. Testing for mediation requires statistically significant correlations among all three constructs (Hair *et al.*, 2019:745). The rationale for exploring mediation arises when one may observe a relationship between constructs, but not know "why" it exists. One can then posit some explanation in terms of an intervening or facilitating variable, which operates to take the "inputs" from for example X and translate them into the "output" Y. Therefore, the mediator (e.g. M) facilitates and explains why the relationship between the two original constructs exists (Hair *et al.*, 2019:745) and links a cause and an effect (Wu & Zumbo, 2008:368). From a theoretical perspective, a mediating construct facilitates the relationship between the other two constructs involved. Only if the mediating construct completely explains the relationship between the two original constructs (e.g. X and Y), does one have complete mediation (Hair *et al.*, 2019:745). The causal model, as explained by Kenny and colleagues (Baron & Kenny, 1986; Kenny, 2018; Kenny & Judd, 2014), implies a relationship between two variables, the independent or causal variable (X) and the dependent or outcome variable (Y). Figure 5.9 illustrates the unmediated causal model where variable X (independent or causal model) has a direct causal effect on variable Y (dependent or outcome variable) with patch c, called the total effect (Kenny, 2018).

$$\mathbf{X} \xrightarrow{\mathbf{c'}} \mathbf{Y}$$

Figure 5.9: Unmediated causal model, illustrating the direct effect of variable X on variable Y

Source: (Kenny, 2018)

As indicated in Figure 5.10, the mediated causal model, variable X (independent or causal variable) has an influence on the intervening or process variable M (path a), which consecutively has an influence on the dependent or outcome variable Y (path b) with the total effect presented by path c'.

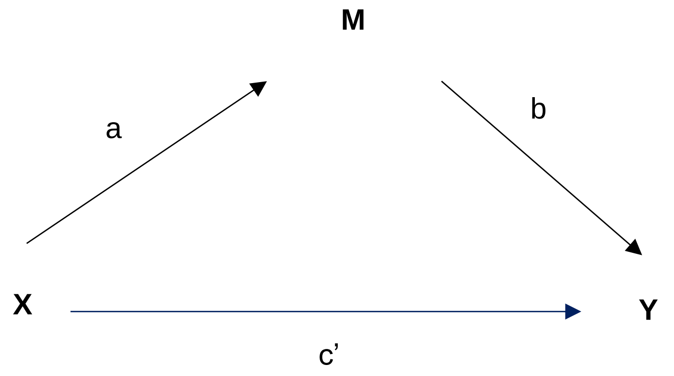


Figure 5.10: Mediated causal model
Source: Kenny (2018)

A direct effect is the relationship linking two constructs with a single arrow (connection). Indirect effects are those relationships that involve a sequence of relationships, with at least one intervening construct involved. Indirect relationships, and thus mediation, commonly appear in structural models. A model proposing mediation that exhibits good fit therefore provides evidence that the mediation exists (Hair *et al.*, 2019:745).

Mediation analysis is useful for getting an understanding of how a process works. Kenny and colleagues explain that when testing for mediation, there are four steps necessary to follow in the statistical analysis. The four steps comprise the four conditions that the relationship between the variables must satisfy in order to indicate mediation (Baron & Kenny, 1986; Kenny, 2018; Kenny & Judd, 2014).

Step 1: indicates whether there is an effect that may be mediated; therefore the independent variable must influence the dependent or outcome variable (path c').
Step 2: the independent variable needs to correlate with the mediator, showing that the independent or causal variable influences the mediator (path a).

Step 3: needs to show that the mediator or intervening variable affects the dependent or outcome variable (path b).

Step 4: establishes whether the effect of the independent variable diminishes after controlling for the effects of the intervening variable or mediator (path c'). Path c' should be zero. If all four of the conditions are met and the influence of the independent or causal variable becomes non-significant and not different from zero in the presence of the mediator, the mediator completely or fully mediates the effects of the independent variable in the relationship with the dependent variable.

If all the conditions are satisfied, but the effects of the independent variable on the dependent variable continue to be statistically significant in the presence of the mediator, partial mediation is indicated (Baron & Kenny, 1986; Kenny & Judd, 2014).

e. Testing for moderation

Moderation effect occurs when a third variable or construct changes the magnitude of the relationship between two related variables/constructs (do Valle & Assaker, 2016; Hair *et al.*, 2019:748) or modifies a causal effect (Wu & Zumbo, 2008:368). Moderation is where the strength and/or direction of a main effect varies between different values of the moderator. It is also viewed as an interaction effect (Hair *et al.*, 2019:397). The discussion of moderation in the context of the current study firstly focuses on the theoretical nature of the relationship and secondly on how this moderating relationship was incorporated into the SEM model.

The moderating variable therefore affects the relationship between the dependent and independent variable and has the potential to alter the strength of this relationship (Baron & Kenny, 1986:1174; Frazier, Tix & Barron, 2004:7). Figure 5.11 demonstrates the moderation effect using a conceptual path diagram. The causal effect of EC on IC is dependent on the value or level of the moderator, EACAP (Wu & Zumbo, 2008:370). For the purposes of this study, the SEM approach was used to test moderator effects; although most previous statistical analysis discussions on testing for moderation illustrate the regression technique, the SEM technique has emerged as a popular new approach for testing research models including moderators (Ro, 2012:952).

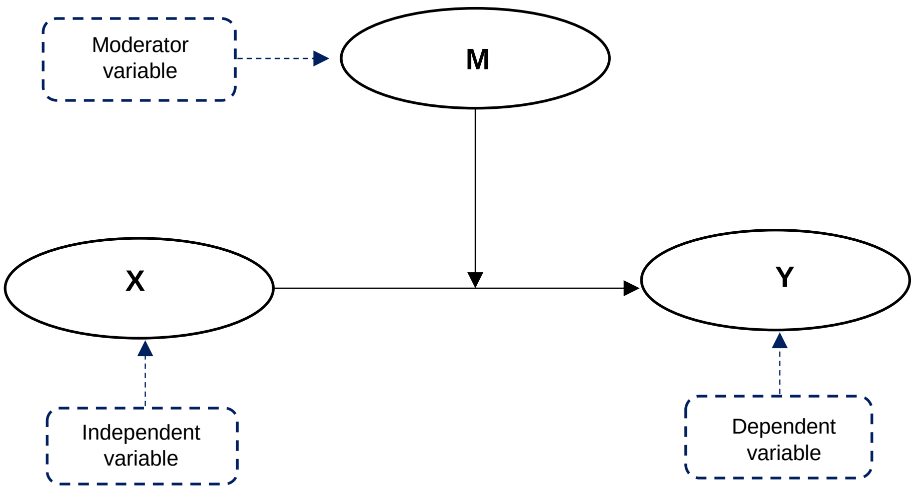


Figure 5.11: The independent and dependent variables and the moderator

According to the statistical rules for moderation (Jose, 2013:11), the following statistical hypotheses were applied in this study:

1) Hypothesis 1: The X-Y relationship (testing for β1)
2) Hypothesis 2: The M-Y relationship (testing for β2)
3) Hypothesis 3: The XM -Y relationship (testing for β3)

The regression coefficient β1 measures the simple effects of X (independent variable) on Y (dependent variable) when the value of the moderating variable M = 0 (no interaction effects), while β2 measures the effects of the moderating variable M on Y. The regression coefficient β3 measures the interaction effect between the independent variable X and the moderating variable M. The test of moderation is operationalised by the term XM (the multiplication between the two independent variables). In order to test the moderation in the model, one needs to test β3 (the coefficient of the interaction term XM). If β3 is significant, then one could conclude that moderating variable M moderates the relationship between X and Y (Jose, 2013:11). The moderator hypotheses is supported if the interaction (M-Y) is significant (Baron & Kenny, 1986:1174). In addition to these basic considerations, it is desirable that the moderator variable be uncorrelated with both the predictor and the criterion (the dependent variable) to provide a clearly interpretable interaction term (Baron & Kenny, 1986:1174). However, according to Jose (2013:26), the moderating variable should not be highly correlated with the dependent variable, but strict non-significant correlation is not necessary.

The moderation effects of the moderator variable M in the model occur if Hypothesis 3 (β3) is statistically significant. Hypothesis 2 (β2) is not statistically significant. As for Hypothesis 1 (β1), there are two possibilities to occur:

1) If Hypothesis 1 is not statistically significant, "complete moderation" occurs.
2) If Hypothesis 1 is statistically significant, "partial moderation" occurs.

f. Artificial Neural Networking

Neural networks (NN), also referred to as artificial neural networks (ANN) represent an emerging technology rooted in many disciplines (Haykin, 1994:v), such as aerospace, automotive areas, banking, defence, electronics, entertainment, financial, insurance, manufacturing, medical, oil and gas, robotics, speech, securities, telecommunications and transportation (Beale, Demuth & Hagan, 1996:1). Neural networks have some unique attributes, such as: universal approximation (input–output mapping), the ability to learn from and adapt to their environment, and the ability to evoke weak assumptions about the underlying physical phenomena responsible for the generation of the input data (Haykin, 1994:v).

The NN analysis used is a feed-forward network and is known as multilayer perception with simple connections between different components. Radial Basis Function (RBF) networks are also known as a type of artificial neural network for application to supervised learning (Broomhead & Lowe, 1988; Orr, 1996:1). In each layer of the multilayer perceptron analysis, one or more processing unit(s) called nodes or artificial neurons are present, which perform a simplified version of what a human brain's neurons do (Ansari & Riasi, 2016:18). A multilayer perceptron is defined as: "a system of simple interconnected neurons, or nodes, which is a model representing a nonlinear mapping between an input vector and an output vector" (Gardner & Dorling, 1998). The brain is a highly complex, nonlinear, and parallel computer (Haykin, 1994:1); the role of neurons in a human brain is to process and analyse the data. This task is simulated by using a mathematical processor in an artificial neural network; the behaviour of the neural network depends on the relationships and connections among individual components of the network (Mirghafoori, Taheri & Zareh Ahmadabadi, 2010). The brain has the capability to organise neurons so as to perform certain computations (e.g., pattern recognition, perception, and motor control), sometimes faster than the fastest digital computer in existence today (Haykin, 1994:1).

Neural networks have three main neural layers in each network. The first layer is called the *input* layer, where the data enter the network and are then transferred to the processor. The second layer is called the *hidden* layer, which functions by receiving the inputs from the input layer, and by considering the weights of the relationships among different input units and hidden units, its function is to intervene between the external input and the network output (Haykin, 1994:19). These weights determine when the hidden layer should be activated. The last layer is called the *output* layer, whose functionality is dependent upon the activities of the hidden layer and the weights between hidden units and output units (Ansari & Riasi, 2016:19). The weightings of the connections are not fixed and can be modified on the basis of a learning procedure derived from the comparison of the network responses with those required (Altman, Marco & Varetto, 1994:516). A neural network is a parallel processor that has a natural propensity for storing experiential knowledge and making it available for use. It resembles the brain in two respects: 1) knowledge is acquired by the network through a learning process; 2) interneuron connection strengths known as synaptic weights are used to store the knowledge. The use of neural networks offers the following useful properties and capabilities (Haykin, 1994:4-5):

- Nonlinearity
- Input–output mapping
- Adaptivity
- Evidential response
- Contextual information
- Fault tolerance
- Very-large-scale-integrated (VLSI) implementability
- Uniformity of analysis and design
- Neurobiological analogy

NN further offer advantages over traditional statistical procedures in developing pattern recognition models. They provide a unique capacity for recognising patterns regardless of the functional form of the relationship, and provide greater flexibility in combining the effects of the predictor variables. For example, in regression models, highly correlated pairs of variables can produce multi-collinearity that masks the information content of the predictor set. On the other hand, if data are available for a large number of input variables, an advantage of using a procedure such as neural networks is that the training process will automatically ignore those variables that do not contribute to the pattern recognition process (i.e., their arc-weights would be near zero) (John *et al.*, 2000:1084). After the network is given a set of inputs that generates a response and the weightings are not changed if the response obtained corresponds with the response required. If the difference exceeds a certain tolerance level, revisions have to be introduced into the weightings and learning starts again (Altman *et al.*, 1994), then a new case is input. The analysis of all the cases supplied constitutes the maximum extension learning cycle. After the interaction of a large number of cycles, the error is reduced to acceptable levels. Once the holdout set accuracy has been exceeded, the learning ends and the weights are locked and the network has achieved a stable equilibrium configuration that represents "its capacity to solve a problem" (Altman *et al.*, 1994:515).

5.9 PRESENTATION OF RESEARCH FINDINGS

Once the date are analysed, the final step is to present the findings effectively. The main purpose of using data-display techniques is to make the findings clear and easily understood (Kumar, 2019). The research findings are presented in chapters 6 and 7, while the conclusions and recommendations are provided in Chapter 8.

5.10 RESEARCH ETHICS

In order to make ethically guided decisions for the humane and sensitive treatment of participants, ethical principles should be practised and internalised by researchers (De Vos *et al.*, 2012:115). As part of the requirements for a doctoral study, an application for ethical clearance was submitted and subsequently approved by the University of

Pretoria [Protocol no: EMS075/18] (Refer to Appendix A for the ethical approval letter). The requirements included approved title registration, completion of research proposal and data collection instrument. Ethical clearance was obtained to emphasise that the study was anonymous. The answers given were treated as strictly confidential as the answers given could not identify the person giving them. Although participants in this study were very important, the participants could choose not to participate and could also stop participating at any time without any negative consequences. Respondents were asked to answer the questions as comprehensively and honestly as possible. It was highlighted that the results of the study would be used for academic purposes only and might be published in an academic journal. The ethical principles of voluntary and informed participation, confidentiality, anonymity and non-harm were therefore considered in conducting the research (De Vos *et al.*, 2012:58). A summary of study findings would be made available on request. The participants were given the study leader's contact details if they had any questions or comments regarding the study.

5.11 CONCLUSION

This chapter discussed and justified the research design employed in this research. The methodological procedure of the present study consisted of three phases. The first two phases represented the secondary research (exploratory research). *Phase 1* involved a literature review (see chapters 3 to 4), while three conceptual frameworks for the relationships between EC, EACAP and IC were developed (see Chapter 5). *Phase 3* represented the primary research (descriptive research) conducted for this study, in which the conceptual frameworks were tested empirically. This chapter (Chapter 5) elaborated on the eight steps in the primary research as applied to this study.

A mixed method research design was used to test the conceptual frameworks, which were based on the knowledge spillover theory, person-entrepreneurial fit theory and absorptive capacity theory. A Delphi study was elected in identifying EC for further testing; thereafter a survey design (quantitative cross-sectional survey) was selected for the research, and a self-administered questionnaire was developed as the research instrument. The questionnaire was developed to measure 1) EC: the four identified competence categories, namely cognitive, functional, social and meta competence, 2)

EACAP: recognition, assimilation, transformation and exploitation, and 3) IC: newness, radicalness, uniqueness and superiority, innovativeness and market pioneering. The constructs and items were based on the conceptual frameworks that were established in the literature review (see Figures 4.1, 4.5 and 4.6).

In order to obtain information on the target population, namely innovative entrepreneurs, a census approach was used to obtain information on the target population (see Figure 5.2). After a pilot test was conducted (see section 5.5), the data for the current study were collected from innovative entrepreneurs in South Africa. The data as used in this study were obtained from n = 452 entrepreneurs. This chapter further outlined the procedures followed in collecting data, with consideration given to maximising reliability and validity (see section 5.6). Data were processed and analysed (see sections 5.7 and 5.8). An overview of data-analysis techniques used in the current study was also given. The statistical methods as applied to this study, namely EFA (see Figure 5.7), CFA (see section 5.8.4) and SEM (see Figure 5.8) were discussed. Because of the nature of individual entrepreneurs as research participants, it was ensured that the process of undertaking the research adhered to sound ethical principles (see section 5.10). The next chapters (chapters 6 and 7) outline the data analysis resulting from these procedures, followed by chapter 8, which represents the conclusions, recommendations and proposed model for innovation capacity.

CHAPTER 6:

RESEARCH FINDINGS (PART 1): DESCRIPTIVE STATISTICS AND FACTOR ANALYSIS

DIAGRAMMATIC SYNOPSIS

INTRODUCTION

↓

DESCRIPTIVE STATISTICS:
BIOGRAPHIC INFORMATION OF RESPONDENTS

↓

DESCRIPTIVE STATISTICS:
CONSTRUCTS IN THIS STUDY

↓

VALIDITY AND RELIABILITY OF THE CONSTRUCTS

↓

CONCLUSION

6.1 INTRODUCTION

Chapter 5 outlined the research design and research methodology used to achieve the objectives of this study. The following chapters (chapters 6 and 7) report and interpret the results and analysis of the data collected for the current study. All of the figures and tables presented in this chapter is produced from the findings of the study and therefore own compilation. The results are arranged according to the three stages used to analyse the data; as illustrated in Figure 6.1. During stage one: descriptive statistics provided information on the biographic information of the respondents of entrepreneurs (Section 6.2) and the current EC, ACAP and IC literacy, describing the three main constructs and sub-constructs (Section 6.3). Factor analysis was employed during stage two to determine the validity and reliability of the components (constructs) used in the current study (Section 6.4). Finally, during stage three: SEM was applied to test the three conceptual frameworks and hypothesis statements presented in Chapter 4. Stage three will be presented in Chapter 7.

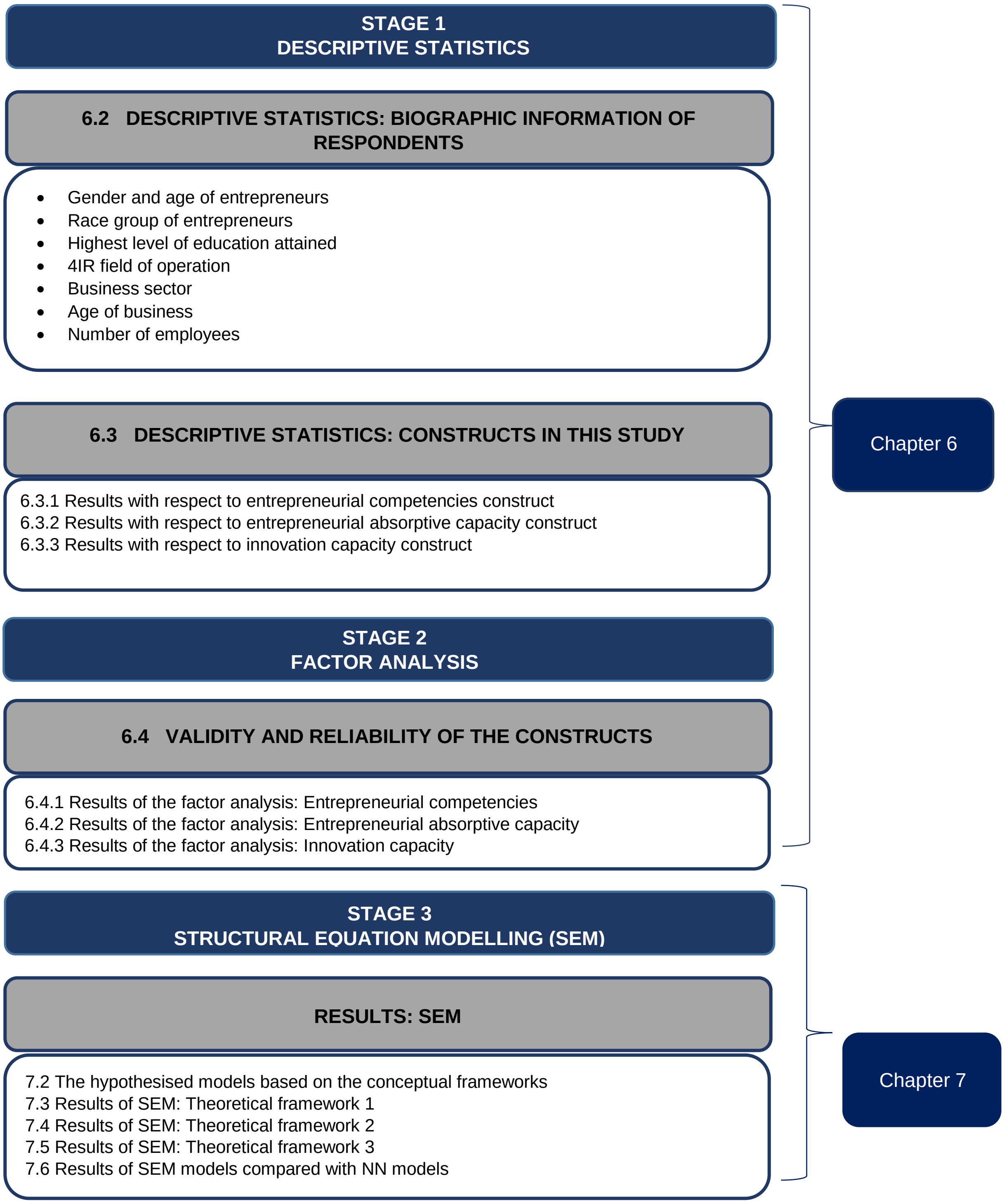


Figure 6.1: Stages of data analysis used in this study

Source: Own compilation

6.2 DESCRIPTIVE STATISTICS: BIOGRAPHIC INFORMATION OF RESPONDENTS

Typical biographic information, such as gender, age, race, level of education, 4IR field of operation, business sector, age of business and number of employees, was obtained to characterise and profile the sample. The sample consisted of innovative entrepreneurs in South Africa who participated in this study during November 2018 to November 2019.

The results are discussed and presented in tables 6.1 and 6.2.

Table 6.1: A socio-demographic profile of respondents

Demographic variables	*N*	*Percent (%)*
Gender:		
Male	342	75.7
Female	110	24.3
		100
Age:		
0-18	2	0.4
19-29	27	6.0
30-40	79	17.5
41-50	100	22.1
51-60	127	28.1
61-70	89	19.7
71-82	28	6.2
		100
Race:		
Black	115	25.4
Coloured	18	4.0
Indian	21	4.6
White	280	61.9
Other (specify)	18	4.0

		99.9*
Level of education:		
None	0	0
Below grade 12	6	1.3
Grade 12 (matric)	51	11.3
Certificate (e.g. short learning programme/s)	51	11.3
Diploma	82	18.1
Degree	73	16.2
Honours degree	54	11.9
Master's degree	88	19.5
Doctoral degree	22	4.9
Other (specify):	23	5.1
Missing	2	0.4
		100

*Due to rounding, percentages do not add up to exactly 100%

Regarding the gender of the sample, more than half of the respondents (75.7%) were male, while 24.3% were female. The average age of the 452 respondents was 51 years old. The modal category was the 51 to 60 year age group (28.1%) followed by the 41 to 50 year age group (22.1%). The results indicate that respondents from different race groups in South Africa participated in the study. Most of the respondents were white (61.9%), followed by black Africans (25.4%). A large majority (82.3%) of the participants had a tertiary qualification, with the modal category being a master's degree (19.5%), followed by a diploma (18.1%) and having a degree (16.2%). The sample loss for level of education was 0.4%.

Table 6.2: A socio-demographic profile of respondent's business information

I4.0 field		Percentage
Robotics	9	2.0
Artificial intelligence	23	5.1
Nanotechnology	2	0.4
Quantum computing	3	0.7
Biotechnology	11	2.4
The Internet of Things	62	13.7
The Industrial Internet of Things (IIoT)	19	4.2
Fifth-generation wireless technologies (5G)	5	1.1
Additive manufacturing/3D printing	21	4.6
Fully autonomous vehicles	2	0.4
Biological technologies	13	3.0
Other	282	62.4
		100
Business sector		
Agriculture, hunting forestry and fishing	30	6.6
Mining and quarrying	12	2.7
Manufacturing	105	23.2
Electricity, gas and water supply	18	4.0
Construction	37	8.2
Wholesale and retail trade; repair of motor vehicles, motor cycles and personal and household goods; hotels and restaurants	59	13.1
Transport, storage and communication	30	6.6
Financial intermediation insurance, real estate and business services	91	20.1
Community, social and personal services	70	15.5
		100
Age of business:		

Nascent	4	0.9
Start-up (Less than 3.5 years)	64	14.1
Established (More than 3.5 years)	384	85
		100
Number of employees		
No employees	63	13.9
1-4 employees	167	37
5-9 employees	92	20.4
10-49 employees	86	19.0
50-99 employees	18	4.0
100-199 employees	16	3.5
200 or more employees	10	2.2
		100
Business turnover		
Less than R150 000	88	19.5
Less than R400 000, but greater than R150 000	50	11.1
Less than R1 million, but greater than R400 000	55	12.2
Less than R2 million, but greater than R1 million	61	13.5
Less than R3 million, but greater than R2 million	19	4.2
Less than R4 million, but greater than R3 million	27	6.0
Less than R5 million, but greater than R4 million	21	4.6
Less than R7.5 million, but greater than R5 million	18	4.0
Less than 10 million, but greater than R7.5 million	20	4.4
Less than R15 million, but greater than R10 million	28	6.2
More than R15 million	65	14.4
		100.1*

Geographical area of business		
Eastern Cape	29	6.4
Free State	20	4.4
Gauteng	198	43.8
KwaZulu-Natal	53	11.7
Limpopo	21	4.7
Mpumalanga	6	1.3
North West	7	1.6
Northern Cape	12	2.7
Western Cape	83	18.4
Outside SA borders (Please specify the country and area)	9	2.0
Missing values	14	3.0
		100

*Due to rounding, percentages do not add up to exactly 100%

The results indicate the I4.0 fields in which the respondent's businesses operate. Out of the 11 options given, apart from the "other" option, the modal category was option six, the internet of things (13.7% of respondents). The second highest percentage of respondents chose the option artificial intelligence (AI) (5.3%), followed by additive manufacturing/3D printing (4.6%). Close to two-thirds (62.4%) of the respondents had chosen "other", where they had to specify the field other than the options provided. The table in Appendix J indicates the answers that were given to additional fields indicated by the respondents. From this option, 249 respondents provided an answer, 5.3% of the respondents indicated "none" or "none of the above". Some of the fields that stood out were manufacturing (7.7%), finance (block chain) (3.8%), communication (2.9%) and information technology (2.9%). For the purposes of this study, eight general business sectors were used. Table 6.2 indicates the main business sectors; the highest percentage of entrepreneurs' businesses lie in the manufacturing sector (23.2%). This is followed by financial intermediation insurance, real estate and business services (20.1%). The business sectors that were the least represented were electricity, gas and water supply (4%) and mining and quarrying (2.7%).

A nascent entrepreneur is in the process of setting up a business, whereas a start-up entrepreneur operates a new business that is less than three and a half years old (Herrington *et al.*, 2019:16). According to Herrington, Kew and Kew (2010:20); Turton and Herrington (2013:15), an "established business" is operated and managed by an established business owner who is in a position to pay wages, salaries, or any other payments to the owners for more than 42 months or 3.5 years. Therefore, an established business is older than 3.5 years. The results indicate the age of the businesses according to nascent (0.9%), start-up (14.2%) and established businesses (85%). According to SEDA (2008:38), the categories of small businesses in South Africa indicate that a micro enterprise has between 0 and 10 employees, a small enterprise has between 11 and 50 employees, while a medium enterprise has between 51 and 200 employees. The modal category was that of the entrepreneurs that had 1-4 employees (36.9). Only 2.2% had 200 or more employees.

The category with the highest number of responses for annual business turnover was less than R150 000, at 19.5%. The last option, which indicated a turnover of more than R15 million, had a response rate of 14.4%, which was the second-highest represented category; thus a spread across all turnover groups was evident

Almost half of the respondents had a business operating in the Gauteng province (43.8%), with Mpumalanga (1.3%) being the least represented province. The respondents who chose the "outside SA border option" (2%) indicated that they had businesses nationally as well as internationally. Those respondents specified the following categories: "international and within South Africa"; "Western Cape and whole Africa"; "Serbia"; "in South Africa, mostly Africa"; "DRC"; "Southern Africa as a whole"; "SA, Zimbabwe, Mozambique, Botswana", "All of Southern Africa; UK, Canada, USA and Australia", "several African countries"; "Gauteng, Western Cape, Zambia, Kenya, Holland", "Lagos", "East African and Ethiopia", "Namibia", "Malawi, Blantyre", "Uganda" and "France". The results indicated that 3% of the respondents did not answer this question.

6.3 DESCRIPTIVE STATISTICS: CONSTRUCTS IN THIS STUDY

The descriptive statistics based on the constructs included in this study are reported in sections 6.3.1 to 6.3.3. Three major constructs and 14 latent constructs were measured in this study, namely entrepreneurial competencies (cognitive competence, functional competence, social competence, meta competence), absorptive capacity (recognition, assimilation, transformation, exploitation), and innovation capacity (newness, radicalness, uniqueness and superiority, innovativeness, competitive advantage, market pioneering).

This section links the primary and secondary objectives of this study, namely:

- To determine whether there is a relationship between entrepreneurial competencies (within the four categories), entrepreneurial absorptive capacity and innovation capacity of innovative entrepreneurial businesses in South Africa.
- To assess reliability, the Cronbach alpha-coefficient, a measure of internal consistency, was used. A generally agreed-upon lower limit for the Cronbach's alpha is 0.70, although it may decrease to 0.60 in exploratory research (Hair *et al.*, 2014:123).

Table 6.3 summarises the number of constructs and items included in the study.

Table 6.3: Main research constructs and items

Research construct	Section of questionnaire	Number of items
1 Entrepreneurial Competencies	B	62
○ Cognitive competencies		4+4+5+4+4+4 = 25
○ Functional competencies		5
○ Social competencies		4+4+4 = 12
○ Meta competencies		16+4 = 20
2 Entrepreneurial Absorptive Capacity	C	14
• Recognition		4
• Assimilation		3
• Transformation		4

• Exploitation		3
3 Innovation Capacity	D	25
• Newness		7
• Radicalness		2+2 = 4
• Uniqueness and superiority		6
• Innovativeness		4
• Competitive advantage		3
• Market pioneering		1
Total		101

The research constructs used were conceptualised in the literature review (refer to chapters 1 to 3). Descriptive statistics for each of the constructs are presented in the next section.

6.3.1 Results with respect to the Entrepreneurial Competencies construct

The 12 ECs of innovative entrepreneurs for measurement resulting from the Delphi study are portrayed in Table 6.4 (see Appendix C – Delphi study Round 2 – Questionnaire 2).

Table 6.4: Summary of the measures employed to assess competencies: Results from Delphi study

Competencies	Question	Mean score	Competence category
Decision-making capability	2	6.58	Functional
Proactiveness	5	6.58	Cognitive/Functional
Leadership skills	9	6.33	Functional
Networking ability	20	6.42	Social
Cognitive ability	34	6.33	Meta
Problem solving	41	6.50	Meta
Creative Problem Solving & Imaginativeness	47	6.50	Cognitive
Innovation/Innovating	49	6.50	Meta
Value creation	54	6.58	Functional
Resilience	74	6.58	Meta/cognitive
Positive attitude	80	6.67	Functional
Opportunity recognition	86	6.50	Functional

Results from the final Delphi round and concept matrix indicated the top 12 competencies that the participants rated as ECs required for 4IR. The top 12 competencies resulting after the second round ranged from 6.33 for cognitive ability to 6.67 for positive attitude. Delphi participants therefore felt that the top-rated essential competencies for 4IR with the highest mean scores were: positive attitude (6.67), decision-making (6.58), proactiveness (6.58), value creation (6.58) and resilience (6.58).

This study requested innovative entrepreneurs (n = 452) to rate their level of agreement (agreement scale ranging from “strongly disagree” to “strongly agree”) with 62 statements according to their ECs (refer to items Q11 to Q72 in Appendix D). Four competence categories were measured with: 1) Cognitive competencies = 25 statements, with 6 competencies (decision-making = 4 statements, proactiveness = 4 statements, creative problem-solving and imaginativeness = 5 statements, innovation/innovating = 4 statements, resilience = 4 statements, opportunity recognition = 4 statements; 2) Functional competencies = 5 statements, with only one competency (value creation = 5 statements); 3) Social competencies = 14 statements, with three competencies (leadership = 4 statements, networking = 4 statements, positive attitude = 4 statements); 4) Meta competencies = 20 statements, with two competencies (cognitive ability = 16 statements, problem-solving = 4 statements). The entrepreneurs’ competency results are illustrated in figures 6.2 – 6.13.

6.3.1.1 Cognitive competencies

- Decision-making

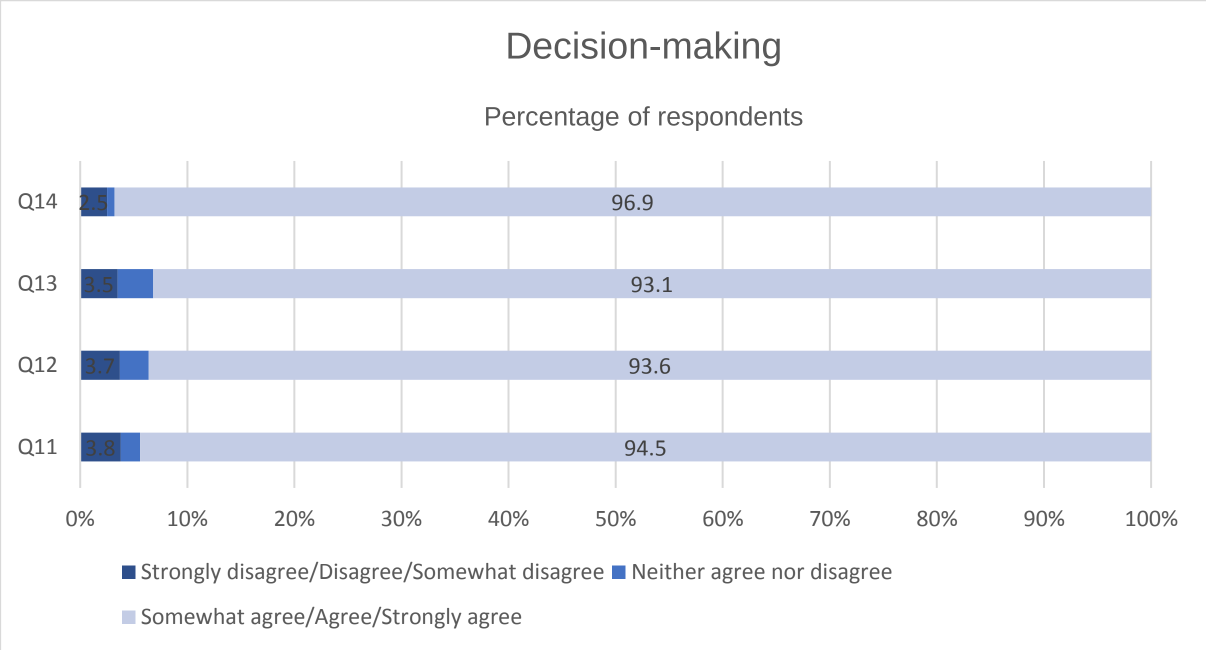


Figure 6.2: Decision-making

Results indicated a high decision-making capability competence among the respondents. Figure 6.2 displays that most of the entrepreneurs were in agreement with the statements regarding decision-making, ranging between 93.1%–96.9%. Specifically, 96.9% (Q144) were in agreement that they "initiate and generate activity and introduce changes into work processes".

- **Proactiveness**

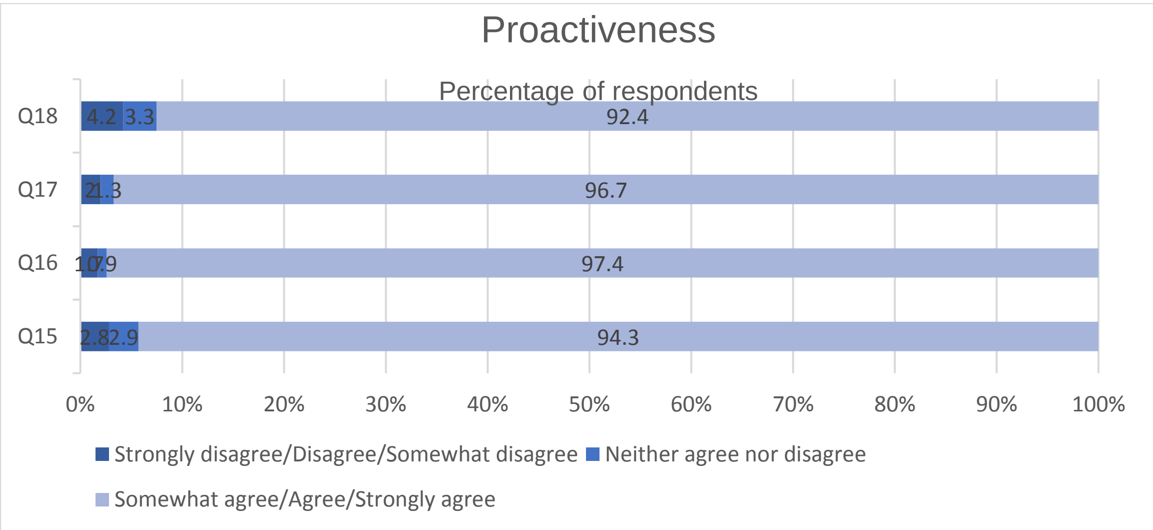


Figure 6.3: Proactiveness

At least 92% of the respondents were in agreement with the statements regarding proactiveness as a competence. Figure 6.3 particularly highlights that 97.5% (Q16) of the respondents were in agreement with the statement that “nothing is more exciting than seeing their ideas turn into reality” and 96.7% (Q17) were in agreement that they are “always looking for better ways to do things in business”.

- **Creative problem-solving and imaginativeness**

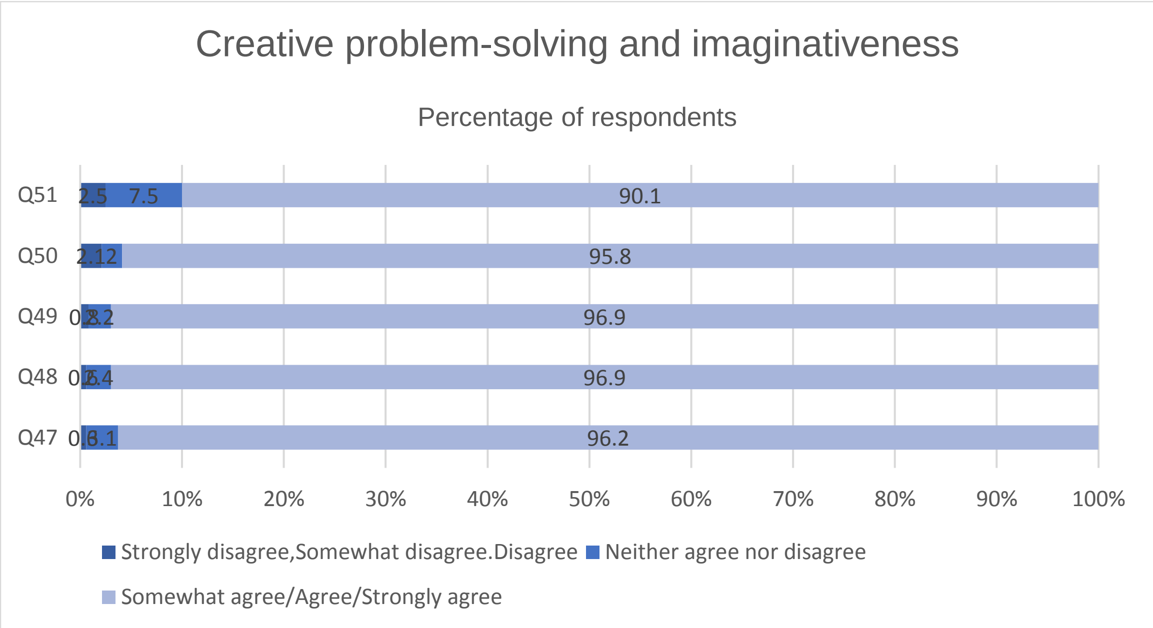


Figure 6.4: Creative problem-solving and imaginativeness

Figure 6.4 indicates that at least 90.1% of the respondents were in agreement with the statements representing problem-solving and imaginativeness. Respondents were in somewhat to strong agreement that they “think outside the box”, 96.9% (Q48) and that they “identify opportunities for new services or products”, 96.9% (Q49).

- **Innovation/innovating**

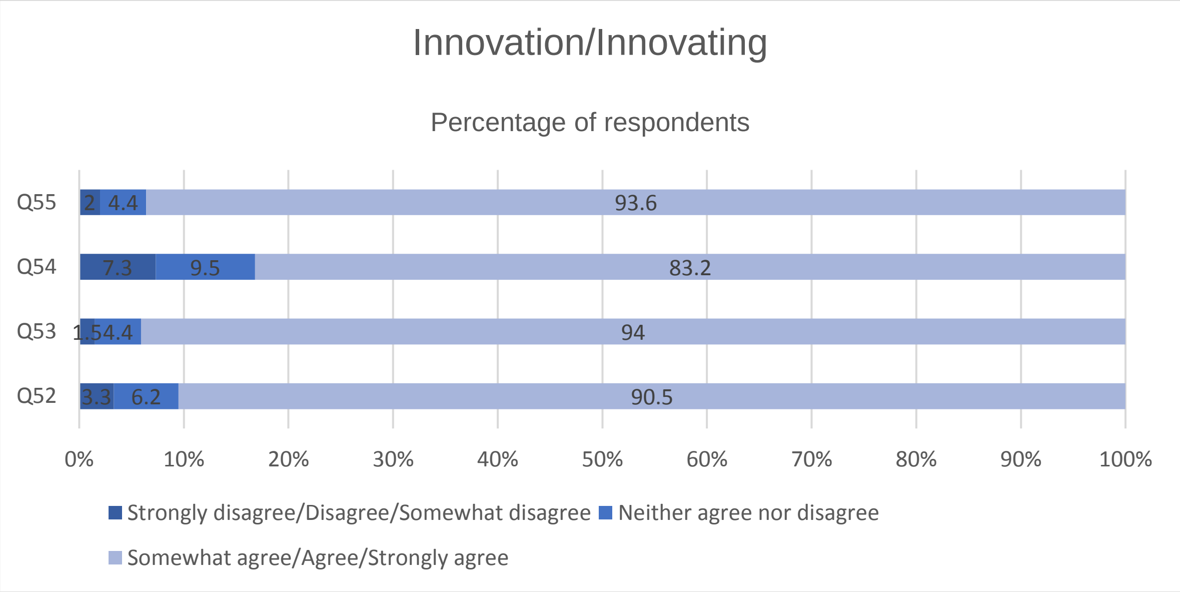


Figure 6.5: Innovation/innovating

In testing the competency innovation/innovating, at least of 83.2% of the respondents were in agreement with the statements. Illustrated in Figure 6.5, 94% (Q53) of the respondents were in agreement that they "improve existing products and services", while 93.6% (Q55) of the respondents were in agreement that they "successfully implement creative ideas within their business".

- **Resilience**

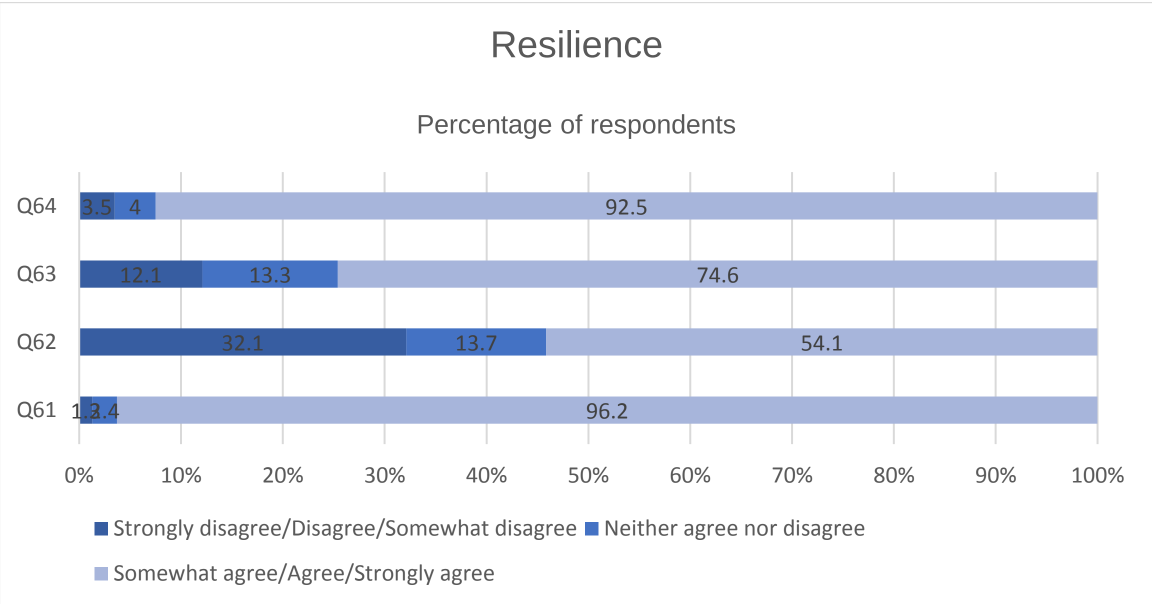


Figure 6.6: Resilience

With regard to respondents' belief that "they can grow in positive ways by dealing with difficult situations" (Q61), 96.2% were in agreement. However, only 54.1% (Q62) were in agreement that they "only set goals which they know they can reach without the help of others". From this response, 32.1% were not in agreement and 13.7% neither agreed nor disagreed. This could perhaps be due to some "setting goals with the help of others" or some setting goals too high or setting goals that are unreachable.

- **Opportunity recognition**

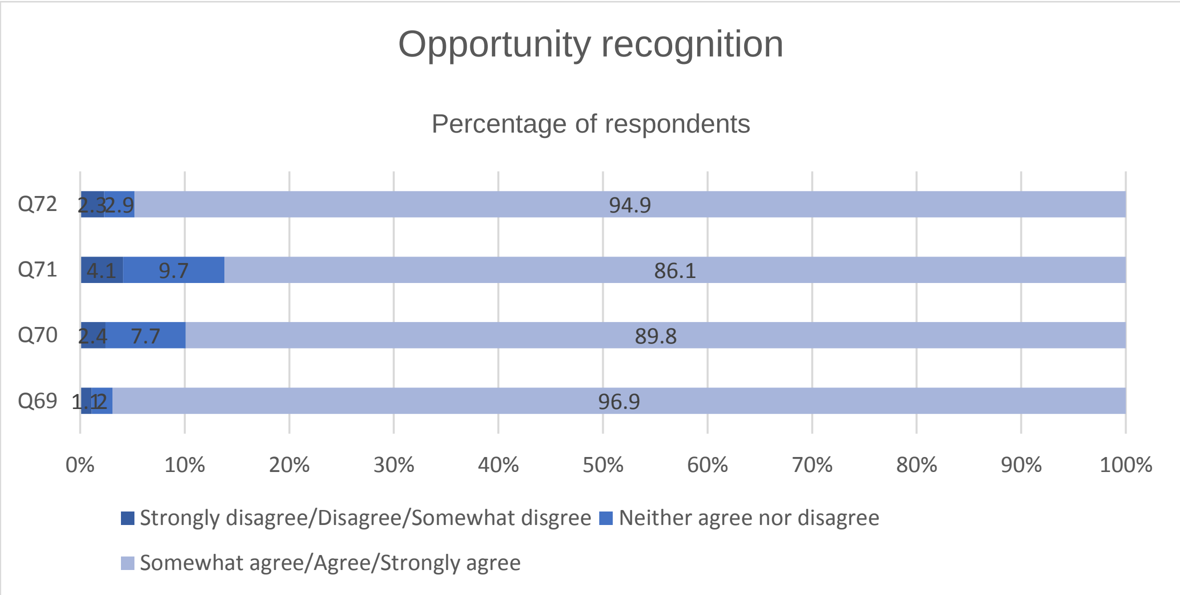


Figure 6.7: Opportunity recognition

Illustrated in Figure 6.7, opportunity recognition had at least 86.1% of the entrepreneurs in agreement with the statements. Participants were particularly in agreement with the fact that they are avid information seekers, 96.9% (Q69).

6.3.1.2 Functional competencies

- **Value creation**

Only one competency was identified to measure functional competence, as indicated in Figure 6.8.

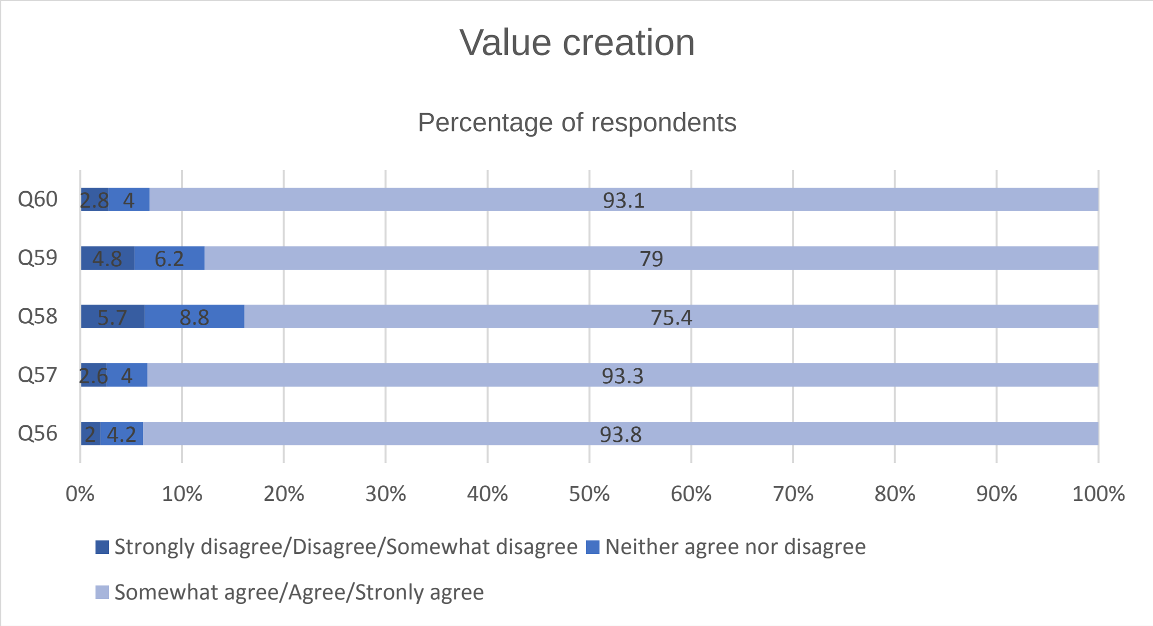


Figure 6.8: Value creation

The results illustrated in Figure 6.8 regarding the entrepreneurs' value creation competency indicates that at least 75.4% of the respondents were in agreement with the statements. Participants were particularly in agreement (93.8%, Q60) with the statement that they "constantly ask questions to understand why products and projects underperform" and that "they love to create new ways of doing things" (93.3%, Q60).

6.3.1.3 Social competencies

- **Leadership**

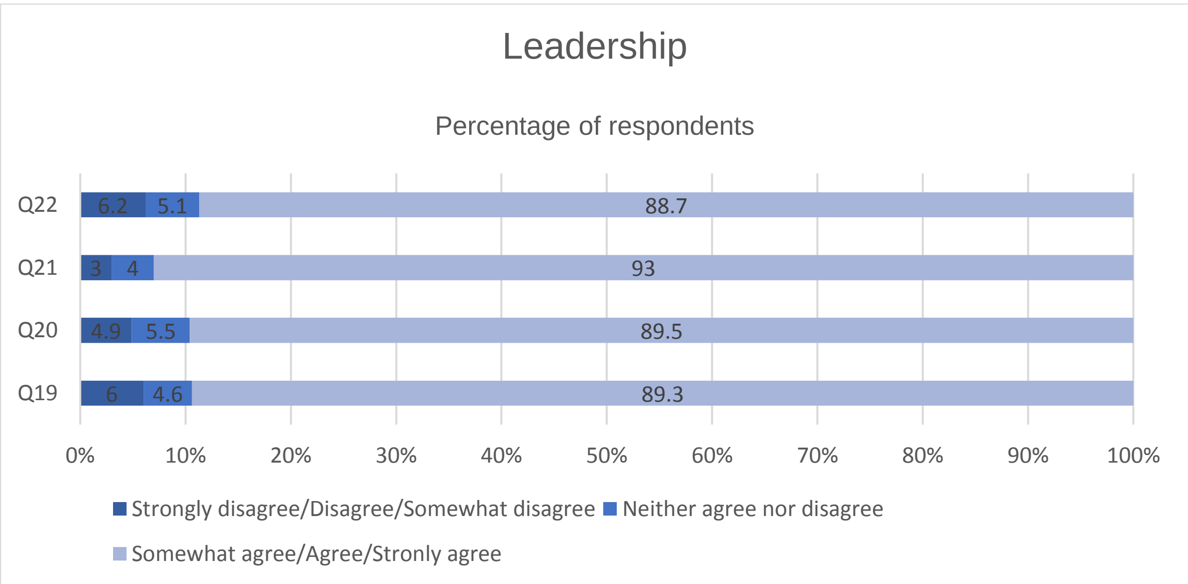


Figure 6.9: Leadership

Figure 6.9 illustrates the responses of leadership, with the highest level of agreement with the respondents often seeking to understand what motivates others, 93% (Q21).

- **Networking**

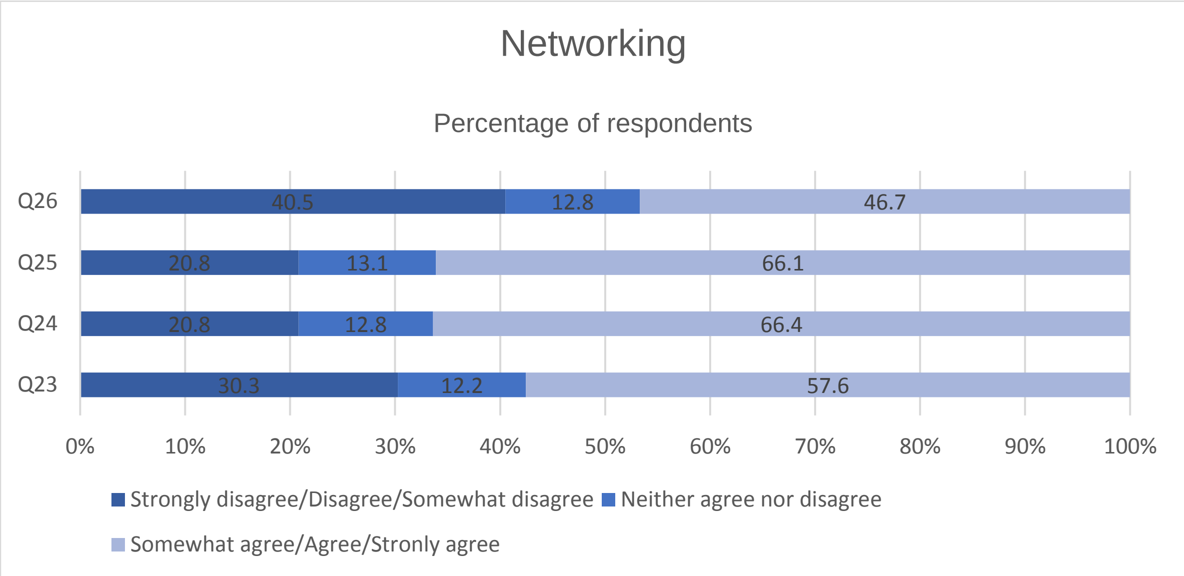


Figure 6.10: Networking

According to the results illustrated in Figure 6.10, the level of networking competency seems to be lower, with at least 46.7% of the respondents in agreement with the statements measuring networking ability. A maximum of 13.1% neither agreed nor disagreed and at least 20.8% were in disagreement. In particular, 40.5% (Q26) were not in agreement that they "serve on a community board, committee or task force". Respondents did also not agree that they "often participate in social gatherings with people that they work with", 30.3% (Q23).

- **Positive attitude**

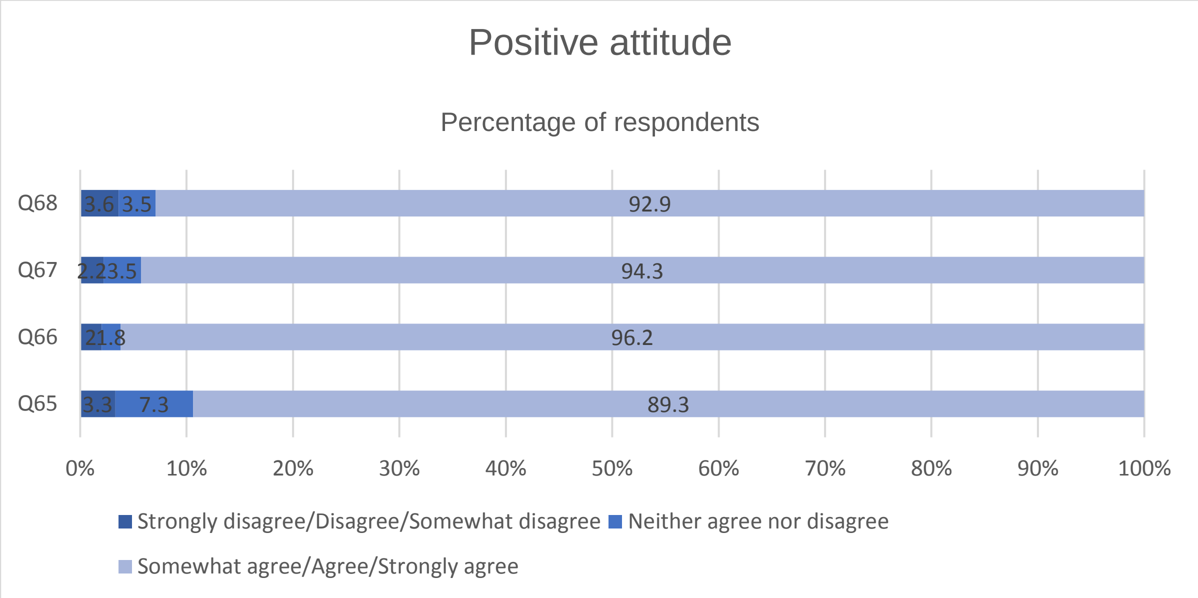


Figure 6.11: Positive attitude

Figure 6.11 indicates that a high percentage of respondents, at least 89.3%, were in agreement with the statements, therefore indicating high levels of positive attitude. The majority of the respondents were in agreement that "being an entrepreneur provides great satisfaction for them", 96.2% (Q66).

6.3.1.4 *Meta competencies*

- **Cognitive ability**

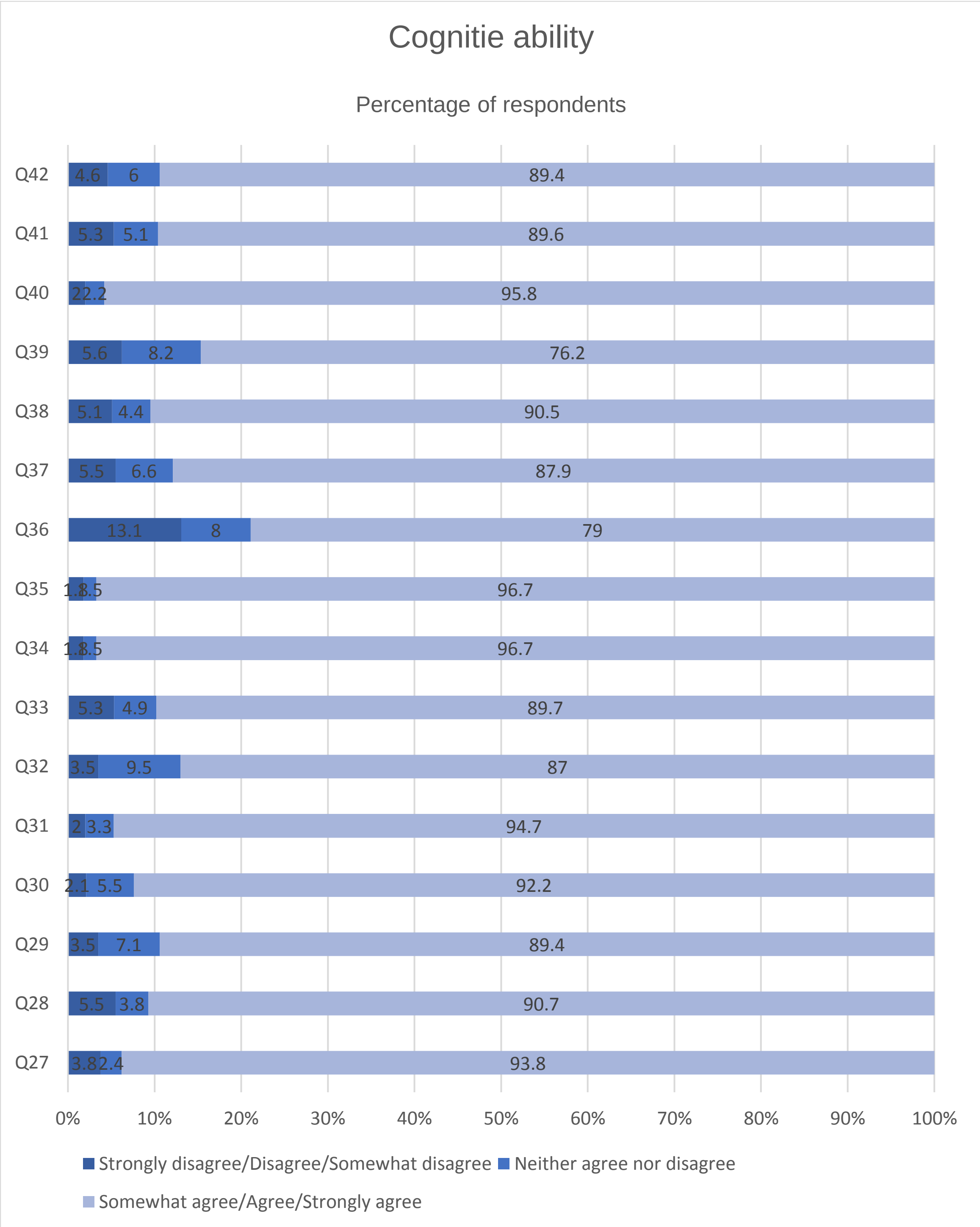


Figure 6.12: Cognitive ability

Regarding the items representing cognitive ability, Figure 6.12 clearly shows that a majority of the respondents were in agreement with the statements, indicating high levels of cognitive ability among the entrepreneurs. The data presented show that 96.7% were in agreement that they "think of several ways to solve a problem and choose the best one" (Q34), and that they "consciously focus their attention on important information" (Q35). However, fewer respondents agreed that they "draw pictures or diagrams to help them understand while learning", 79% (Q36).

- **Problem-solving**

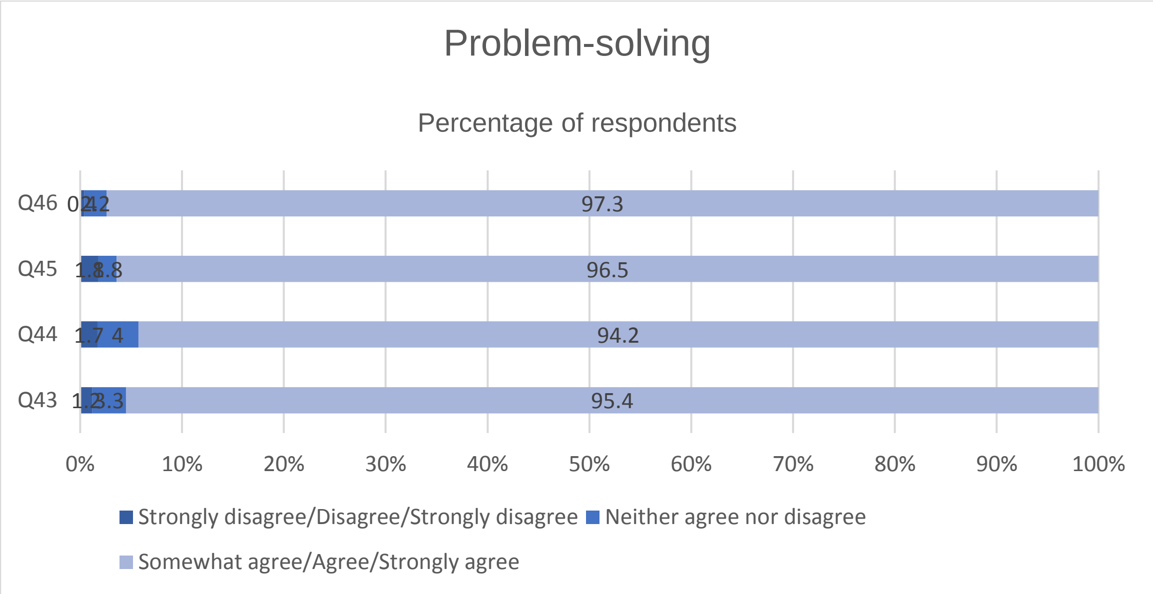


Figure 6.13: Problem-solving

High levels of agreement resulted from problem-solving ability – at least 94.2% of the respondents. Respondents particularly showed high levels of agreement in their ability to "use information to make decisions", 97.3% (Q46) and with having critical thinking skills, 96.5% (Q45).

6.3.2 Results with respect to the Absorptive Capacity construct

As indicated in the literature review, the higher an entrepreneur's ACAP, the more likely they are to understand new technology, recognise its market value and bring it into commercialisation (Qian & Acs, 2013:193).

Against this background, this study included 14 EACAP statements which entrepreneurs were requested to rate using a 7-point agreement scale (Likert scale) ranging from "strongly disagree" to "strongly agree". Items Q75 to Q78 represented recognition, items Q79 to Q81 represented assimilation, items Q82 to Q85 represented transformation and items Q86 to Q88 represented exploitation.

Before EACAP was tested, two questions (Q73 and Q74) were asked that concerned their work experience and the number of years of work experience.

- **Previous work experience**

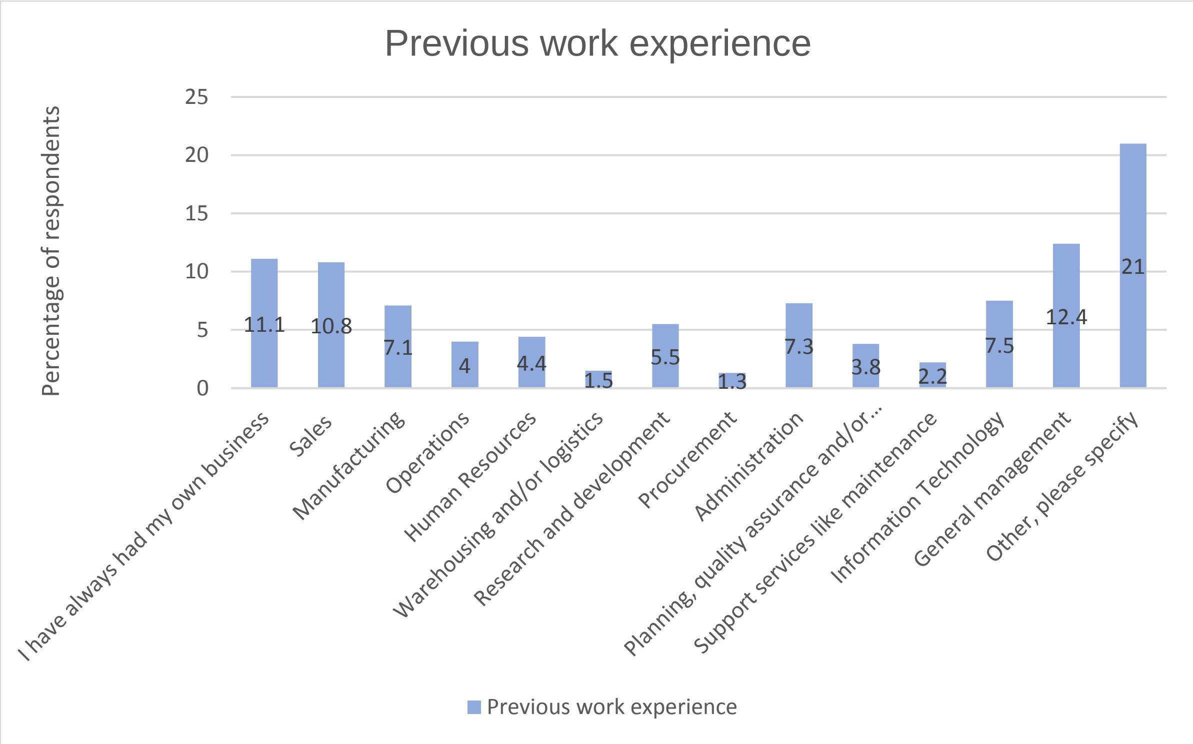


Figure 6.14: Previous work experience

Respondents were asked to give an indication of their work experience before they started their own business by indicating the field they had the most experience in. Respondents were given the option to provide one answer only. Figure 6.14 indicates that 12.4% had the most experience in general management, followed by those who had always had their own business (11.1%). Some of the respondents had the most experience in sales (10.8%), information technology (7.5%), administration (7.3%), manufacturing (7.1%), research and development (5.5%), human resources (4.4%), operations (4%), planning, quality assurance and/or production engineering (3.8%), support services such as maintenance (2.2%), warehousing and/or logistics (1.5%), and procurement (1.3%). There were 21% of the respondents who indicated work experience other than the options that were provided.

Question 74 asked participants to indicate their total number of years of work experience, which resulted in an average of 7.53 years. Each of the EACAP dimensions will be explained next.

- **Recognition**

Figure 6.15 presents the proportion (%) of entrepreneurs showcasing their level of agreement regarding the recognition statements.

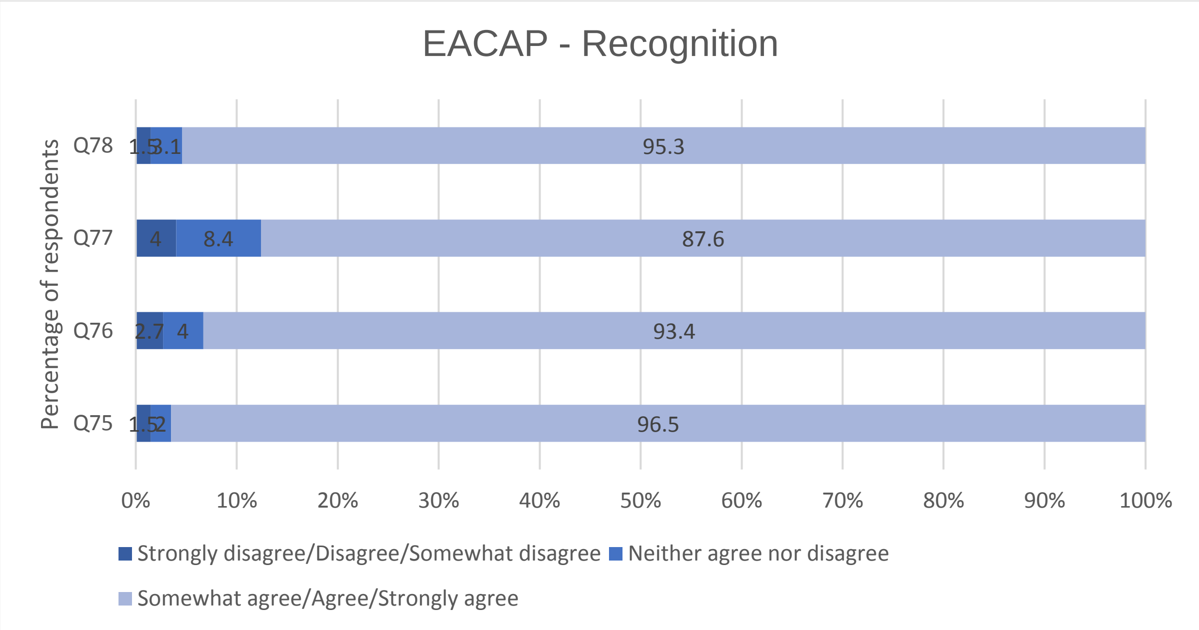


Figure 6.15: EACAP: Recognition

The items representing recognition are presented in Figure 6.15. The results show that at least 87.6%% of the respondents were in agreement with the statements, with 96.5% (Q75) of the respondents in agreement that they “are always actively looking for new knowledge”. The least number of respondents, 87.6% (Q77), somewhat agreed to strongly agreed that they “are good at distinguishing between profitable opportunities and not-so-profitable opportunities”. With this statement 8.4% neither agreed nor disagreed.

- **Assimilation**

Figure 6.16 presents the proportion (%) of entrepreneurs showcasing their level of agreement regarding the assimilation statements.

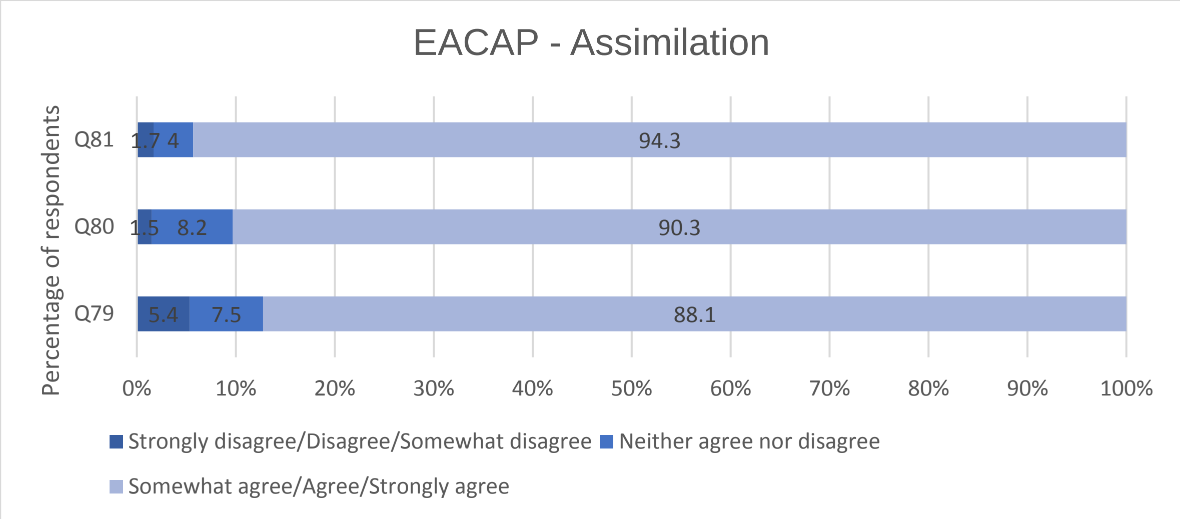


Figure 6.16: EACAP: Assimilation

In measuring assimilation, at least 88.1% of respondents were in agreement with the statement, indicating their assimilation ability. The majority of the entrepreneurs, 94.3% (Q81), were in agreement that they "communicate newly acquired knowledge that might be of interest to the business", while 90.3% (Q80) agreed that they "translate new knowledge in such a way that employees understand what is meant".

- **Transformation**

Figure 6.17 presents the proportion (%) of entrepreneurs showcasing their level of agreement regarding the transformation statements.

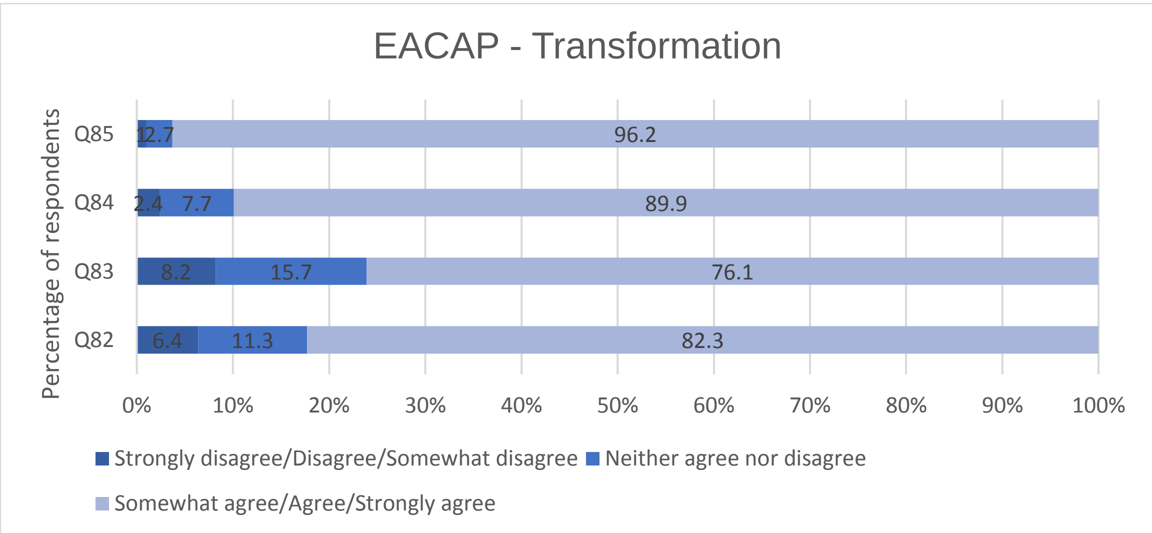


Figure 6.17: EACAP: Transformation

In measuring transformation, at least 76.1% were in agreement with the statements measuring transformation. From Q83, slightly fewer respondents were in agreement that they “attend meetings with people from different departments to come up with new ideas”, with 15.7% indicating that they neither agree nor disagree with the statement. The majority of the participants, 96.2% (Q85), were in agreement that they could turn existing knowledge into new ideas.

- **Exploitation**

Figure 6.18 presents the proportion (%) of entrepreneurs showcasing their level of agreement regarding the exploitation statements.

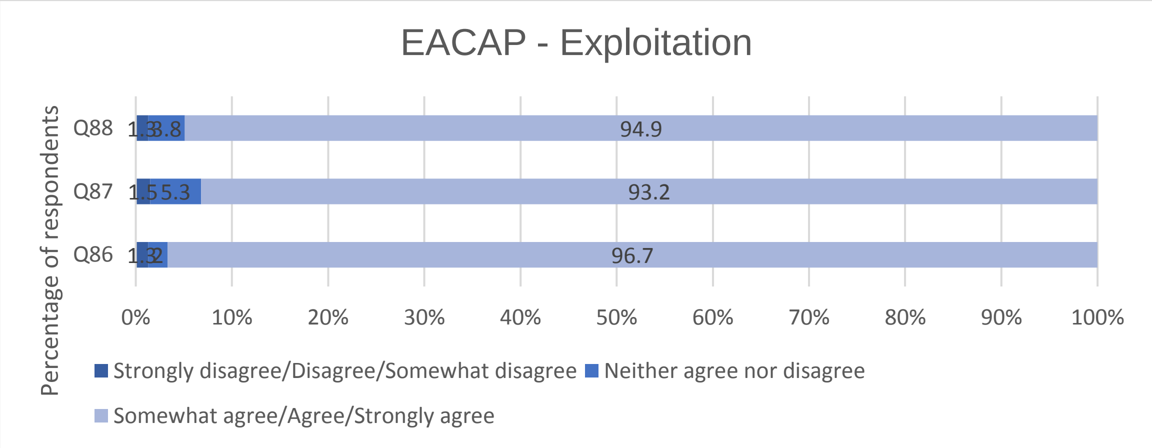


Figure 6.18: EACAP: Exploitation

In measuring exploitation, at least 93.2% were in agreement with the statements indicating their exploitation ability. Respondents’ response regarding the statement ”I often apply newly acquired knowledge to their business/work” was 96.7% (Q86) in agreement, while 93.2% (Q87) were in agreement that they exploited new knowledge to create new products, services or work methods.

6.3.3 Results with respect to the Innovation Capacity construct

In order to measure IC, aspects such as newness, radicalness, uniqueness and superiority, innovativeness, competitive advantage and market pioneering were used. The aim was therefore to determine how high the level of these measures tested. In other words, as the level of invention increases, the more innovations and new technologies can be expected. The same applies to the level of innovation, where the higher the level, the more radical, which is a closer indication of an innovation for I4.0. Measuring the level of invention further provides an important indicator of the potential IC and the introduction of new technologies.

Measures for IC included 25 statements which entrepreneurs were requested to rate using an agreement scale ranging from “strongly disagree” to “strongly agree” for items Q89 to Q107. Items Q89 to Q95 represented newness, items Q96 to Q97 represented radicalness, items Q98 to Q103 represented uniqueness and superiority and Q104 to Q107 represented innovativeness. Items Q108 to Q110 represented competitive advantage, where entrepreneurs were asked to relate the statements to the competitive advantage of their most current product/service, where 1 = low, 4 = moderate and 7 = high. Items Q111 were measured with yes/no relating to the market pioneering of their product and the last question was regarding the innovations of their business during the last three years and measured radicalness with items Q112 to Q113.

- **Newness**

Figure 6.19 presents the proportion (%) of entrepreneurs showcasing their level of agreement regarding the newness of their most current product/service.

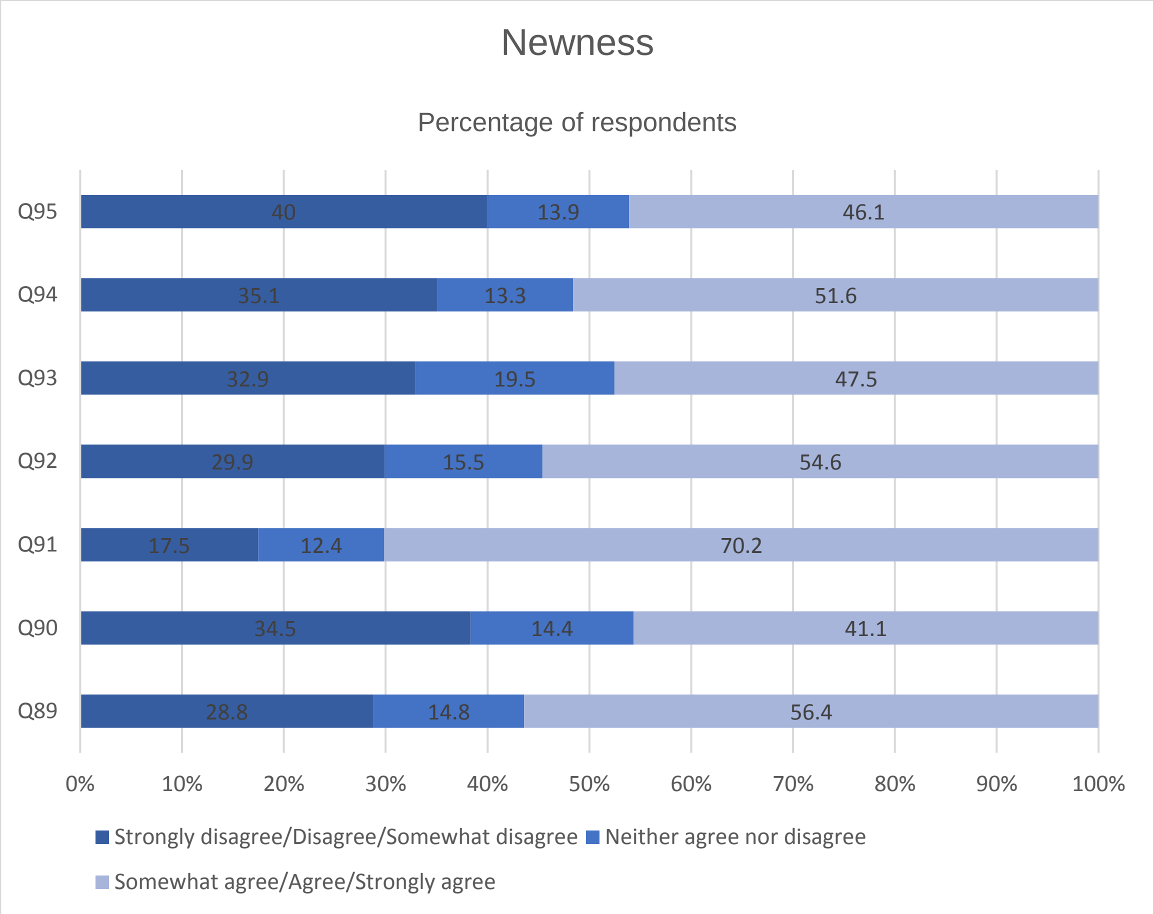


Figure 6.19: Newness

The data presented in Figure 6.19 shows that at least 41.1% of the participants were in agreement, 14.8% neither agreed nor disagreed and 31.2% were in disagreement with the statements. The majority of the participants were in agreement, where 70.2% (Q91) of the entrepreneurs agreed that "their product/service is an improvement/modification of an existing product/service". In addition, 56.4%% (Q89) of the entrepreneurs were in agreement that "the customers/potential customers are totally new to the business". However, a large percentage of entrepreneurs, 40% (Q95) were in disagreement with the statement "the product use (need served) is totally new to the business".

- **Radicalness**

Figure 6.20 presents the proportion (%) of entrepreneurs showcasing their level of agreement regarding the radicalness of their most current product/service.

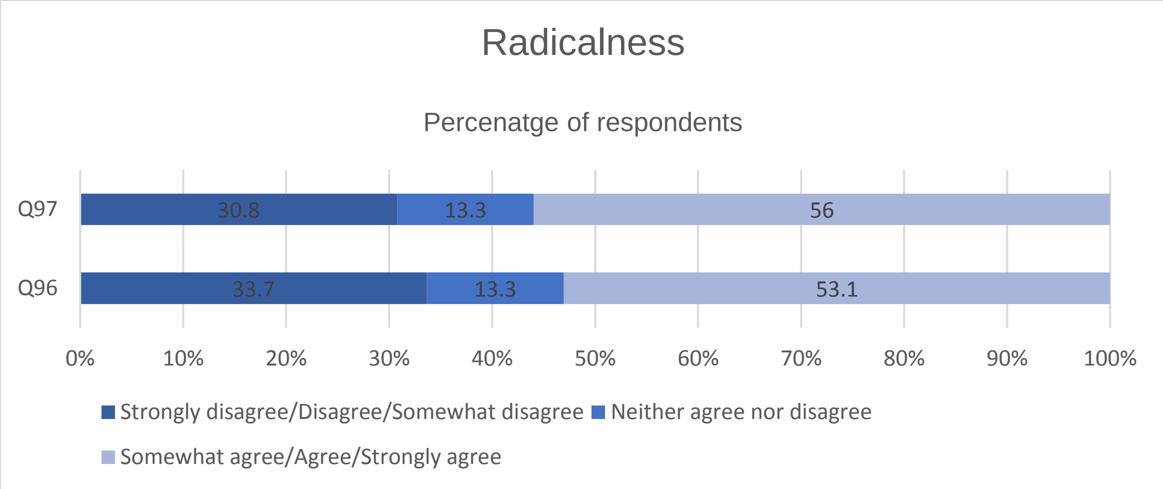


Figure 6.20: Radicalness

The results measuring radicalness indicated that more than half of the respondents were in agreement with the statements regarding the radicalness of their products or service. For the statement “the product/service is unlike any other”, 53.1% (Q96) of the respondents were in agreement and 33.7% were in disagreement. The next statement “the product/service requires users to change their ways” resulted in 56% (Q97) who were in agreement and 30.8% who were in disagreement. With both statements, 13.3% neither agreed nor disagreed with the statements.

- **Uniqueness and superiority**

Figure 6.21 presents the proportion (%) of entrepreneurs showcasing their level of agreement regarding the uniqueness and superiority of their most current product/service.

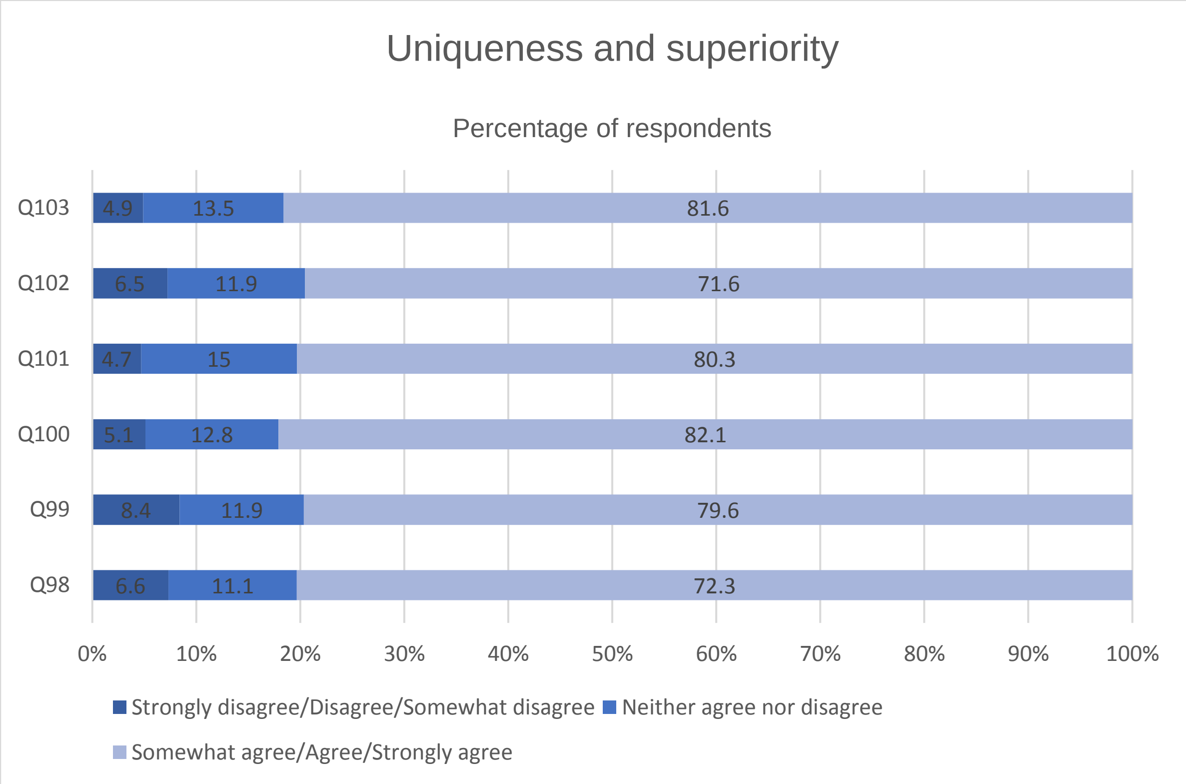


Figure 6.21: Uniqueness and superiority

In general, Figure 6.21 illustrates the uniqueness and superiority of the entrepreneurs' product/service, where at least 71.6% of the respondents indicated that "their product/service has developed a high-quality image", (Q102). Most of the respondents, 82.1% (Q100) indicated that "in terms of quality, the product/service provides a faster or more efficient service". In addition, 81.6% (Q103) agreed that, "in terms of quality it has better value than previously available products/services".

- **Innovativeness**

Figure 6.22 presents the proportion (%) of entrepreneurs showcasing their level of agreement regarding the innovativeness of their most current product/service.

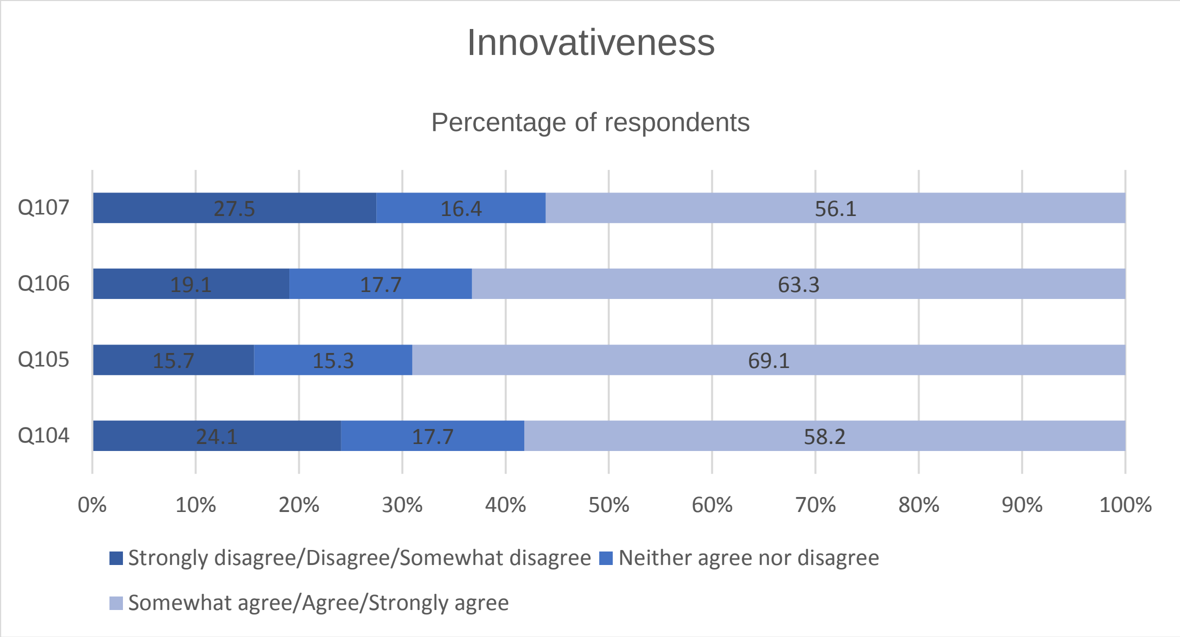


Figure 6.22: Innovativeness

Results measuring the innovativeness of the entrepreneurs' products/services showed that the majority of the respondents were in agreement with the statements, with an average of 61.7%. The majority of the respondents, 69.1% (Q105) were in agreement that "their product/service follows an innovation strategy rather than a follower strategy". Furthermore, 63.3% (Q106) agreed that "it has radical changes rather than subtle differences". The least number of entrepreneurs agreed that "the product technology is new to the customer", 56.1% (Q107).

- **Competitive advantage**

Figure 6.23 presents the proportion (%) of entrepreneurs showcasing their level of agreement regarding the competitive advantage of their most current product/service.

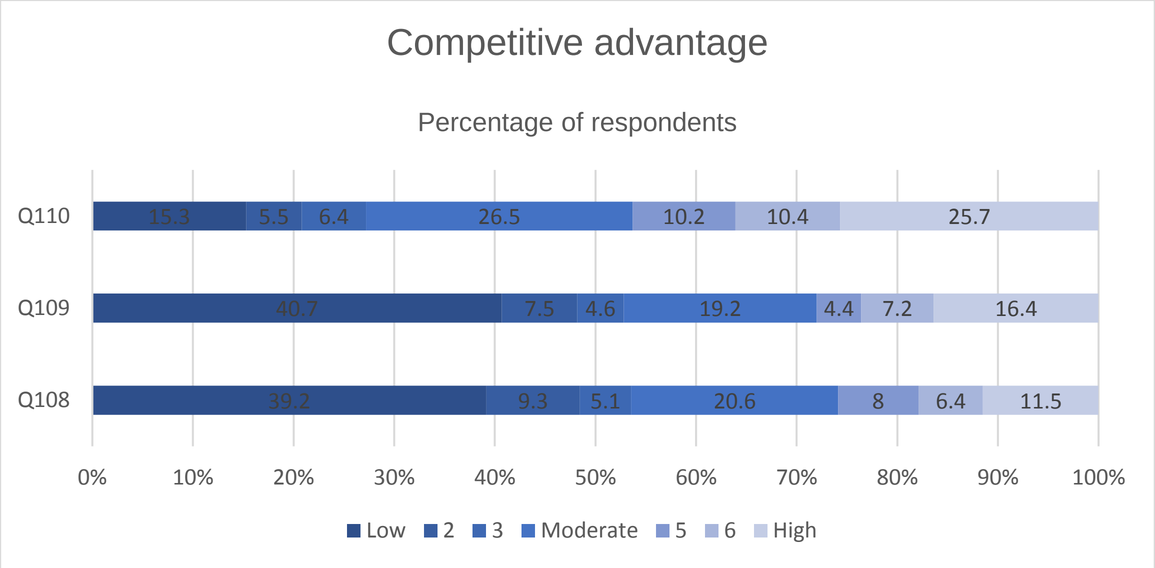


Figure 6.23: Competitive advantage

With an interval scale ranging from low to high, only 11.5% (Q108) of entrepreneurs indicated that the extent of patent protection is high and 39.2% indicated that it is low. When asked to indicate the "extent of licence protection of their products/services", the results rated high at 16.4% (Q109) and low at 40.7%; and "the ease of competitive duplication" rated low at 15.3% (Q110) and high at 25.7%. Overall, the competitive advantage of the entrepreneurs' products/services did not measure as favourably as one would have expected for a sample including innovating entrepreneurs, but the majority of the respondents did also rate "moderate" to these statements, with an average of 22.1% of the answers.

- **Market pioneering**

Figure 6.24 presents the proportion (%) of entrepreneurs showcasing their level of agreement regarding the market pioneering of their most current product/service. The question asked to entrepreneurs was whether their business was the first into the market with this type of product; 31.2% indicated that it was and 68.8% indicated that it was not.

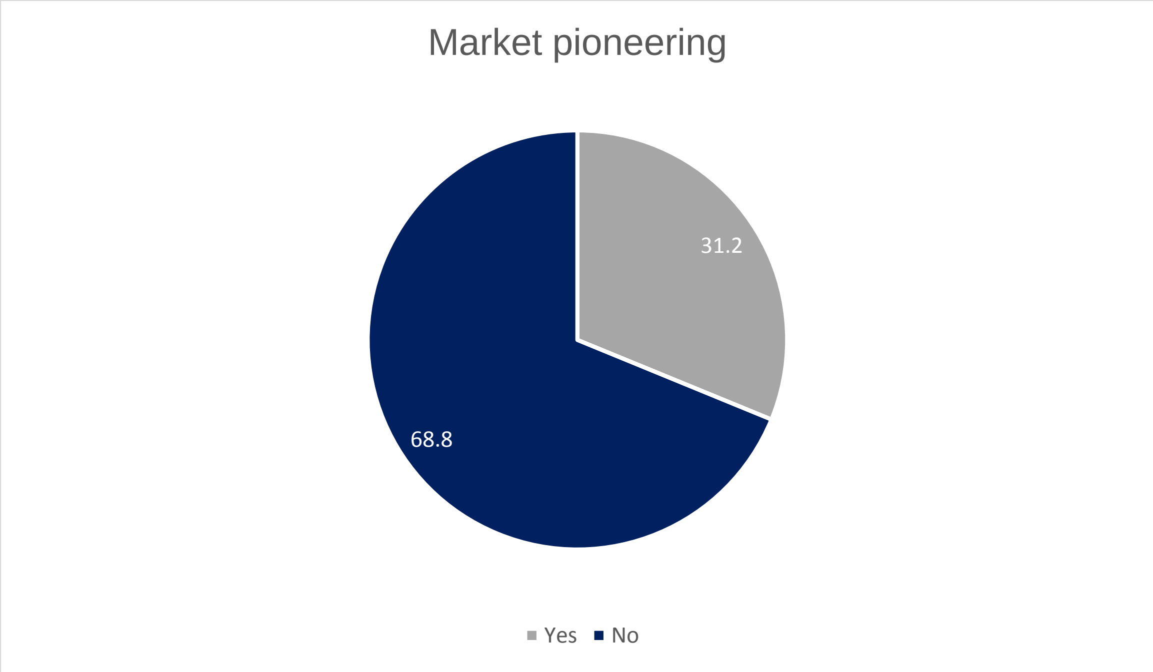


Figure 6.24: Market pioneering

- **Innovations within the last three years**

This question asked participants to indicate the type of radical innovation (an innovation that is new and different from what the competitors are doing) that has been developed in their business during the past three years. Participants had to choose yes or no for each statement.

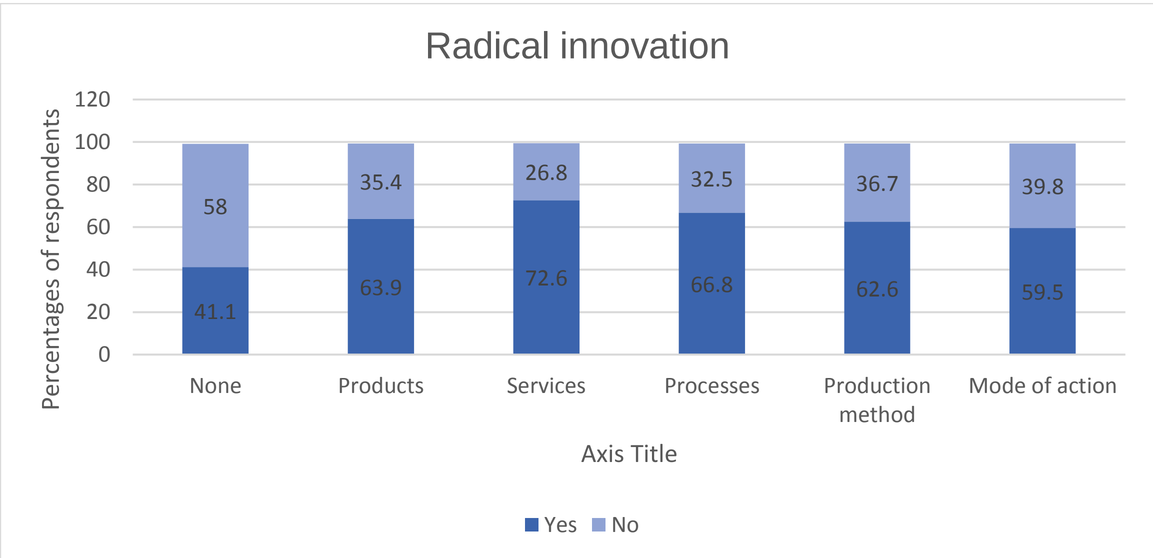


Figure 6.25: Radical innovation

From the results, 41.4% of the entrepreneurs indicated that they had not developed any radical innovations within the last three years, whereas 58% indicated that they had. Furthermore, 63% of the respondents indicated that they had developed radical products, 72.6% developed services, 66.8% developed processes, 62.6% developed a production method and 59.5% developed a mode of action.

The second question asked participants to indicate the type of incremental innovation (an improvement that is different from the existing offerings in the market in terms of some of its features) that had been developed in their business during the past three years. Participants had to choose yes or no for each statement.

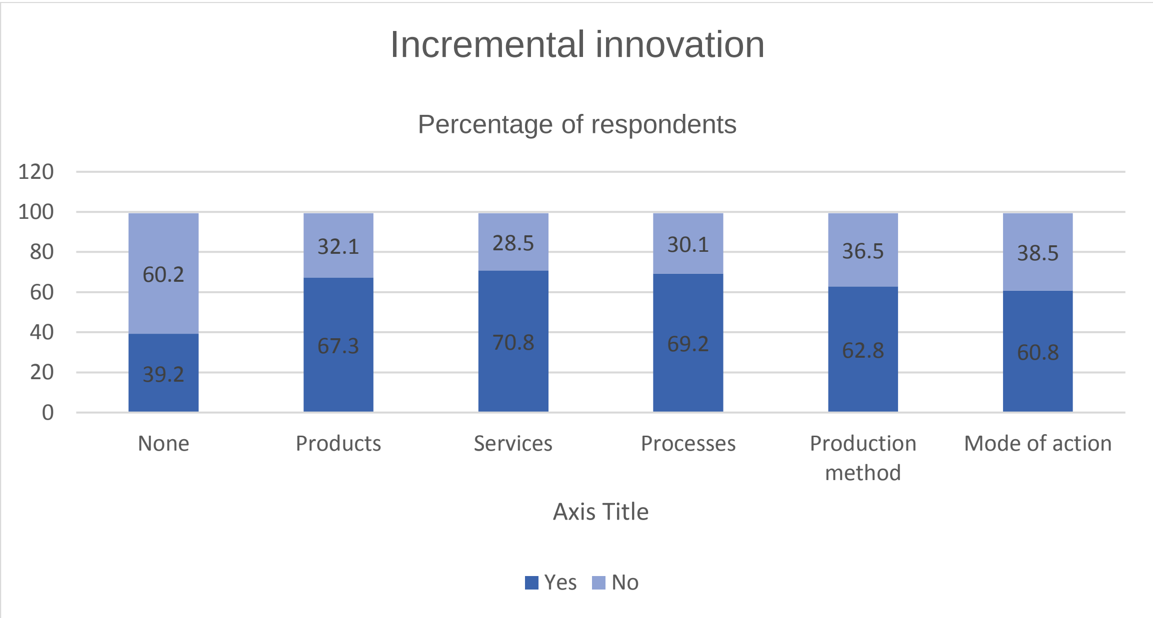


Figure 6.26: Incremental innovation

From the results, 39.2% of the respondents indicated that they had not developed any incremental innovations within the last three years, whereas 67.3% indicated that they had. Specifically, 67.3% of the respondents indicated that they had developed incremental products, 70.8% developed services, 69.2% developed processes, 62.8% developed a production method and 60.8% developed a mode of action, meaning a single action that had led to innovations of the entire managerial or organisational practices and procedures.

The next section discusses the validity and reliability of the three major constructs, namely: entrepreneurial competencies cognitive (CEC), functional (FEC), social

(SEC), meta (MEC), entrepreneurial absorptive capacity (EACAP) and innovation capacity (IC).

6.4 VALIDITY AND RELIABILITY OF THE CONSTRUCTS

Firstly, EFA was conducted on each of the individual ECs for the four categories, EACAP and IC. EFA was conducted on each individual construct to determine the dimensionality of each construct given changes in wording, constructs created from more than one instrument and reduced set of items. This was followed by a measurement model (confirmatory factor analysis) for each category of competencies, IC and EACAP.

The results of the exploratory factor analysis on ECs are discussed. The initial EFA procedure commenced with the Kaiser-Meyer-Olkin (KMO) test for sampling adequacy and Bartlett's test of sphericity, which assesses the suitability of the data for factor analysis. According to Pallant (2011:183) and Kline (2014), Bartlett's test of sphericity should be significant ($p < 0.05$) for the factor analysis to be considered appropriate. The KMO index ranges from 0 to 1 and a minimum value of 0.6 is considered appropriate for factor analysis.

6.4.1 Results of the factor analysis: Entrepreneurial competencies

The factor analysis of the 12 ECs is presented in the four competence categories.

6.4.1.1 Exploratory factor analysis: EC

- **Cognitive competencies**

To confirm the appropriateness of EFA, the KMO measure of sampling adequacy and the Bartlett's test of sphericity were considered. The KMO value for 1) decision-making was 0.821, 2) proactiveness, 0.794, 3) creative problem-solving, 0.822, 4) innovation/innovating, 0.721, 5) resilience, 0.593 and 5) opportunity recognition, 0.805, exceeding the value of 0.6 (Kaiser, 1970; Kaiser, 1974; Kline, 2014; Tabachnick *et al.*, 2007). However, some authors argue that a threshold of 0.5 is acceptable (Hair, Anderson, Tatham & Black, 1998; Kline, 2014; Pallant, 2011; Tabachnick *et al.*, 2007).

All of the values were therefore above the threshold of 0.5. The Bartlett's test of sphericity (Bartlett, 1954) showed statistical significance $p < 0.001$, supporting the factorability of the correlation matrix. The PAF method was used to extract the factors, and this was followed by a promax rotation with Kaiser Normalisation.

The PAF method, based on the eigenvalue larger than 1 criteria, revealed unidimensionality for 5 of the 6 cognitive competencies. In the case of resilience, two factors were identified with eigenvalues exceeding 1, cumulatively explaining 51.9% of the variance in the data.

To aid in the interpretation and scientific utility of these two factors, promax rotation with Kaiser Normalisation was performed. Table 6.5 indicates the communality estimates and the factor loadings as indicated in the pattern matrix for all six ECs. Communalities indicate the extent to which an individual item correlates with the rest of the items (Hair *et al.*, 2010a:117). For this study, the guideline used for considering the inclusion of items in a factor solution was whether they were at least 10% (communality of 0.31) of their variance with the other items under consideration. Factor loadings of 0.30 and larger were considered significant and used for the interpretation of structures due to $n > 350$ (Hair *et al.*, 2010a:117).

Table 6.5: Factor loadings and communality estimates from the EFA for the factors representing cognitive competence

1) Cognitive competence					
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings Factor 1**	
Decision-making capability	Q11. I take initiative and work under my own direction.	0.596	64.8%	0.772	
	Q12. I like to take charge of situations.	0.708		0.841	
	Q13. I make quick, clear decisions, which may include tough choices or considered risks.	0.610		0.781	
	Q14. I initiate and generate activity and introduce changes into work processes.	0.677		0.823	

Construct	Item	Communalities	Variance explained	Loadings Factor 1	
Proactiveness	Q15. When I have a problem, I tackle it head-on.	0.486	53.8%	0.697	
	Q16. Nothing is more exciting than seeing my ideas turn into reality.	0.700		0.836	
	Q17. I am always looking for better ways to do things in my business.	0.591		0.769	
	Q18. If I believe in an idea, no obstacle will prevent me from making it happen.	0.378		0.612	
Creative Problem-Solving / imaginativeness	Q47. I am creative when asked to work with limited resources.	0.506	50.3%	0.711	
	Q48. I think outside the box.	0.552		0.743	
	Q49. I identify opportunities for new services/products.	0.534		0.731	
	Q50. Freedom to be creative is extremely important to me.	0.592		0.769	
	Q51. Originality is very important to me.	0.333		0.577	
Innovation/ Innovating	Q52. I generate new innovations that differ from competitors' offering.	0.489	43.5%	0.699	
	Q53. I improve existing products and services.	0.710		0.843	
	Q54. I exploit (use/utilise) innovations developed by others.	0.158		0.397	
	Q55. I successfully implement creative ideas within my business.	0.382		0.618	
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings Factor 1**	**Loadings Factor 2**
Resilience: Resilience coping	Q61. I believe that I can grow in positive ways by dealing with difficult situations.	0.374	51.9%		0.681
	Q64. I look for creative ways to alter difficult situations.	0.363			0.753

Resilience: Use of social support	Q62. I only set goals which I know I can reach without the help of others.	0.666		0.668	
	Q63. I actively look for ways to replace the losses I encounter in life.	0.671		0.766	
Opportunity recognition	Q69. I am an avid information seeker.	0.441	63%	0.664	
	Q70. I often make novel connections and perceive new or emergent relationships between various pieces of information.	0.750		0.866	
	Q71. I often see connections between previously unconnected domains of information.	0.784		0.885	
	Q72. I am good at "connecting dots".	0.545		0.738	

*Extraction method: Principal axis factoring

Rotation method: Promax with Kaiser Normalisation

Rotation convergence in three iterations

The two factors that were identified to explain the resilience of the entrepreneurs were labelled (F5) resilience-coping (Q62 & Q63) and (F6) use of social support (Q61 & Q64). Next, the reliability of the new factors was calculated.

Table 6.6 indicates that factors: decision-making (0.878), proactiveness (0.808), creative problem-solving/imaginativeness (0.824), innovation/innovating (0.707) and opportunity recognition (0.867) demonstrated satisfactory internal consistency as illustrated by Cronbach's alpha coefficients, which meets the generally agreed-upon limit for Cronbach's alpha of 0.60 (Hair *et al.*, 2014:123).

Table 6.6: Reliability statistics for the cognitive competencies

Subscale	Description	Number of items	Cronbach's alpha
F1	Decision-making capability	4	0.878
F2	Proactiveness	4	0.808
F3	Creative Problem-Solving / imaginativeness	5	0.824
F4	Innovation/Innovating	4	0.707
F5	Resilience: Resilience coping	4	0.636
F6	Resilience: Use of social support	4	0.631
F7	Opportunity recognition	4	0.867

Table 6.6 also indicates that the resilience coping (0.64) and use of social support (0.63) factors demonstrated acceptable internal consistency as illustrated by the Cronbach's alpha coefficients, as the numbers were above the cut-off threshold for exploratory research of 0.60 (Hair *et al.*, 2010a:127).

Table 6.7 reflects the descriptive statistics for the factors representing the respondent's cognitive competencies that were identified as a result of EFA.

Table 6.7: Descriptive statistics for the two extracted factors representing resilience

		Mean*	Median	Std. deviation	Skewness	Kurtosis
F1	Decision-making capability	6.2434	6.5000	0.96658	-3.225	14.132
F2	Proactiveness	6.2815	6.5000	.81964	-2.946	13.921
F3	Creative Problem-Solving / imaginativeness	6.2482	6.4000	.70706	-1.804	7.501
F4	Innovation/Innovating	5.9452	6.0000	.80527	-1.192	3.504
F5	Resilience: Resilience coping	6.0996	6.0000	.82508	-1.522	4.621
F6	Resilience: Use of social support	4.8518	5.0000	1.42870	-0.546	-0.355
F7	Opportunity recognition	6.0149	6.0000	0.88010	-1.278	2.944

***The scale consists of a Likert-scale measuring 1 = strongly disagree up to 7=strongly agree

A higher mean score indicates a stronger agreement with the factor. The average mean score levels of the respondents in terms of factors F1-F6 tended to be towards the strong agreement level, in particular regarding their proactiveness competence (mean score = 6.28). The respondents' mean level of agreement in terms of the use of social support factor (mean score = 4.85) tended to be at the agree level of the scale.

Asymmetry and kurtosis values between -2 and +2 are considered acceptable in order to assume a normal univariate distribution (Bliss, 1967; George & Mallery, 2010). According to Hair *et al.* (2019:96) and Field (2009:139), commonly critical values for kurtosis are $\pm$ 2.58 (0.01) significance level) and $\pm$ 1.96, which correspond to a 0.05 error level; however, absolute values above 3.29 are significant at p < 0.001. In large samples (200 or more) the criterion should be increased to 2.58, and in very large samples no criterion should be applied (Field, 2009:139). Chou, Bentler and Satorra (1991:351) considered a wider range of skewness and kurtosis, with skewness ranging from -2.0 to 2.0 and kurtosis ranging from -1.0 to 8.0. Curran, West and Finch (1996:20) further suggest that moderate normality thresholds of -2.0 to 2.0 and -7.0 to 7.0 for skewness and kurtosis respectively be used when assessing multivariate normality in structural equation models.

In this study the data normality skewness ranged from -3.225 to -0.546, while kurtosis ranged from 14.132 to 0.355. As some of the variables exhibited deviations outside the acceptable ranges, it was necessary to establish to what extent the multivariate techniques applied were robust to deviation of the assumption of normality and whether alternative estimation methods should be applied. Correlation analysis, robust to deviations from normality, was conducted to ensure that the nature of relationships was understood (Havlicek & Peterson, 1976:1319). Inferential statistics were done to determine the statistical significance and strength of the relationships between the seven different cognitive competencies. Pearson correlation coefficients were calculated to evaluate the strength and statistical significance of the relationships. The correlations between the variables reported with levels of significance were denoted as depicted in Table 6.8.

Table 6.8: The correlations for the cognitive competency variables

Cognitive Competencies	Decision Making	Proactiveness	Creative problem-solving	Innovation/ Innovating	Resilience Coping	Use of Social Support	Opportunity Recognition
Decision Making	1						
Proactiveness	.681**	1					
Creative problem-solving	.330**	.502**	1				
Innovation/ Innovating	.343**	.471**	.694**	1			
Resilience Coping	.312**	.471**	.644**	.611**			
Use of Social Support	.100*	.174**	.199**	.236**	.318**		
Opportunity Recognition	.278**	.329**	.603**	.581**	.524**	.157**	1

*Significance at the 5% level (p<0.05), ** Significance at the 1% level (p<0.01).

The descriptive statistics and correlations of the cognitive competencies are presented in Table 6.7 and Table 6.8. The results indicated that statistically significant relationships existed at the 1% level ($p<0.01$) between all combinations of cognitive competencies. It is evident from the table that all the cognitive competencies were weakly to moderately correlated, except for a strong correlation between innovation and creative problem-solving (0.694), proactiveness and decision-making (0.681), resilience coping and creative problem-solving (0.644), and resilience coping and innovation (0.611).

The results of the EFA conducted for social competencies are reported next.

- **Social competencies**

EFA was conducted on each of the three competencies. To confirm the appropriateness of EFA, the KMO measure of sampling adequacy and the Bartlett's test of sphericy were considered. The KMO value for 1) leadership was 0.591, 2) networking 0.649 and 3) positive attitude 0.794, exceeding the minimum value of 0.5 (Kaiser, 1974:183; Pallant, 2011; Tabachnick *et al.*, 2007). The Bartlett's test of sphericity (Bartlett, 1954) showed statistical significance $p < 0.001$, supporting the factorability of the correlation matrix. Table 6.9 indicates the communality estimates and the factor loadings as indicated in the pattern matrix.

Table 6.9: Factor loadings and communality estimates from the EFA for the factors representing social competence

2) Social competence				
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings Factor 1**
Leadership	Q19. It is extremely unlikely that I feel uncomfortable leading a group.	0.170	29.9%	0.412
	Q20. I often use persuasion to motivate others.	0.267		0.517
	Q21. I often seek to understand what motivates others.	0.408		0.639
	Q22. It is very likely that I trust, and thus empower, others.	0.353		0.594
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings Factor 1**

Networking	Q23. I often participate in social gatherings with people that I work with.	0.376	43.6%	0.613
	Q24. I often attend social functions for purposes of building professional relationships.	0.525		0.724
	Q25. I often participate in community projects.	0.560		0.748
	Q26. I serve on a community board, committee or task force.	0.283		0.532
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings**
				Factor 1
Positive attitude	Q65. Being an entrepreneur implies more advantages than disadvantages for me.	0.543	63%	0.737
	Q66. Being an entrepreneur provides great satisfaction for me.	0.696		0.834
	Q67. Among various employment options, I would rather be an entrepreneur.	0.648		0.805
	Q68. A career as an entrepreneur has been very attractive for me.	0.634		0.796

*Extraction method: Principal axis factoring

Rotation method: Promax with Kaiser Normalisation

Rotation convergence in three iterations

The communalities of the items were all above 0.30, except for Q19 (0.17), Q20 (0.27), both under the competency leadership, and Q26 (0.28) under networking. The PAF method revealed uni-dimensionality for all three constructs with the eigenvalue for factor 1. A concern is that leadership was 1.878 but only explained 29.9% of the variance, therefore it will be interpreted with caution. The second factor, networking, showed an eigenvalue of 2.285, explaining 43.6% of the variance, and factor 3, positive attitude with an eigenvalue of 2.886, explaining 63% of the variance.

Table 6.10: Reliability statistics for the factors for social competence

Subscale	Description	Number of items	Cronbach's alpha
F1	Leadership	4	0.615
F2	Networking	4	0.735
F3	Positive attitude	4	0.866

The Cronbach's alpha coefficients in Table 6.10 illustrate the factors for social competence: leadership (0.62), networking (0.74) and positive attitude (0.87) demonstrated internal consistency (Hair *et al.*, 2010a:127; Perry, Charlotte, Isabella & Bob, 2004:363).

Table 6.11 reflects the descriptive statistics for the factors representing the respondent's social competence that were identified as a result of EFA.

Table 6.11: Descriptive statistics for the factors representing social competence

	Mean*	Median	Std. deviation	Skewness	Kurtosis
Leadership	5.8933	6.0000	.81394	-1.584	5.711
Networking	4.6361	4.7500	1.37497	-0.339	-0.454
Positive attitude	6.2671	6.5000	.88415	-1.789	4.735

*****The scale consists of a Likert-scale measuring 1 = strongly disagree up to 7=strongly agree

The higher mean scores indicated a tendency towards stronger agreement with the factors, with positive attitude having the highest (mean score = 6.27), while dispersion of the scores around the mean was 0.88. Skewness ranged from -1.789 to - 0.339 and kurtosis values from -0.454 to 5.711 respectively.

Inferential statistics were done to determine the statistical significance and strength of the relationships between the three social competencies. The correlations between the variables are reported, with levels of significance denoted, as depicted in Table 6.12.

Table 6.12: The correlations for the social competency variables

Social Competencies	Positive Attitude	Networking	Leadership
Positive Attitude	1		
Networking	.228**	1	
Leadership	.402**	.386**	

*Significance at the 5% level (p<0.05), ** Significance at the 1% level (p<0.01).

The descriptive statistics and correlations of the social competencies are presented in Tables 6.11 and 6.12, respectively. The results indicated that statistically significant relationships existed at the 1% level ($p<0.01$) between all combinations of social competencies. The value of the correlation coefficient varied between 0.228 and 0.402, indicating moderately positive relationships between these variables.

The results of the EFA conducted for functional competencies are reported next.

- **Functional competencies**

EFA was applied to responses on the 5-item scale for the single construct that represents functional competencies. To confirm the appropriateness of EFA, the KMO measure of sampling adequacy and the Bartlett's test of sphericy were considered. The KMO value for 1) value creation was 0.747, exceeding the minimum value of 0.5 (Hair *et al.*, 1998; Kline, 2014; Pallant, 2011; Tabachnick *et al.*, 2007). The Bartlett's test of sphericity (Bartlett, 1954) showed statistical significance $p < 0.001$, supporting the factorability of the correlation matrix.

The PAF method was used to extract the factors, and this was followed by a promax rotation with Kaiser Normalisation. The factor loadings and communality estimates are presented in Table 6.13.

Table 6.13: Factor loadings and communality estimates from the EFA for the factors representing functional competence

3) Functional competence			

Construct	Item	Communalities	Variance explained	Loadings
				Factor 1
Value creation	Q56. I am constantly asking questions to understand why products and projects underperform.	0.369	51.2%	0.608
	Q57. New business ideas often come to me when directly observing how people interact with products and services.	0.537		0.732
	Q58. I have a continuous flow of new business ideas that come through observing the world.	0.646		0.804
	Q59. I love to experiment to understand how things work.	0.511		0.715
	Q60. I love to create new ways of doing things.	0.499		0.707

*Extraction method: Principal axis factoring

Rotation method: Promax with Kaiser Normalisation

Rotation convergence in three iterations

The PAF method revealed the presence of one factor (uni-dimensionality) with eigenvalue exceeding 1, with eigenvalue 3.037, explaining 51.2% of the variance in the data. All items were retained for further analysis as they demonstrated loadings of more than 0.30.

Table 6.14: Reliability statistics for the factors for functional competence

Description	Number of items	Cronbach's alpha
Value creation	5	0.837

Table 6.14 indicates that the factor value creation (0.84) demonstrated acceptable internal consistency as illustrated by the Cronbach's alpha coefficient.

The results of the EFA conducted for meta competencies are reported next.

- **Meta competencies**

EFA was applied to each of the two competencies representing meta competencies. To confirm the appropriateness of EFA, the KMO measure of sampling adequacy and the Bartlett's test of sphericity were considered. The KMO value for 1) cognitive ability was 0.916, and 2) problem-solving 0.786, exceeding the minimum value limit of 0.5 (Kaiser, 1974; Pallant, 2011). The Bartlett's test of sphericity (Bartlett, 1954) showed statistical significance $p < 0.001$, supporting the factorability of the correlation matrix.

The PAF method revealed uni-dimensionality for the problem-solving competency and identified two factors for the cognitive ability competency. The eigenvalues exceeded 1, cumulatively explaining 43.8% of the variance for cognitive ability competency and 52.5% for the problem-solving competency.

Table 6.15 indicates the communality estimates and the factor loadings as indicated in the pattern matrix.

Table 6.15: Factor loadings and communality estimates from the EFA for the factors representing meta competence

4) Meta competence					
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings**	
				Factor 1	**Factor 2**
Cognitive ability: Knowledge of cognition	Q27. I am good at organising information.	0.476	43.8%	0.728	
	Q28. I am good at remembering information.	0.404		0.720	
	Q29. I try to use strategies for my business that have worked in the past.	0.361		0.648	
	Q30. I find myself using helpful learning strategies automatically.	0.515		0.735	
	Q31. I use different learning strategies (plans of action) depending on the situation.	0.568		0.698	

	Q32. I know when each strategy I use will be most effective.	0.429		0.661	
	Q33. I take into consideration what I really need to learn before I begin a task.	0.411		0.427	
	Q34. I think of several ways to solve a problem and choose the best one.	0.536		0.505	
	Q35. I consciously focus my attention on important information.	0.494		0.609	
	Q36. I draw pictures or diagrams to help me understand while learning.	0.178			Factor loading was too low
Cognitive ability: Regulation of cognition	Q37. I ask myself periodically if I am meeting my goals.	0.433			0.469
	Q38. I ask myself if I considered all options when solving a problem.	0.520			0.560
	Q39. I change strategies when I fail to understand a task or problem at hand.	0.301			0.418
	Q40. I stop and go back over new information that is not clear.	0.349			0.478
	Q41. I ask myself if there was an easier	0.498			0.859

	way to do things after I finish a task.				
	Q42. I ask myself how well I accomplished my goals once I'm finished.	0.539			0.797

Construct	Item	Communalities	Variance explained	Loadings
				Factor 1
Problem-solving	Q43. I have good analysis skills.	0.573	52.5%	0.757
	Q44. I have the ability to prioritise problems.	0.525		0.725
	Q45. I have good critical thinking skills.	0.673		0.821
	Q46. I use information to make decisions.	0.327		0.572

*Extraction method: Principal axis factoring

Rotation method: Promax with Kaiser Normalisation

Rotation convergence in three iterations

Due to the communalities of all the items being above 0.31, except for Q36 (0.18), and all factors demonstrating loadings of more than 0.30 on one of the two extracted factors, all items were retained for further analysis, while Q36 was excluded from further analysis. The two factors identified for cognitive ability were labelled (F1) knowledge of cognition, and (Q27-Q35); Q36 was excluded and (F2) regulation of cognition (Q37-Q42).

Table 6.16 indicates the reliability statistics for the two extracted factors and problem-solving.

Table 6.16: Reliability statistics for the factors for meta competence

Subscale	Description	Number of items	Cronbach's alpha
F1	Cognitive ability: Knowledge of cognition	10	0.879
F2	Cognitive ability: Regulation of cognition	6	0.805
F3	Problem-solving	4	0.810

Table 6.16 indicates that the factors: knowledge of cognition (0.88), regulation of cognition (0.8) and problem-solving (0.810) demonstrated acceptable internal consistency as illustrated by Cronbach's alpha coefficients, as they met the generally agreed upon lower limit for Cronbach's alpha of 0.60 (Hair *et al.*, 2014:123).

Table 6.17 reflects the descriptive statistics for the two factors representing the

Table 6.17: Descriptive statistics for the three extracted factors representing meta competence

		Mean*	Median	Std. deviation	Skewness	Kurtosis
F1	Cognitive ability: Knowledge of cognition	5.9248	6.0000	0.73845	-2.021	9.965
F2	Cognitive ability: Regulation of cognition	5.8754	6.0000	0.81805	-1.533	4.739
F3	Problem solving	6.2555	6.2500	0.72451	-1.918	8.477

*The scale consists of a Likert-scale measuring 1 = strongly disagree up to 7=strongly agree

The respondents' mean level of agreement with the problem-solving values factor tended towards strong agreement (mean score = 6.23). The mean level of agreement for knowledge of cognition tended towards agreement (mean score = 5.93), as well as regulation of cognition (mean score = 5.88).

Regarding data normality, skewness ranged from -1.533 to -2.5021, while kurtosis ranged from 4.739 to 9.965. As some of the variables exhibit deviations outside the acceptable ranges, it was necessary to establish to what extent the multivariate techniques applied were robust to deviation of the assumption of normality, and whether alternative estimation methods should applied.

The correlations between the variables are reported with levels of significance denoted, as depicted in Table 6.18.

Table 6.18: The correlations for the meta competence variables

Meta Competencies	Problem- Solving	Knowledge of Cognition	Regulation of Cognition
Problem Solving	1		
Knowledge of Cognition	.645**		
Regulation of Cognition	.571**	.636**	1

*Significance at the 5% level (p<0.05), ** Significance at the 1% level (p<0.01).

The descriptive statistics and correlations of the meta competencies are presented in Table 6.17 and Table 6.18, respectively. The results indicated that statistically significant relationships exist at the 1% level (p <0.01) between all combinations of meta competencies. It is evident from the table that the competencies were strongly correlated between knowledge of cognition and problem-solving, 0.645, regulation of cognition and problem-solving, 0.571 and regulation of cognition and knowledge of cognition, 0.636.

The results of the CFA for the four EC categories are discussed next.

6.4.1.2 Confirmatory factor analysis for the four EC categories

CFA was subsequently employed to test whether each of the four categories of ECs, categorised as cognitive, functional, social and meta competence, found in the literature search could be confirmed in this study. The measurement model (CFA) was employed to confirm fit for the social, meta and cognitive competencies groups, as well as for EACAP and IC and to evaluate construct validity.

1. **CFA for cognitive competencies**

The cognitive competence model is illustrated and discussed next.

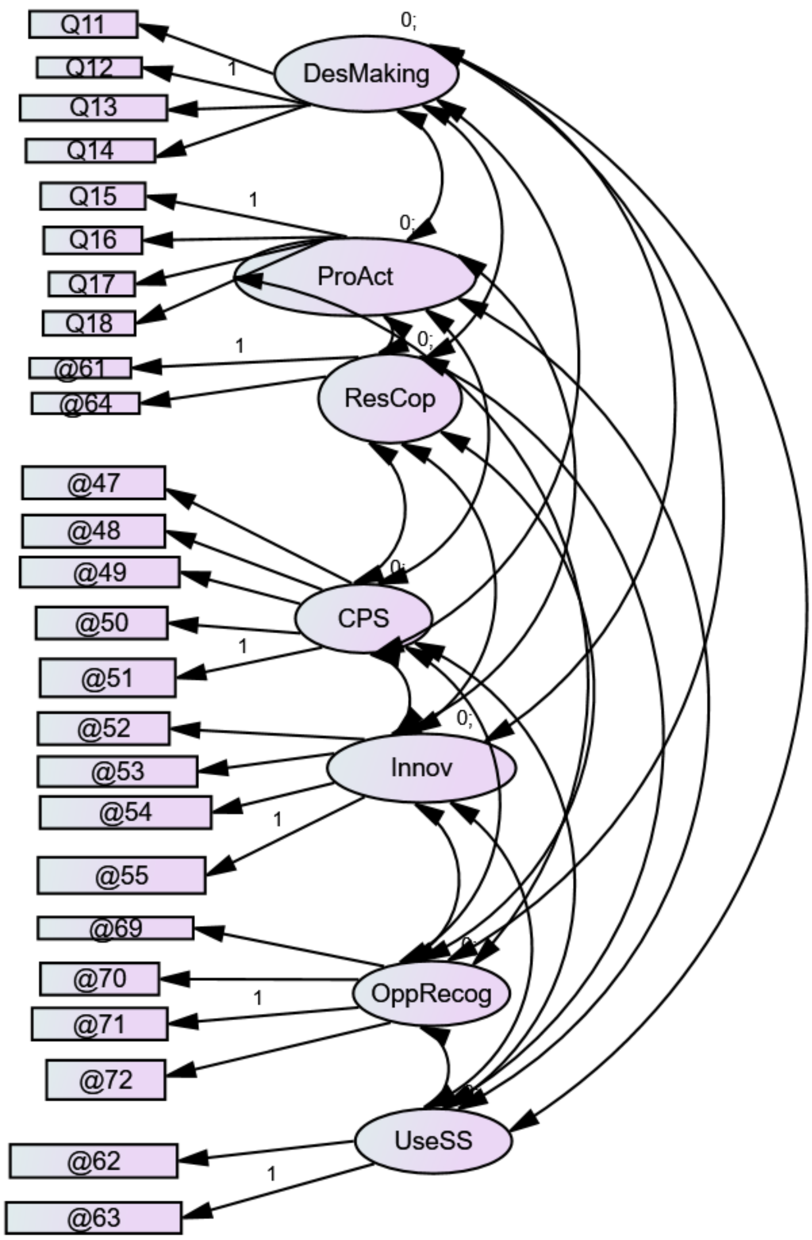


Figure 6.27: Model 1 as originally postulated with respect to factors underlying cognitive competencies

In Figure 6.27, the measurement model was presented for the seven competencies associated with the cognitive competency category using Q11-Q18, Q47-Q55, Q69-Q72 and Q61-Q64 for the observed variables. The model was tested for consistency with the observed data using a SEM approach. A model with the following goodness-of-fit indices indicates acceptable fit: The RMSEA values between 0.05 and 0.08; CFI, IFI and TLI above 0.9 and the CMIN/df value smaller than 3 (Hair *et al.*, 2014:579; Raykov & Marcoulides, 2000:36) or smaller than 5 (Schumacker & Lomax, 2004).

Table 6.19 provides the goodness-of-fit indices of the measurement model, representing the cognitive competence values of innovative entrepreneurs.

Table 6.19: Goodness-of-fit indices of the CFA measurement model 1 for the cognitive competence category

Model	CMIN (χ^2)	df	P	CMIN/df	RMSEA	CFI	TLI	IFI	SRMR
Model 1	757,000	254	0.000	2.980	0.066	0.912	0.896	0.913	0.0579
Indicate acceptable fit	-	-	-	<3 or <5	$\leq$ 0.08	$\geq$ 0.90	$\geq$ 0.90	$\geq$ 0.90	<0.08

The model fit statistics indicated acceptable fit indices with RMSEA (0.066) values between 0.05 and 0.08, the CFI (0.0.912) and IFI (0.913) all tested above 0.90, with TLI (0.896) testing very close to 0.90. The CMIN/df value of 2.980 was smaller than 3, therefore indicating acceptable fit.

Discriminant validity entails that two latent variables that are meant to represent two different theoretical concepts are statistically sufficiently different. It indicates the extent to which a construct is truly distinct from other constructs (Hair *et al.*, 2014:788). Based on the correlation results displaying the outputs of the cognitive competencies' original model in Appendix I, potential multicollinearity was observed between "resilience coping" and "creative problem solving" (0.850), "resilience coping" and "innovation" (0.892), "creative problem-solving" and "innovation" (0.896) as well as "decision-making" and "proactiveness" (0.817). Multicollinearity could result in large standard errors and large sampling errors, making the coefficients unreliable and decreasing their precision (Alin, 2010:370). Furthermore, the standardised regression weights for items Q62 (0.449) and Q54 (0.4) were below 0.5 and were considered for deletion (Appendix I).

The average variance extracted (AVE) is a conservative measure of convergent validity and should be larger than the square root of the correlation and heterotrait/monotrait ratio of the correlations (Fornell & Larcker, 1981). The composite reliability (CR) value is computed as the squared sum of factor loading for each construct divided by the sum of the error variance terms for that construct (Hair *et al.*, 2010b:710). High CR indicates that internal consistency exists, meaning that the measures all consistently represent the same latent construct. The rule of thumb is therefore 0.7 or higher (Anderson *et al.*, 2010:125).

Table 6.20 provides a summary of the convergence validity statistics. The table indicates the calculated values for the AVE, composite reliability (CR) for each construct.

Table 6.20: AVE analysis – cognitive competencies

	Rho vc = AVE	AVE with Items deleted	Joreskog rho = CR	CR with items deleted
Decision-making	0.647		0.88	
Proactiveness	0.536		0.821	
Creative problem-solving	0.503		0.834	
Innovation/Innovating	0.428	0.518	0.741	0.763
Use of social support	0.65		0.762	
Opportunity recognition	0.632		0.872	
Resilience coping	0.481		0.647	

The results indicate that innovation (0.428) and resilience coping (0.481) are less than 0.5, indicating that on average, more error remains in the items than variance held in common with the latent factor upon which they loaded (Hair *et al.*, 2014:676). Item Q54 was therefore deleted from innovation in order to increase the AVE from 0.428 to 0.518, leaving the measurement for innovation with only three items. No deletion of items could take place for resilience coping as the construct only consist of two items. Ave is a conservative measure of convergent validity and one can conclude, on the basis of CR, that the latent construct is acceptable even though more than 50% of the variance is attributable to error (Wong, 2013:21). Hence, for this measurement model based on CR values, all the constructs presented can be considered reliable.

Fornell-Larcker Criterion

The Fornell-Larcker criterion establishes discriminant validity of a set of constructs (Garson, 2016:67). The criterion stipulates that for any latent construct, the AVE should be higher than its squared correlation with any other construct (Garson, 2016:67).

Furthermore, each construct's AVE exceeded the squared correlations with the other measurement model factors. The squared correlations of proactiveness and decision-making are 0.667, creative problem-solving and proactiveness (0.325), use of social support and innovation/innovating (0.094), opportunity recognition and use of social support (0.041) and resilience-coping and opportunity recognition (0.424), except for innovation and creative problem-solving and (0.803), indicating good discriminant validity (Fornell & Larcker, 1981).

Heterotrait-Monotrait Approach (HTMT)

Although the use of the Fornell-Larcker criterion is an accepted method for assessing the discriminant validity of a SEM model, an alternative criterion – HTMT (Henseler *et al.*, 2015:120) was additionally considered (Garson, 2016:69). The HTMT of the correlations is the ratio between trait correlation and the within-trait correlations (Hair *et al.*, 2014:688) (that is, the correlations of indicators across constructs measuring different phenomena) divided by the average of the monotrait method correlations (that is, the correlations of indicator within the same construct). Heterotrait correlations should be smaller than monotrait correlations, meaning that the HTMT should be below 1.0 in a well-fitting model. It is suggested that the HTMT should be lower than 0.85 (more strict threshold) or 0.90 (more lenient threshold) or significantly smaller than 1 (Hair *et al.*, 2014:788-789).

Table 6.21: HTMT analysis – cognitive competencies

	Decision-making	Proactiveness	Creative problem-solving	Innovation	Use of social support	Opportunity recognition	Resilience coping
Decision-Making							
Proactiveness	0.805						
Resilience Coping	0.417	0.647					
Creative Problem- Solving	0.392	0.602	0.874				
Innovation/Innovating	0.447	0.624	0.911	0.907			
Opportunity recognition	0.326	0.393	0.711	0.720	0.732		
Use of Social Support	0.140	0.248	0.500	0.272	0.357	0.229	

*Resilience Coping and CPS are statistically indistinguishable.

Resilience Coping and Innovation are nearly indistinguishable.

Creative Problem-Solving and Innovation/Innovating are nearly indistinguishable.

As shown in Table 6.21, all values associated with the constructs of the measurement model were acceptable (< 0.85), except the values between resilience coping and creative problem-solving, between resilience coping and innovation/innovating and between creative problem-solving and innovation/innovating.

Based on the analysis, the value of the HTMT for resilience coping and creative problem-solving was 0.874, which is below the threshold of 0.9, but higher than 0.85 as suggested by Clark and Watson (1995:316). The HTMT value between resilience-coping and innovation was 0.911 and between creative problem-solving and innovation was 0.907, meaning a threshold above 0.9, suggesting a lack of discriminant validity.

Although acceptable model fit was determined in CFA model 1, potential multicollinearity was detected between some of the competencies, and subsequent discriminant validity analysis indicated that reconsideration of the individual competency constructs was necessary. It was therefore decided to merge the constructs “creative problem-solving” (items Q47 to Q50) and “resilience coping” (item Q64) with “innovation/innovating” (items Q52, Q53 and Q55), where item 54 was deleted in AVE. These items were considered applicable to be merged as they support the measurement theory of the construct innovation (Henseler *et al.*, 2015:130). As part of resilience coping, item Q61 could not be merged with innovation as it does not support the measurement theory of the construct innovation. This item was therefore excluded from further analysis.

Figure 6.28, therefore presents the adapted model (2) which illustrates the measurement model for the cognitive competency category with merged constructs.

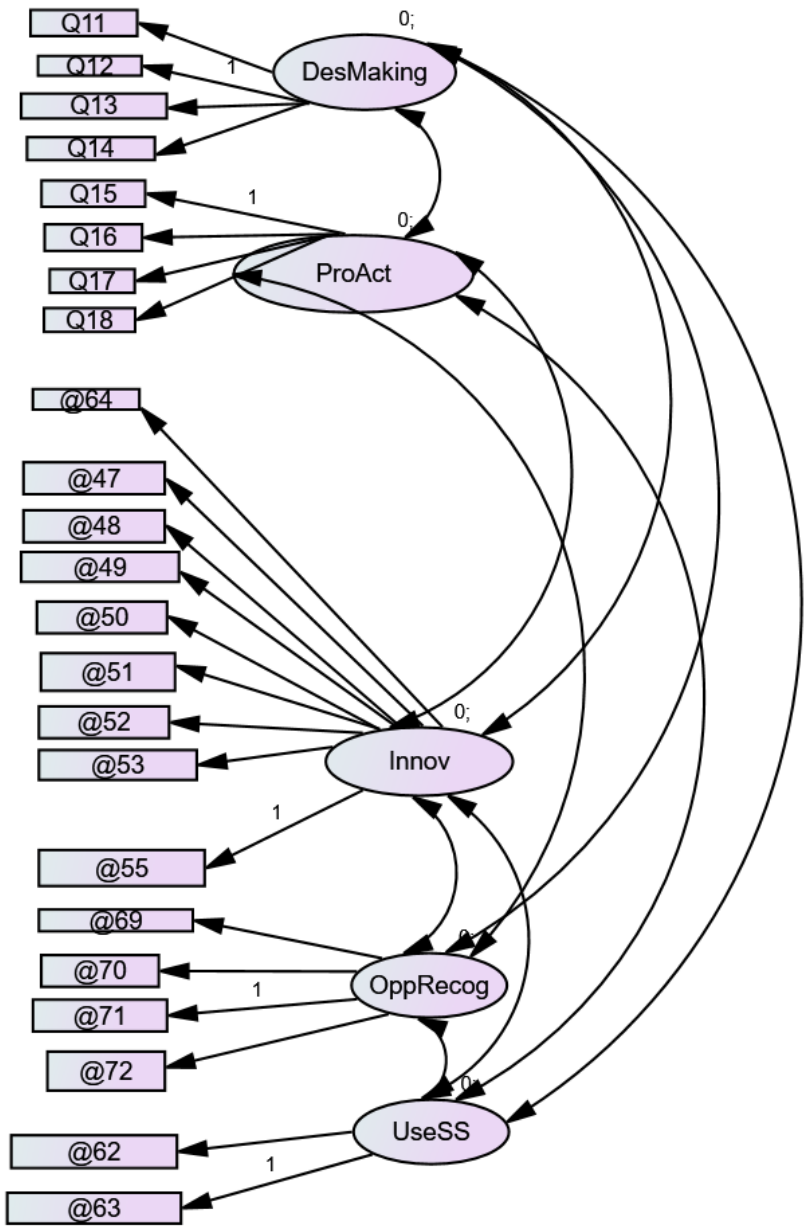


Figure 6.28: Model 2 with respect to factors underlying cognitive competencies

Table 6.22: Goodness-of-fit indices of the CFA measurement model 1 and 2 for cognitive competence

Model	CMIN (χ^2)	df	P	CMIN/df	RMSEA	CFI	TLI	IFI	SRMR
Model 1	757,000	254	0.000	2.980	0.066	0.912	0.896	0.913	0.0579
Model 2	725,475		0.000	3.283	0.071	0.906	0.893	0.907	0.0642
Indicate acceptable fit	-	-	-	<3 or <5	$\leq$ 0.08	$\geq$ 0.90	$\geq$ 0.90	$\geq$ 0.90	<0.08

The model fit statistics indicated adequate fit for model 2, although this was slightly weaker when compared with model 1, with RMSEA at 0.071, CFI (0.906) and IFI (0.907), above the threshold of 0.90 and TLI at 0.893, slightly lower than 0.90. The CMIN/df value of 3.283 was larger than 3, but still smaller than 5 (Schumacker & Lomax, 2004). Model 2 was considered the final CFA model for cognitive competencies. The output for model 2, presenting the standardised regression weights and correlations, is displayed in Appendix I.

The same process that had been followed to determine the final model fit and discriminant validity was conducted on the three remaining competency categories. Due to space limitations, the summary of the findings and conclusions is presented for the remaining three categories.

2. CFA for Social Competence

Figure 6.29 represents the social competence category measurement model with respect to the underlying individual competencies included in this category.

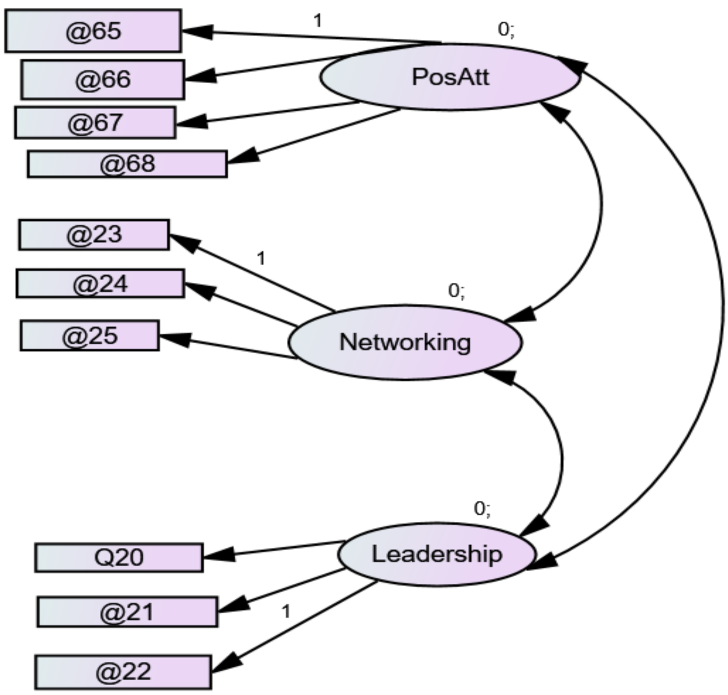


Figure 6.29: Model with respect to competencies factors underlying the social competencies

In Figure 6.29, the model is presented using Q65-Q68 (positive attitude), Q23-Q25 (networking), and Q20-Q22 (leadership), for the observed variables. Items Q26 (0.484 and Q19 (0.350), with standardised regression weights below 0.5, were deleted in the model fit estimation for model 2. Table 6.23 provides the goodness-of-fit indices of the measurement models 1 and 2 representing the social competence model.

Table 6.23: Goodness-of-fit indices of the CFA measurement model for social competence

Model	CMIN (χ^2)	df	P	CMIN/df	RMSEA	CFI	TLI	IFI	SRMR
Model 1	273.698	51	0.000	5.367	0.98	0.881	0.845	0.882	0.0576
Model 2	99.272	32	0.000	3.102	0.068	0.941	0.941	0.985	0.0407
Indicate accepta ble fit	-	-	-	<3 or <5	$\leq$ 0.08	$\geq$ 0.90	$\geq$ 0.90	$\geq$ 0.90	<0.08

The initial model (1) did not indicate acceptable fit. RMSEA (0.98) did not indicate acceptable fit to the threshold of $\leq$ 0.08. The CFI (0.881), TLI (0.849) and IFI (0.882) values were all below 0.90, indicating close, but not adequate fit. The CMIN/df (5.369) tested above 3 and 5 (Schumacker & Lomax, 2004). In order to improve model fit, items Q19 (0.350) and Q26 (0.484), with low standardised regression weights below 0.5, were deleted (Hair *et al.*, 2014:786). When model 2 was fitted to the data, all the goodness-of-fit indices supported the model. The RMSEA (0.068), CFI (0.941), TLI (0.941), IFI (0.985), CMIN/df (3.102), close to 3 and lower than 5, indicated acceptable fit. The output for model 2, presenting the standardised regression weights and correlations for social competencies, is displayed in Appendix I.

Average Variance Extracted (AVE)

Convergent validity was achieved for positive attitude (0.63) and networking (0.51) as they tested above 0.5, suggesting adequate convergence (Hair *et al.*, 2014:676). Leadership (0.363) tested below the estimated threshold, indicating a lack of convergent validity. Item Q20 was therefore removed due to its low standard regression weight of 0,456, which increased the AVE to 0.440, but still did not achieve convergence. The AVEs for positive attitude (0.63) and networking (0.51) were above the 0.5 threshold, except for leadership; similarly, the CR values for positive attitude

(0.872) and networking (0.755) were above 0.7, with the exception of leadership (0.623).

Furthermore, each construct's AVE exceeded the squared correlations with the other measurement model factors. The squared correlations of networking and positive attitude (0.073) and leadership and networking (0.412), indicated good discriminant validity (Fornell & Larcker, 1981).

Heterotrait-Monotrait Approach (HTMT)

As shown in Table 6.24, all the values associated with the constructs of the measurement model met the criteria. Therefore, HTMT indicates that further statistical analysis could be conducted, as these constructs showed discriminant validity.

Table 6.24: HTMT analysis – social competencies

	Positive attitude	Networking	Leadership
Positive attitude			
Networking	0.278		
Leadership	0.550	0.709	

***HTMT Warnings**

There are no warnings for this HTMT analysis.

Lastly, because of the sensitivity of the AVE approach to lower factor loadings and following the recommendations of Voorhees, Brady, Calantone and Ramirez (2016), the leadership construct was retained.

3. CFA for Functional Competence

Figure 6.30 represents the functional competence category measurement model with respect to the underlying competencies.

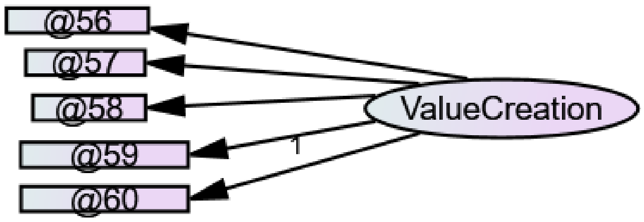


Figure 6.30: Model with respect to competencies factors underlying the functional competency category

In Figure 6.30, the model is presented using Q56-Q60 (value creation). Table 6.25 provides the goodness-of-fit indices of the measurement model representing the functional competence category measurement model.

Table 6.25: Goodness-of-fit indices of the CFA measurement model for functional competence

Model	CMIN (X2)	df	P	CMIN/df	RMSEA	CFI	TLI	IFI	SRMR
Model 1	188.958	5	0.000	37.792	0.286	0.813	0.627	0.814	0.0841
Model 2	55.741	4	0.000	13.935	0.169	0.948	0.869	0.948	0.0435
Indicate acceptable fit	-	-	-	<3 or <5	≤ 0.08	≥ 0.90	≥ 0.90	≥ 0.90	<0.08

The model (1) did not indicate acceptable fit. RMSEA (0.286), CFI (0.813), TLI (0.628) and IFI (0.814) were not within the recommended thresholds. After the modification indices had been studied, an error covariance term was added to item 59 and item 60, (0.555). This is theoretically justifiable as item 59 and item 60 are concerned with value creation, in that Q59 states that “I love to experiment to understand how things work” and Q60 “I love to create new ways of doing things.” This explains the relationships over and above their relationship with the value creation construct.

The results of the second model indicated RMSEA (0.169) above the threshold of <0.08, CFI (0.948), IFI (0.948) testing above the threshold of 0.90 and TLI (0.869) just below the threshold. However, the main concern is that CMIN/df (13.935) tested above the threshold of <3 and <5 (Schumacker & Lomax, 2004). However, due to functional competence being a single-factor model (Kline, 1998b:45) and the lack of agreement on the threshold value of the chi square df ratio or χ^2/df in the literature (Kenny, 2014; Usp & Winter, 2012) and the fact that RMSEA is largely based of this ratio accept the measurement model as adequate. The Standardised Root Mean Residual (SRMR) (0.0435) is also below 0.08 providing enough evidence to accept the measurement model as adequate.

The output for model 2, presenting the standardised regression weights and correlations for functional competencies, is displayed in Appendix I.

4. CFA for Meta Competence

Figure 6.31 represents the meta competence category measurement model with respect to the underlying competencies.

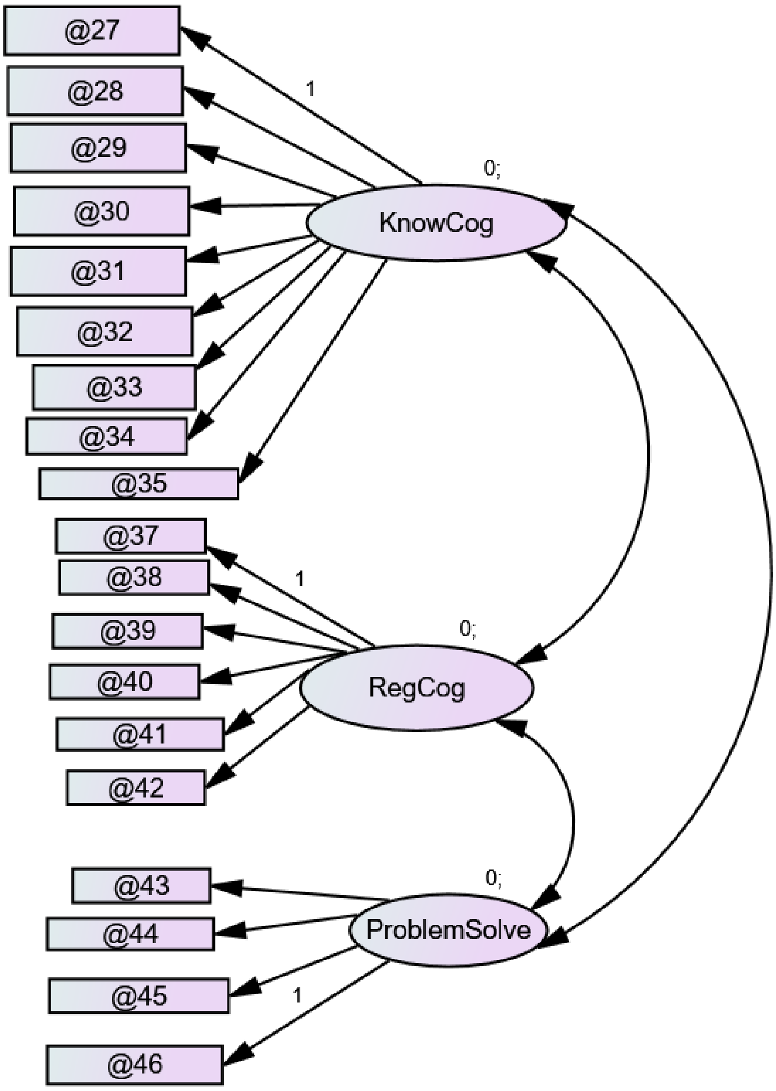


Figure 6.31: Model with respect to competency factors underlying the meta competencies

Table 6.26 provides the goodness-of-fit indices of the measurement model representing the meta competence category measurement model.

Table 6.26: Goodness-of-fit indices of the CFA measurement model for meta competence

Model	CMIN (X2)	df	P	CMIN/df	RMSEA	CFI	TLI	IFI	SRMR
Model 1	561.353	149	0.000	3.767	0.078	0.890	0.873	0.890	0.0574
Model 2	483.537	148	0.000	3.267	0.071	0.910	0.896	0.911	0.0537
Indicate acceptable fit	-	-	-	<3 or <5	$\leq$ 0.08	$\geq$ 0.90	$\geq$ 0.90	$\geq$ 0.90	<0.08

The model (1) did not indicate acceptable fit initially. RMSEA (0.071) indicated acceptable fit. The CFI (0.890), TLI (0.873) and IFI (0.890) all tested below 0.9, indicating a close, but unacceptable model fit.

An additional error term covariance was added between e6 (Q41) and e7 (Q42), (0.433). Both items were measured under the competence "regulation of cognition", where these statements were phrased in a similar way, e6 "I ask myself if there was an easier way to do things after I finish a task" and e7 "I ask myself how well I accomplish my goals once I'm finished", thereby indicating their relationship over and above their relationship with the regulation of cognition construct.

In Model 2, the RMSEA (0.071) indicated acceptable fit to the threshold of $\leq$ 0.08. The CFI (0.910) and IFI (0.911) all tested above 0.9, with TLI (0.896) testing very close to the threshold. The CMIN/df (3.267) were close to 3 and less than 5 (Schumacker & Lomax, 2004). The output for model 2, presenting the standardised regression weights and correlations for meta competencies, is displayed in Appendix I.

Average Variance Extracted (AVE)

Table 6.27 indicates the calculated values for the AVE, CR statistics for each construct.

Table 6.27: AVE analysis – meta competencies

	Rho vc = AVE	AVE with Items deleted	Joreskog rho = CR
Knowledge of cognition	0.454	0.515	0.881
Regulation of cognition	0.397	0.537	0.795
Problem-solving	0.526		0.815

The results indicate that convergent validity was achieved for problem solving (0.526), but not for knowledge cognition (0.454) and regulation of cognition (0.397). In order to achieve convergent validity, items Q32 and Q33 were removed from the analysis due to lower factor loadings, resulting in an AVE value of 0.515 for knowledge cognition. For regulation of cognition, three items were removed (Q40-Q42), which resulted in an AVE of 0.537, proving convergent validity. There were no CR values with items deleted to report.

Fornell-Larcker Criterion

From the squared correlation results, discriminant validity is not confirmed between the latent constructs in this measurement model as each construct's AVE exceeded its squared correlations with the other measurement model factors (Fornell & Larcker, 1981). The squared correlation values between regulation of cognition and knowledge of cognition are (0.632) and problem-solving and regulation of cognition (0.449). High correlation values, almost at the level (0.8) where potential multicollinearity would be present, resulted in non-confirmation using this criterion.

Heterotrait-Monotrait Approach

As shown in Table 6.28, all the values associated with the constructs of the measurement model meet the criteria and the threshold of below 0.85. Therefore HTMT indicates that further statistical analysis can be conducted as these constructs have shown discriminant validity (Kline, 2011).

Table 6.28: HTMT analysis – meta competencies

	Knowledge of Cognition	Regulation of Cognition	Problem-Solving
Knowledge of cognition			
Regulation of cognition	0.759		
Problem-solving	0.771	0.719	

***HTMT Warnings**

There are no warnings for this HTMT analysis.

Based on the analysis, discriminant validity was achieved for knowledge cognition and regulation of cognition (0.759), knowledge of cognition and problem solving (0.771) and regulation of cognition and problem solving (0.719), meaning a threshold of below 0.9, indicating discriminant validity (Hair *et al.*, 2014:688; Henseler *et al.*, 2015:121).

6.4.2 Results of the factor analysis: Entrepreneurial absorptive capacity

6.4.2.1 Exploratory factor analysis: EACAP

EFA was applied to each of the four sub constructs (recognition = 4-items, assimilation = 3-items, transformation = 4-items, exploitation = 3-items). The KMO value for 1) recognition was 0.647, 2) assimilation, 0.733, 3) transformation, 0.740, and 4) exploitation, 0.749, exceeding the minimum value of 0.5 (Hair *et al.*, 1998; Kline, 2014; Pallant, 2011; Tabachnick *et al.*, 2007). The Bartlett's test of sphericity (Bartlett, 1954) showed statistical significance $p < 0.001$, supporting the factorability of the correlation matrix.

The PAF method was used to extract the factors, and this was followed by a promax rotation with Kaiser Normalisation. The PAF method revealed uni-dimensionality for each of the factors by identifying one factor for each with eigenvalues exceeding 1. The eigenvalue for factor 1 was at 2.394, which explained 48.4% of the variance, factor 2 with an eigenvalue of 2.325, explaining 66.3% of the variance, factor 3 at 2.635, explaining 55.6% of the variance and factor 4 at 2.461, with the highest variance explained at 73%.

Table 6.29: Factor loadings and communality estimates from the EFA for the factors representing EACAP

5) Social competence				
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings Factor 1**
Recognition	Q75. I am always actively looking for new knowledge for my business.	0.605	48.4%	0.834
	Q76. I intentionally search for knowledge in many different domains by looking 'outside the box'.	0.589		0.776

	Q77. I am good at distinguishing between profitable opportunities and not-so-profitable opportunities.	0.297		0.444
	Q78. I easily identify what new knowledge is most valuable for the business.	0.426		0.663
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings Factor 1**
Assimilation	Q79. I frequently share my new knowledge with employees to establish a common understanding.	0.619	66.3%	0.787
	Q80. I translate new knowledge in such a way that my employees understand what I mean.	0.690		0.830
	Q81. I communicate newly acquired knowledge that might be of interest for the business.	0.680		0.825
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings Factor 1**
Transformation	Q82. I often sit together with employees to come up with good ideas.	0.629	55.6%	0.793
	Q83. I attend meetings with people from different departments to come up with new ideas.	0.623		0.789
	Q84. I develop new insights from knowledge that is available within the business.	0.675		0.822
	Q85. I can turn existing knowledge into new ideas.	0.298		0.546
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings Factor 1**
Exploitation	Q86. I often apply newly acquired knowledge to my business/work.	0.722	73%	0.850
	Q87. I exploit new knowledge to create new products, services, or work methods.	0.749		0.865

	Q89. I constantly consider how I can apply new knowledge to come up with new ideas.	0.721		0.849

*Extraction method: Principal axis factoring

Rotation method: Promax with Kaiser Normalisation

In general, most of the communalities tested above 0.31, except for Q77 (0.297) and Q85 (0.298), however, their factor loadings tested above the threshold of 0.30 (Hair *et al.*, 2010a:117), ranging from 0.444 to 0.865. All items were retained for further analysis.

Next, the reliability of the new factors was calculated. Table 6.30 indicates the reliability statistics for the extracted factors for EACAP.

Table 6.30: Reliability statistics for the EACAP factors

Description	Number of items	Cronbach's alpha
Recognition	4	0.761
Assimilation	3	0.848
Transformation	4	0.821
Exploitation	3	0.890

Table 6.30 indicates that recognition (0.761), assimilation (0.848), transformation (0.821) and exploitation (0.890) demonstrated acceptable internal consistency as illustrated by Cronbach's alpha coefficients, which met the generally agreed upon threshold for Cronbach's alpha values of 0.70 (Hair *et al.*, 2010b:127).

Table 6.31 reflects the descriptive statistics for the factors representing the respondent's EACAP that were identified as a result of EFA.

Table 6.31: Descriptive statistics for the factors representing EACAP

		Mean*	Median	Std. deviation	Skewness	Kurtosis
F1	Recognition	6.1018	6.0000	0.82189	-1.554	4.766
F2	Assimilation	5.9602	6.0000	0.92187	-1.361	3.007
F3	Transformation	5.7749	6.0000	0.98566	-1.306	2.879
F4	Exploitation	5.5715	5.6667	0.91498	-0.629	1.010

***The scale consists of a Likert-scale measuring 1 = strongly disagree up to 7=strongly agree

The entrepreneurs' mean level of agreement in terms of factors F1-F4 tended towards agreement, in particular recognition (mean score = 6.1).

Table 6.32 illustrates that the skewness and kurtosis values for all EACAP variables ranged between -1.554 and -0.629 and 1.010 and 4.766 (Chou *et al.*, 1991:351). The correlations between the variables are reported with levels of significance denoted, as depicted in Table 6.32.

Table 6.32: The correlations for the absorptive capacity variables

	Recognition	Assimilation	Transformation	Exploitation	AC
Recognition	1				
Assimilation	.516**	1			
Transformation	.540**	.701**	1		
Exploitation	.532**	.430**	.495**	1	

*Significance at the 5% level (p<0.05), ** Significance at the 1% level (p<0.01).

The descriptive statistics and correlations of EACAP are presented in Table 6.31 and 6.32, respectively. The results indicated that statistically significant relationships existed at the 1% level (p<0.01) between all combinations of EACAP. The value of the correlation coefficients varied between 0.430 and 0.701, which means that the variables were positively moderately to strongly correlated, in particular between transformation and assimilation, 0.701 and transformation and recognition, 0.540.
The results of the CFA for EACAP are discussed next.

6.4.2.2 Confirmatory factor analysis: EACAP

CFA was employed to test whether the individual EACAP factors consisting of recognition, assimilation, transformation and exploitation could be confirmed in this study.

Figure 6.32 illustrates the EACAP model with respect to the underlying factors.

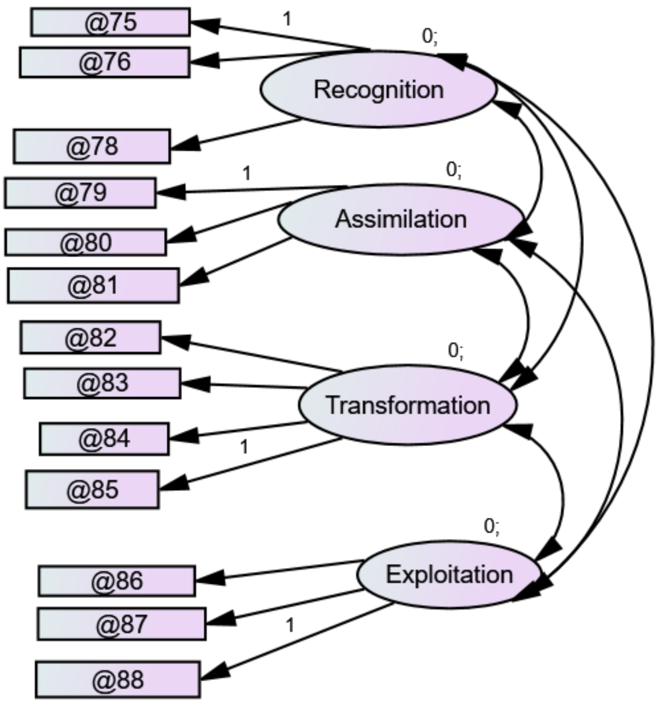


Figure 6.32: Model with respect to factors underlying EACAP

Table 6.33: Goodness-of-fit indices of the CFA measurement model for EACAP

Model	CMIN (χ^2)	df	P	CMIN/df	RMSEA	CFI	TLI	IFI	SRMR
Model 1	300.756	56	0.000	5.371	0.098	0.936	0.911	0.937	0.0649
Indicate acceptable fit	-	-	-	<3 or <5	$\leq$ 0.08	$\geq$ 0.90	$\geq$ 0.90	$\geq$ 0.90	<0.08

The initial model (1) indicated that the RMSEA (0.098) and CMIN/df (5.371) did not indicate acceptable fit. The CFI (0.936), TLI (0.911) and IFI (0.937) all tested above the 0.9, indicating acceptable fit. The output for the model presenting the standardised regression weights and correlations for EACAP is displayed in Appendix I. Although the total set of indices does not indicate acceptable fit, lack of agreement still exists on the threshold value of the chi square df ratio or χ^2/df in the literature (Kenny, 2014; Usp & Winter, 2012) and the fact that RMSEA is largely based on this ratio. Therefore, as CFI, TLI, and IFI are above the threshold value of 0.9, and the SRMR is below 0.08, these provide enough evidence to accept the measurement model as adequate.

From the correlation results (Appendix I), the corresponding items of e22 and e21 (0.589) were Q76 ("I intentionally search for knowledge in many different domains by looking outside the box) and Q75 ("I am always actively looking for new knowledge for my business"). Both items refer to "recognition" and the search for knowledge. It is therefore reasonable to co-vary these error terms. The same argument could be followed for e28 and e29 (0.524), which correspond to items Q82 ('I often sit together with employees to come up with good ideas") and Q83 ("I attend meetings with people from different departments to come up with new ideas"). In the questionnaire, both items measure the construct "transformation", where the one makes a statement about good ideas and the other about new ideas. The corresponding items e29 and e30 (0.221) were Q83 ("I attend meetings with people from different departments to come up with new ideas") and Q84 ("I develop new insights from knowledge that is available within the business"). Both items fall under ACAP – transformation.

- **Convergent validity**

Based on the correlation results of model 1, illustrated in Table 6.34, it is evident that certain constructs and items were highly correlated (between 0.822 and 0.926), indicating poor discriminant validity.

Table 6.34: AVE analysis - EACAP

	Rho vc = AVE	AVE with Items deleted	Joreskog rho = CR
Recognition	0.452	-	0.712
Assimilation	0.662	-	0.854
Transformation	0.478	-	0.783
Exploitation	0.727	-	0.889

AVE was applied and convergent validity was achieved for assimilation (0.662) and exploitation (0.727), as they tested above 0.5, but not for recognition (0.452) and transformation (0.478). No deletion of items could take place for recognition and transformation as the constructs consisted of only two items. The CRs and Cronbach alphas of all factors exceeded the suggested minimum of 0.70, indicating acceptable reliability (Nunnally, 1978).

Fornell-Larcker Criterion

The AVE of each construct did not exceed its correlations with all the other measurement model factors, indicating no/poor discriminant validity (Fornell & Larcker, 1981), a direct result of multicollinearity present. The squared correlations of assimilation and recognition are 0.564, transformation and assimilation (0.663), and exploitation and transformation (0.0.835).

Heterotrait-Monotrait Approach

As a second measure, HTMT analysis was conducted to determine discriminant validity.

As shown in Table 6.35, all the values associated with the constructs of the measurement model met the criteria and threshold of below 0.85.

Table 6.35: HTMT analysis – EACAP

	Recognition	Assimilation	Transformation	Exploitation
Recognition				
Assimilation	0.635			
Transformation	0.716	0.835		
Exploitation	0.819	0.599	0.798	

Based on the HTMT analysis, discriminant validity was achieved for recognition and assimilation (0.635), recognition and transformation (0.716), recognition and exploitation (0.819), assimilation and transformation (0.835), assimilation and exploitation (0.599) and transformation and exploitation (0.798), as the results were all below 0.85 (Anderson *et al.*, 2010; Hair *et al.*, 2014).

As each of the constructs of EACAP was considered to be important to retain in the model, it was decided, based on the results of the measurement model and discriminant validity results, to determine if a second-order model would be sufficient to represent the EACAP structure.

6.4.2.3 Second-order model

High-order constructs allow an examination of the relative strengths of lower-order constructs. The structural path coefficients (standardised) can represent how reliability of each of the lower-order constructs reflects the higher-order construct and how important they are. A higher-order factor further provides the flexibility to encompass additional factors as lower levels when needed (Hong & Thong, 2013:281). A higher-order model is more parsimonious (it consumes fewer degrees of freedom), thus should perform better on indices that reflect parsimony (Hair *et al.*, 2019:735).

The target coefficient (T) is used, the ratio of the chi-square value from the first-order model to that of the second-order model. T has an upper limit of 1.0 when the covariance among the first-order factors is completely accounted for by the second-order model, and a value of 0.90 or greater suggest that the higher-order factor provides a good explanation for correlations between the lower-order factors (Marsh & Hocevar, 1985).

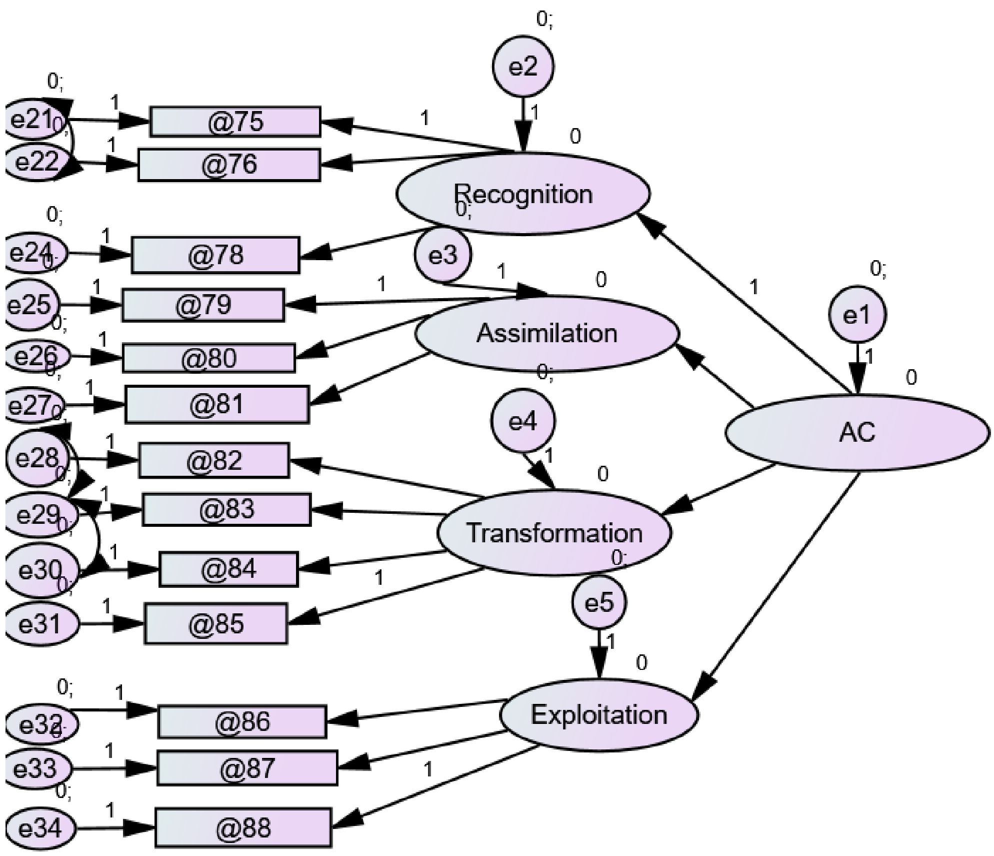


Figure 6.33: Second order model with respect to factors underlying EACAP

The model represents a second-order factor model with four lower-order components and one higher-order component (AC) (Hong & Thong, 2013:281). In Figure 6.33, the model was presented using Q75-Q88 for the observed variables, for the error terms associated with observed variables and recognition, assimilation, transformation and exploitation as latent variables. Item Q77 was considered for deletion after model 1 was fitted to the data with a factor loading of 0.444.

Table 6.36: Second order measurement model for EACAP

Model	CMIN (χ^2)
Model (second order)	332.913
Model (first order)	300.8

CMIN χ^2 in the second-order model was determined with a target coefficient of 90.4% (300.8/332.9).

Based on theoretical support for the second-order model, the results suggest that EACAP may be a higher-order construct. Structural theory specifies the latent constructs (recognition, assimilation, transformation and exploitation) in the theoretical SEM model and their relationships (Hair *et al.*, 2019:774). The output for the model presenting the standardised regression weights and correlations for the EACAP second-order model is displayed in Appendix I.

6.4.3 Results of the factor analysis: Innovation Capacity

6.4.3.1 Exploratory factor analysis: IC

EFA was applied to each of the five sub constructs of IC (newness = 7-items, radicalness = 2-items, uniqueness and superiority = 6-items, innovation = 4-items, competitive advantage = 3-items). The KMO value for 1) newness was 0.872, 2) radicalness, 0.500, 3) uniqueness and superiority, 0.871, 4) innovativeness, 0.871, and 5) competitive advantage, 0.501, exceeding the minimum value of 0.5 (Hair *et al.*, 2019; Kaiser, 1970; Kaiser, 1974; Pallant, 2011; Tabachnick *et al.*, 2007), except for competitive advantage. The Bartlett's test of sphericity (Bartlett, 1954) showed statistical significance $p < 0.001$, supporting the factorability of the correlation matrix.
The PAF method revealed the uni-dimensionality for each of the five sub constructs, all eigenvalues exceeding 1. The eigenvalue for factor 1 was 4.072, explaining 52.2% of the variance, factor 2, 1.566 with 56.6% of the variance, factor 3, 4.225, with 64.7%

of the variance, factor 4, 3.188, with 73,1% of the variance and factor 5, 1.687 with 47.6% of the variance explained. The factors were therefore retained for rotation.

To aid in the interpretation and scientific utility of these two factors, promax rotation with Kaiser Normalisation was performed. Table 6.37 indicates the communality estimates and the factor loadings as indicated in the pattern matrix.

Table 6.37: Factor loadings and communality estimates from the EFA for the factors representing innovation capacity

Innovation Capacity				
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings Factor 1**
Newness	Q89. The customers/potential customers are totally new to the business.	0.341	52.2%	0.584
	Q99. The class of the product/service is totally new to the business.	0.604		0.777
	Q91. *It is an improvement/modification of an existing product/service.	0.138		0.372
	Q92. The exploited technology is totally new to the business.	0.642		0.801
	Q93. The production process is totally new to the business.	0.660		0.812
	Q94. The competitive environment is totally new to the business.	0.618		0.786
	Q95. The product use (need served) is totally new to the business.	0.655		0.809
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings Factor 1**
Radicalness	Q96. The product/service is unlike any other.	0.566	56.6%	0.752

	Q97. The product/service requires users to change their ways.	0.566		0.752
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings**
				Factor 1
Uniqueness and Superiority	Q98. It has a better "service outcome" than competitors' (end result).	0.703	64.7%	0.839
	Q99. It has unique benefits and features – perceived as superior to those of competitors.	0.680		0.824
	Q100. In terms of quality, the product/service provides a faster or more efficient service.	0.674		0.821
	Q101. In terms of quality, the product/service provides a more reliable service (fewer fail points).	0.658		0.817
	Q102. It has developed a "high quality" image.	0.457		0.661
	Q103. In terms of quality, it has better value than previously available products/service.	0.665		0.850
Construct	**Item**	**Communalities**	**Variance explained**	**Loadings**
				Factor 1
Innovativeness	Q104. It is a highly innovative product/service – there is nothing like it (it replaces the inferior alternative).	0.746	73.1%	0.864
	Q105. It follows an innovation strategy rather than a follower strategy.	0.764		0.874
	Q106. It has radical changes rather than subtle differences.	0.794		0.891
	Q107. The product technology is new to the customer.	0.618		0.786

Construct	Item	Communalities	Variance explained	Loadings
				Factor 1
Competitive advantage	Q108. The extent of patent protection	0.497	47.6%	0.705
	Q109. The extent of licence protection	0.928		0.963
	Q110. The ease of competitive duplication	0.004		No loading

*Extraction method: Principal axis factoring

Rotation method: Promax with Kaiser Normalisation

The communalities of all of the items, except for Q91 (0.138), demonstrated factor loadings of more than 0.30 and were therefore retained for further analysis.

Table 6.38 indicates that factors of newness (0.875), radicalness (0.723), uniqueness and superiority (0.916) and innovativeness (0.913) demonstrated acceptable internal consistency as illustrated by Cronbach's alpha coefficients. Competitive advantage (0.526) tested below the threshold of 0.6 (Perry *et al.*, 2004:363-364).

Table 6.38: Reliability statistics for the IC factors

		Number of items	Cronbach's alpha
F1	Newness	7	0.875
F2	Radicalness	2	0.723
F3	Uniqueness and superiority	6	0.916
F4	Innovativeness	4	0.913
F5	Competitive advantage	3	0.526

Table 6.39 reflects the descriptive statistics for the factors representing IC that were identified as a result of EFA.

Table 6.39: Descriptive statistics for the factors representing IC

		Mean*	Median	Std. deviation	Skewness	Kurtosis
F1	Newness*	4.4849	4.5833	-0.263	-0.263	-0.618
F2	Radicalness*	4.4923	4.5000	-0.343	-0.343	-0.830
F3	Uniqueness and superiority*	5.6475	6.0000	-1.070	-1.070	1.426
F4	Innovativeness*	3.8037	4.0000	-1.331	-1.331	4.171
F5	Competitive advantage**	3.6158	3.3333	0.275	0.275	-0.482

*The scale consists of a Likert-scale measuring 1 = strongly disagree up to 7=strongly agree

**The scale consists of a Likert-scale measuring 1 = low 4 = moderate and 7 = high

A higher mean score indicates a stronger agreement with the factor. The average mean score levels of the respondents in terms of factors F1 and F2 tend to be towards neutral to somewhat agreement, with newness (mean score = 4.48) and radicalness (mean score = 4.49), in particular, regarding uniqueness and superiority of their products or services (mean score = 5.65), which tended towards agreement. The mean level of agreement of the respondents regarding innovativeness (mean = 3.80) and competitive advantage (mean = 3.62) tended towards somewhat agreement. Regarding data normality, skewness ranged between -1.070 and 0.275, while kurtosis ranged from -0.830 and 4.171.

The correlations between the variables reported with levels of significance are denoted as depicted in Table 6.40.

Table 6.40: The correlations for the innovation capacity variables

	Radicalness	Newness	Innovation	Competitive Advantage	Uniqueness and Superiority
Radicalness	1				
Newness	.592**	1			
Innovation	.167**	.131**	1		
Competitive Advantage	.356**	0.255**	-0.005	1	
Uniqueness and Superiority	.550**	.385**	-0.007	.326**	1

*Significance at the 5% level (p<0.05), ** Significance at the 1% level (p<0.01).

The descriptive statistics and correlations of the IC variables are presented in tables 6.39 and 6.40, respectively. The results indicated that statistically significant relationships existed at the 1% level ($p<0.01$) between all combinations of IC variables, except between competitive advantage and innovation, and between uniqueness and superiority and innovation. The value of the correlation coefficient varied between -0.005 and 0.592, indicating very weak negative relationships to positive moderate relationships between newness and radicalness (0.592) and uniqueness and superiority and radicalness (0.550). There were positive modest relationships between competitive advantage and radicalness (0.365), competitive advantage and newness (0.255), uniqueness and superiority and newness (0.385) and uniqueness and superiority and competitiveness (0.326). However, negative very weak relationships were indicated between competitive advantage and innovation.

The results of the confirmatory factor analysis conducted for the IC measurement model are reported next.

6.4.4.2 Confirmatory factor analysis: IC

The measurement model for IC, categorised as newness, radicalness, networking, innovativeness and competitive advantage found in exploratory research, was fitted to the data. The IC model is illustrated and discussed next.

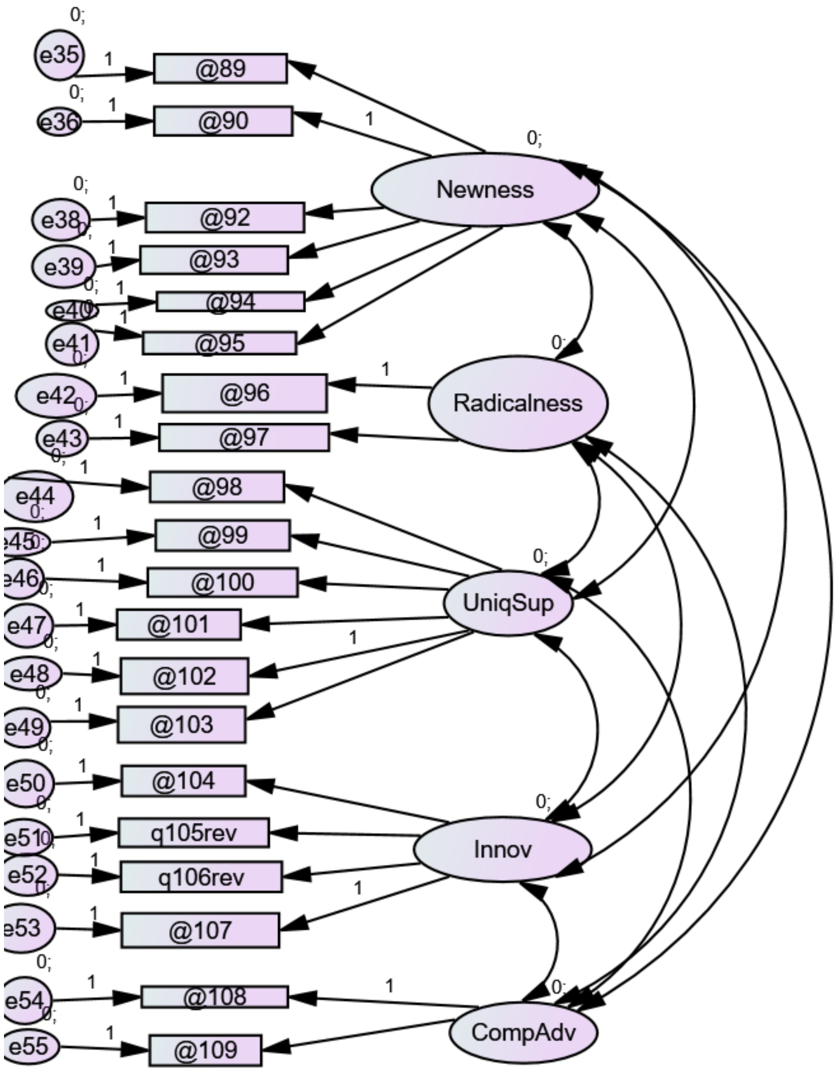


Figure 6.34: Model with respect to factors underlying IC

In Figure 6.34, the model was presented using Q89-Q90, Q92-Q95 (newness), Q96-Q97 (radicalness), Q98-Q103 (uniqueness and superiority), Q104-Q107 (innovation) and Q108-Q109 (competitive advantage) for the error terms associated with observed variables. Items Q91and Q110 were considered for deletion due to low factor loadings (<0.5).

Table 6.41 provides the goodness-of-fit indices of the measurement model, representing the IC values of innovative entrepreneurs.

Table 6.41: Goodness-of-fit indices of the CFA measurement model for IC

Model	CMIN (χ^2)	df	P	CMIN/df	RMSEA	CFI	TLI	IFI	SRMR
Model 1	597.324	160	0.000	3.733	0.078	0.930	0.917	0.931	0.0409
Indicate acceptable fit	-	-	-	<3 or <5	$\leq$ 0.08	$\geq$ 0.90	$\geq$ 0.90	> 0.90	<0.08

The model fit statistics indicated acceptable fit indices with RMSEA (0.078) values between 0.05 and 0.08; CFI (0.9930), TLI (0.917) and IFI (0.931) all tested above the 0.9, and the CMIN/df (3.733) was below 5 (Schumacker & Lomax, 2004). The output for the model presenting the standardised regression weights and correlations for IC is displayed in Appendix I.

Average Variance Extracted (AVE)

The AVE values were used in the assessment of confirmed discriminant convergent validity, as results tested were all above 0.5, indicating that there was no error in the items with the latent factor upon which they loaded. The CRs and Cronbach alphas of all factors exceeded the suggested minimum of 0.70, indicating acceptable reliability (Nunnally, 1978).

Table 6.42: AVE analysis - IC

	Rho vc = AVE	Joreskog rho = CR
Newness	0.577	0.889
Radicalness	0.584	0.735
Uniqueness and Superiority	0.617	0.905
Competitive Advantage	0.691	0.816
Innovation	0.732	0.916

Fornell-Larcker Criterion

As shown in Table 6.42, discriminant validity is confirmed between the latent constructs in this measurement model. Furthermore, each construct's AVE exceeded the squared correlations with the other measurement model factors. The squared correlations of radicalness and newness are 0.501, uniqueness and superiority and radicalness 0.491, competitive advantage and uniqueness and superiority 0.137 and innovation and competitive advantage 0.567, indicating good discriminant validity (Fornell & Larcker, 1981).

Heterotrait-Monotrait Approach

As a second measure, HTMT analysis was conducted to determine discriminant validity. As shown in Table 6.43, all the values associated with the constructs of the measurement model meet the criteria and threshold of below 0.85, except for the innovation construct (Clark & Watson, 1995; Kline, 2015). The NaN (not a number) message can indicate division of two values very close to zero. However, as the Fornell-Larcker criteria indicated discriminant validity for all constructs, the non-availability of a number in the HTMT analysis is not of concern.

Table 6.43: HTMT analysis – IC

	Newness	Radicalness	Uniqueness and Superiority	Innovation	Competitive Advantage
Newness					
Radicalness	0.725				
Uniqueness and Superiority	0.380	0.674			
Innovation	NaN	NaN	NaN		
Competitive Advantage	0.286	0.467	0.379	NaN	

***HTMT Warnings**

There are no warnings for this HTMT analysis.

As each of the constructs of IC was considered to be important to retain in the model, it was decided, based on the results of the measurement model and discriminant +validity results, as well as simplification of the model, to determine if a second-order model would be sufficient to represent the IC structure.

6.4.4.3 Second-order model

Figure 6.35 depicts a CFA model where a second-order factor (IC) is introduced.

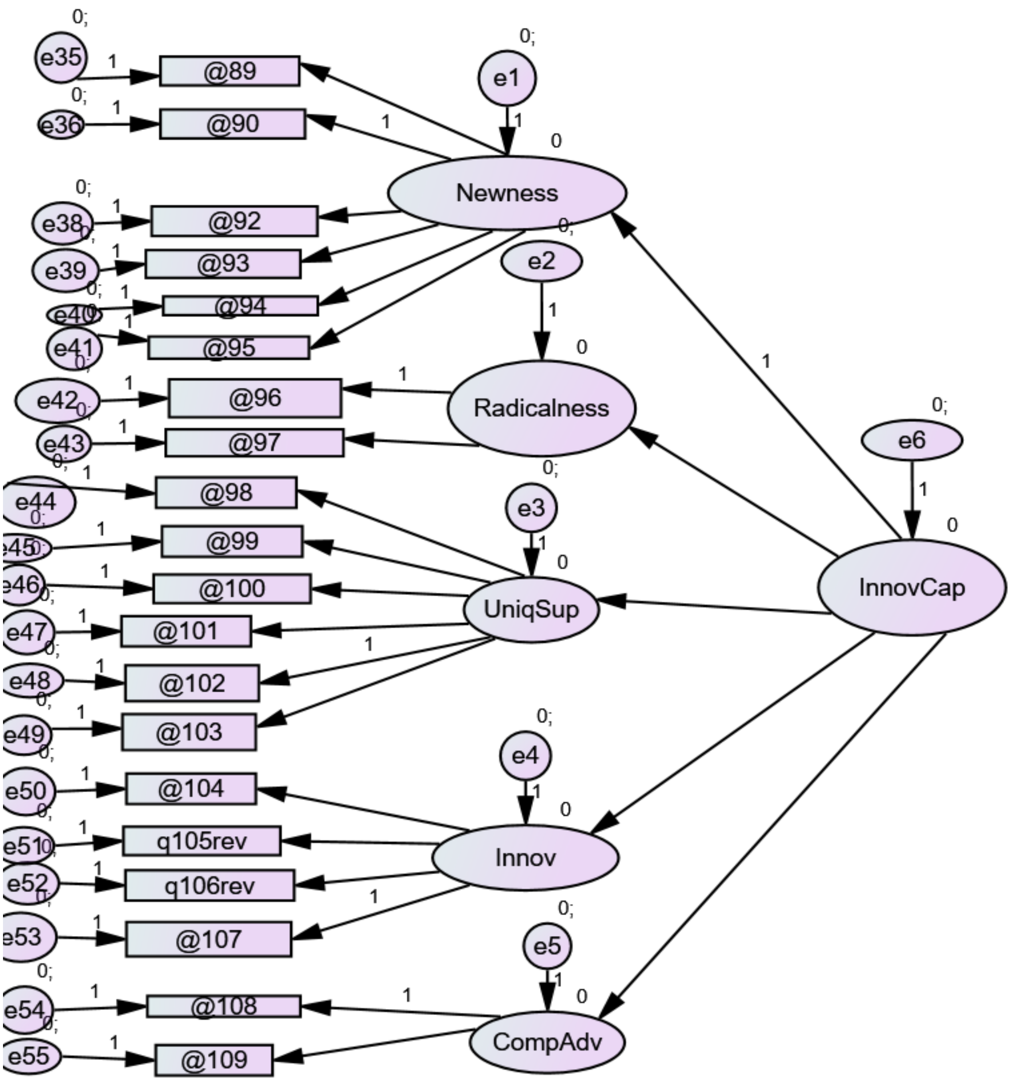


Figure 6.35: Second order model with respect to factors underlying IC

The model represents a second-order factor model with five first-order factors (Hong & Thong, 2013:281).

Table 6.44: Second order measurement model for IC

Model	CMIN (χ^2)
Model (second order)	638.708
Model (first order)	-597.3

The target coefficient CMIN (χ^2) ratio was determined with a target coefficient of 93.5% (597.3/638.708). The output for the model presenting the correlations for IC second-order model is displayed in Appendix I.

6.5 CONCLUSION

The first two stages of the data analysis (refer to Figure 6.1), the descriptive statistics and the factor analysis were presented in this chapter. The chapter was organised to address the descriptive statistics and the validity and reliability of the constructs. The techniques and methods discussed in Chapter 5 have been useful in analysing and interpreting the data. The main results emanating from this chapter are synthesised below:

- The chapter presented biographic information of the respondents. A considerably larger ratio of male entrepreneurs (75.7%) were observed. The majority of the entrepreneurs participating in the study were between the ages of 51 and 60. The majority of the respondents had a master's degree (19.5%) and were mostly in the white (62%) and black (25.4%) racial categories.
- The socio-demographic profile of the entrepreneurs indicated that the majority of the respondents operated in the manufacturing sector (23.2%). The respondents had mostly established businesses (85%) and most had between 5 to 9 employees (20.4%), with a business turnover of less than R150 000 (19.5%). Overall, the majority of the respondents' businesses were based in the Gauteng province (43.8%).
- Entrepreneurial competencies of innovative entrepreneurs:

  When measuring the individual ECs of innovative entrepreneurs, high levels were generally observed for all the competencies among the respondents. The respondents' competencies tested particularly high for decision-making, proactiveness, creative problem-solving and problem-solving, and measured the lowest for resilience and networking.

- Absorptive capacity of innovative entrepreneurs:
  Based on the entrepreneurs' work experience, most of the entrepreneurs had experience in general management (12.4%). Regarding the entrepreneurs' absorptive capacity, the majority of the respondents are likely to understand new

technology, recognise its market value and bring it into commercialisation. However, slightly more attention should be given to their ability to "transform" knowledge (phase 3), where their ability to develop and refine routines that facilitate the combining of new and existing knowledge could be improved.

- Innovation capacity of innovative entrepreneurs:

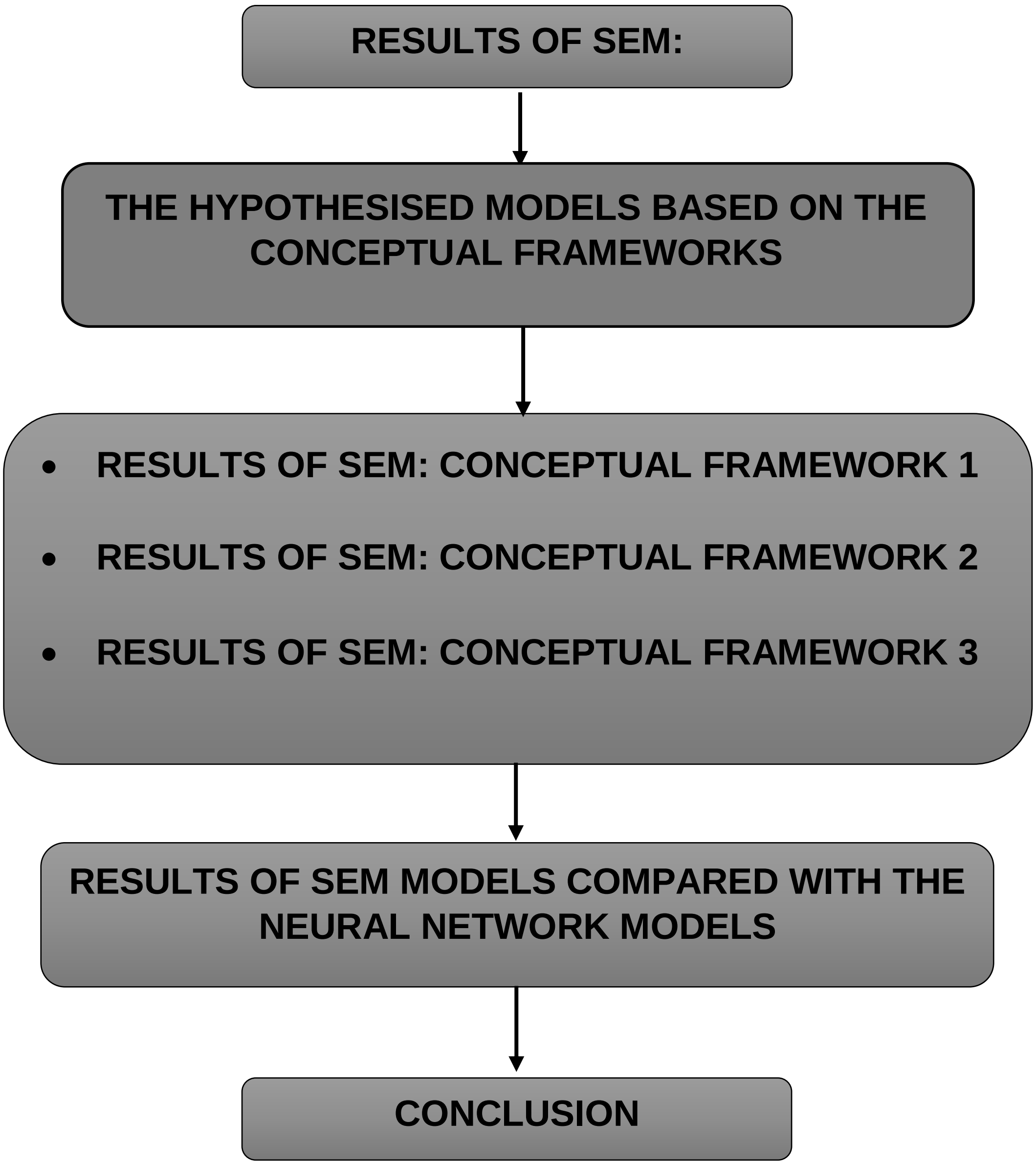
  It is evident that the level of these measures indicated that the respondents have unique and superior businesses, as well as very innovative and radical ones.

This chapter also reported on the factor analyses (EFA and CFA) that were conducted on the three major constructs in the study. It provided information with regard to the construct validity and reliability of the questionnaire. Since all the Cronbach's alpha coefficients reported in this section indicated good reliability, it was possible to continue further analysis of the data. The conceptual frameworks, as outlined in Chapter 4, were tested empirically, and the SEM results are reported in the next chapter (*Stage 3* of the data analysis in Figure 6.1).

CHAPTER 7:

RESEARCH FINDINGS (PART 2): STRUCTURAL EQUATION MODELLING AND NEURAL NETWORK MODEL

DIAGRAMMATIC SYNOPSIS



7.1 INTRODUCTION

To achieve the objectives of this study, the methodological procedure was operationalised in three phases. In *phase 1*, the body of knowledge on entrepreneurial competencies (EC), absorptive capacity (AC) and innovation capacity (IC) was outlined (chapters 2 and 3). In *phase 2*, based on the literature on EC, a concept matrix of ECs was developed (Chapter 2). In *phase 3,* three conceptual frameworks were developed, indicating the possible interrelationships between the constructs (Chapter 4). In this chapter, the three frameworks are tested as the hypotheses outlined in Chapter 5.

The stages of the data analysis used in the present study, illustrated in Figure 6.1 and Stages 1 and 2 (descriptive statistics and factor analysis), were presented in Chapter 6, while stage 3, Structural Equation Modelling (SEM) and Neural Networking (NN), is presented in Chapter 7. This chapter commences with the three hypothesised models of the conceptual frameworks, which are followed by the results of the SEM. The structure and flow of the results of SEM (stage 3 of the data analysis), as reported in this section, are illustrated in Figure 7.1. All of the figures and tables presented in this chapter is produced from the findings of the study and therefore own compilation.

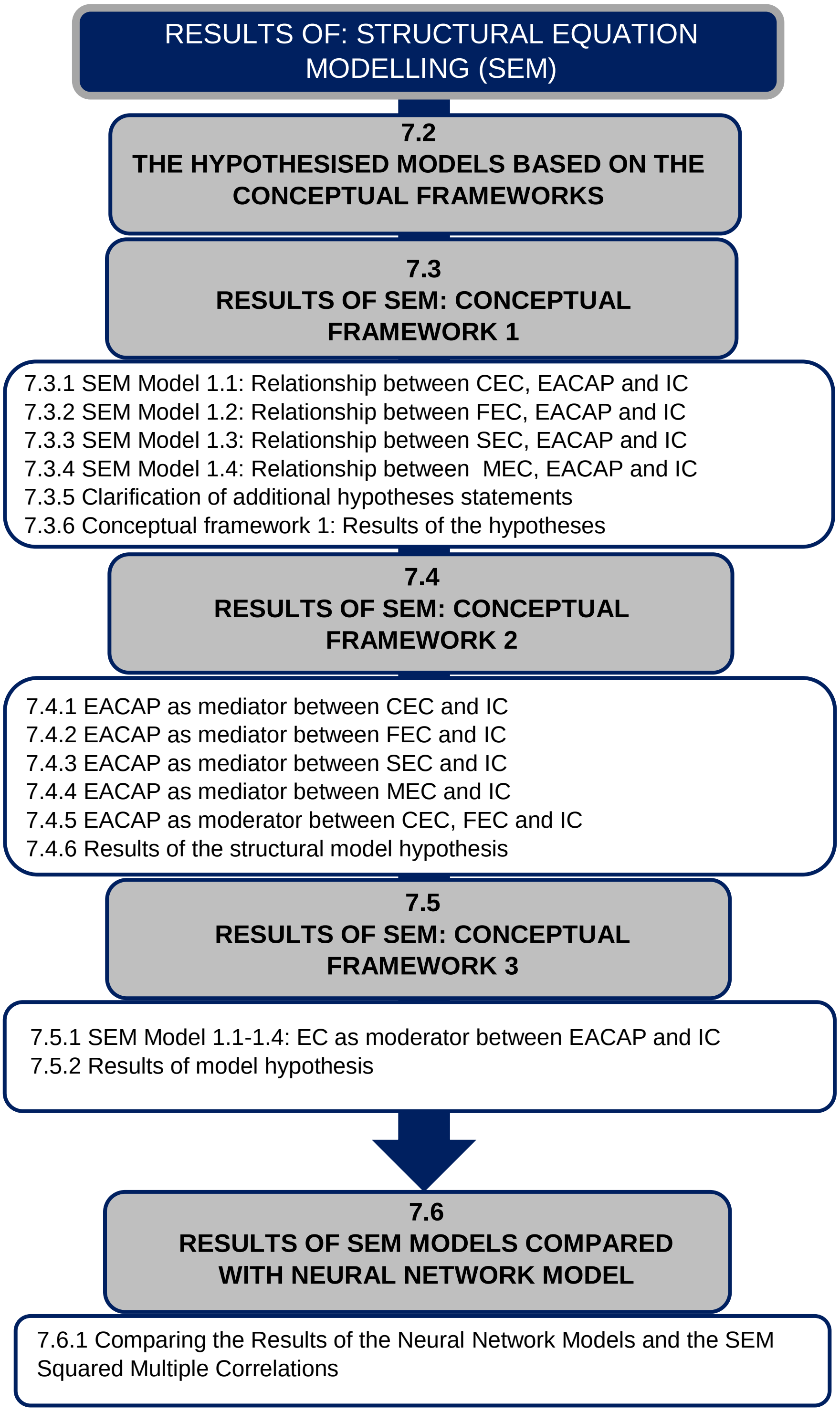


Figure 7.1: Structure and flow of SEM results

Source: Own compilation

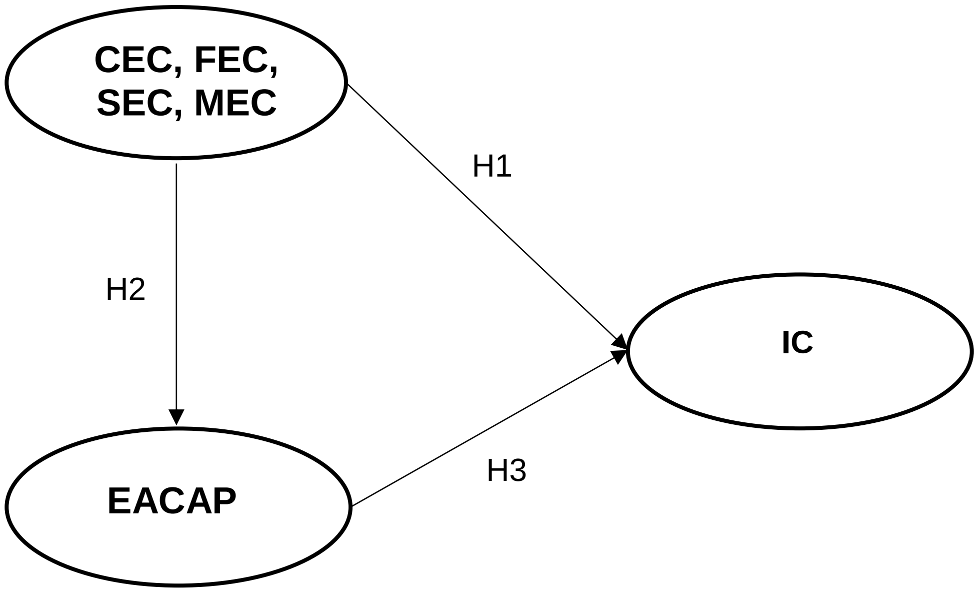
As indicated in Figure 7.1, the SEM results of the three conceptual frameworks of EC, EACAP and IC are discussed in sections 7.2 to 7.4. The hypotheses are tested, leading to the results of the Neural Network model in order to determine whether the testing of non-linear relationships through NN provides an improved model fit over linear relationships tested through SEM. The goodness-of-fit indices discussed in Chapter 5 and the cut-off values presented in each table in this chapter were applied to establish the goodness-of-fit of each SEM model.

This chapter, which deals with the structural models, differs from measurement models in that the emphasis moves from the relationship between latent constructs and measured variables to the nature and magnitude of the relationships between constructs (Hair *et al.*, 2019:702). However, capturing these interaction effects using only SEM, particularly when the effects are complex, might be limiting. Additionally, the investigation of non-linear relationships as a potentially fruitful avenue for enhancing the understanding of IC, is undertaken. Hence, artificial neural networks (ANN) are used (i.e. testing non-linear relationships) as a novel approach to resolving these challenges. This approach has been relatively underutilised in entrepreneurship research, yet has grown in other disciplines and refers to a technique which performs a simplified version of that of human brain neurons in developing pattern recognition (Ansari & Riasi, 2016). ANN is utilised to model ECs, EACAP and IC, and to determine to what extent a non-linear relationship explains IC. In the final part of this chapter, the ANN results are compared with the SEM results in order to compare the explanatory power of ANN (a non-linear approach) with SEM (a linear approach).

The hypothesised models, which are based on the three conceptual frameworks, are discussed next.

7.2 THE HYPOTHESISED MODELS BASED ON THE CONCEPTUAL FRAMEWORKS

The initial hypothesised model was developed based on conceptual framework 1 for EC, EACAP and IC (Refer to Figure 4.1), and is presented in simple form in Figure 7.2. The four SEM models presented in section 7.3 will form the basis of the analysis presented in section 7.4 and 7.5.



EACAP = Entrepreneurial Absorptive Capacity

IC = Innovation Capacity

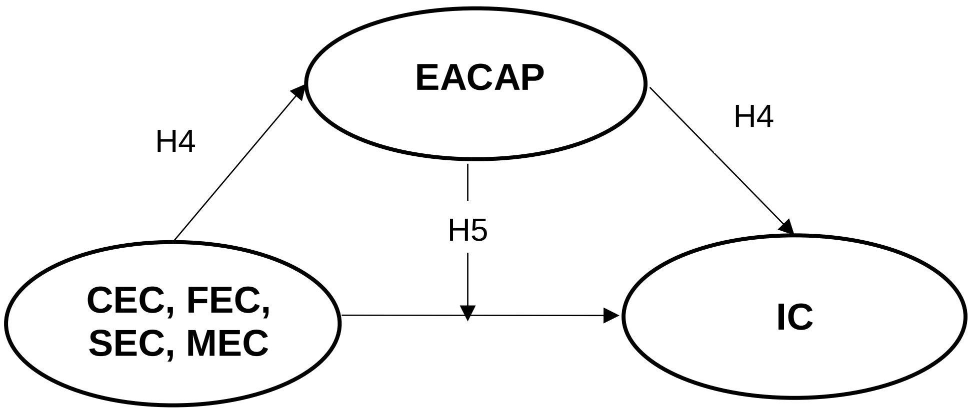
CEC = Cognitive Entrepreneurial Competencies

FEC = Functional Competencies

SEC = Social Competencies

MEC = Meta Competencies

Figure 7.2: Hypothesised model based on conceptual framework 1: Relationships between the constructs



EACAP = Entrepreneurial Absorptive Capacity

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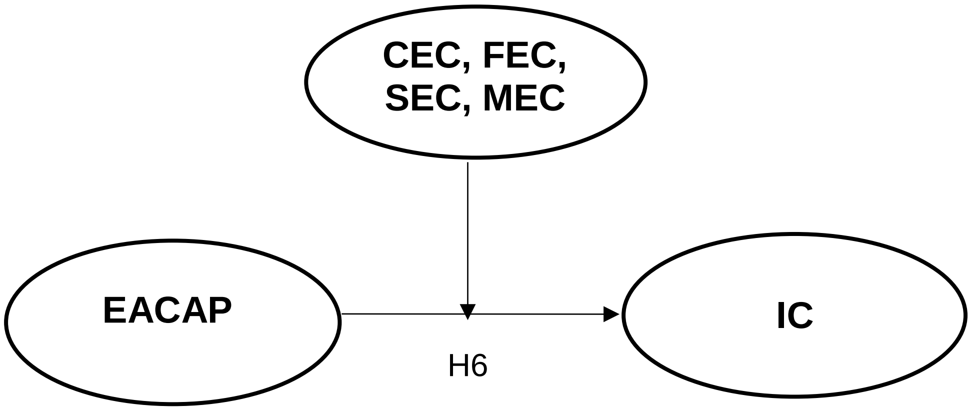
SEC = Social Competencies

MEC = Meta Competencies

Figure 7.3: Hypothesised model based on conceptual framework 2: EACAP as mediator and moderator



EACAP = Entrepreneurial Absorptive Capacity

IC = Innovation Capacity

CEC = Cognitive Entrepreneurial Competencies

FEC = Functional Competencies

SEC = Social Competencies

MEC = Meta Competencies

Figure 7.4: Hypothesised model based on conceptual framework 3: EC as moderator

7.3 RESULTS OF SEM: CONCEPTUAL FRAMEWORK 1

With all the measurement models validated through CFA, the next step was to fit the structural model. SEM was employed to test the structural relationships between the constructs (Hair *et al.*, 2019:700), in particular the relationships between the four EC categories, EACAP and IC.

The results of the model hypotheses (SEM 1.1–1.4) are discussed in section 7.2.5. The relationships in the models represent the research hypotheses set for conceptual framework 1. Figures 7.6 to 7.9 illustrate the results of the SEM model incorporating the structural relationships between the four competence categories, EACAP and IC.

7.3.1 SEM Model 1.1: Relationship between CEC, EACAP and IC

Firstly, the SEM model including the three constructs IC, EACAP and CEC is presented. It consists of six latent constructs: opportunity recognition, decision-making, proactiveness, resilience, creative problem-solving and imaginativeness and innovation/innovating. Secondly, based on the results of model 1 (model fit), goodness-of-fit indices were studied in order to improve model fit, and an improved model 2 was presented.

The visual portrayal of the hypothesised path diagram for CEC is illustrated in Figure 7.5.

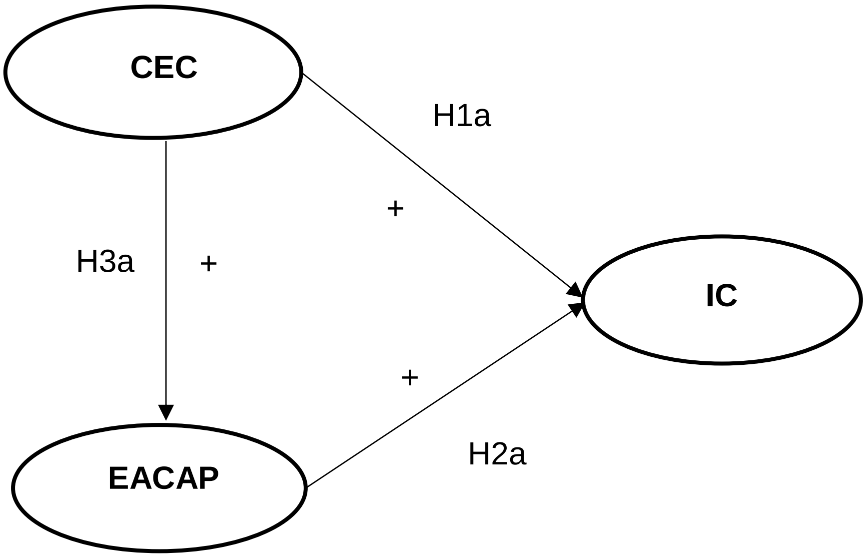


Figure 7.5: Hypothesised path diagram (Cognitive competencies – Model 1.1)

A structural model involves specifying structural relationships between latent constructs (Hair *et al.*, 2014:662). These relationships (paths) in the model represent the research hypothesis that was set in the research methodology. Figure 7.6 illustrates the interrelationships that were indicated between cognitive competence (CEC), EACAP and IC. Furthermore, the figures depict the covariance relationships that were specified between these latent competency variables. The model was then evaluated by the goodness-of-fit indices to test whether the proposed model emulates the sample matrix (Hair *et al.*, 2014:579; Raykov & Marcoulides, 2000:36).

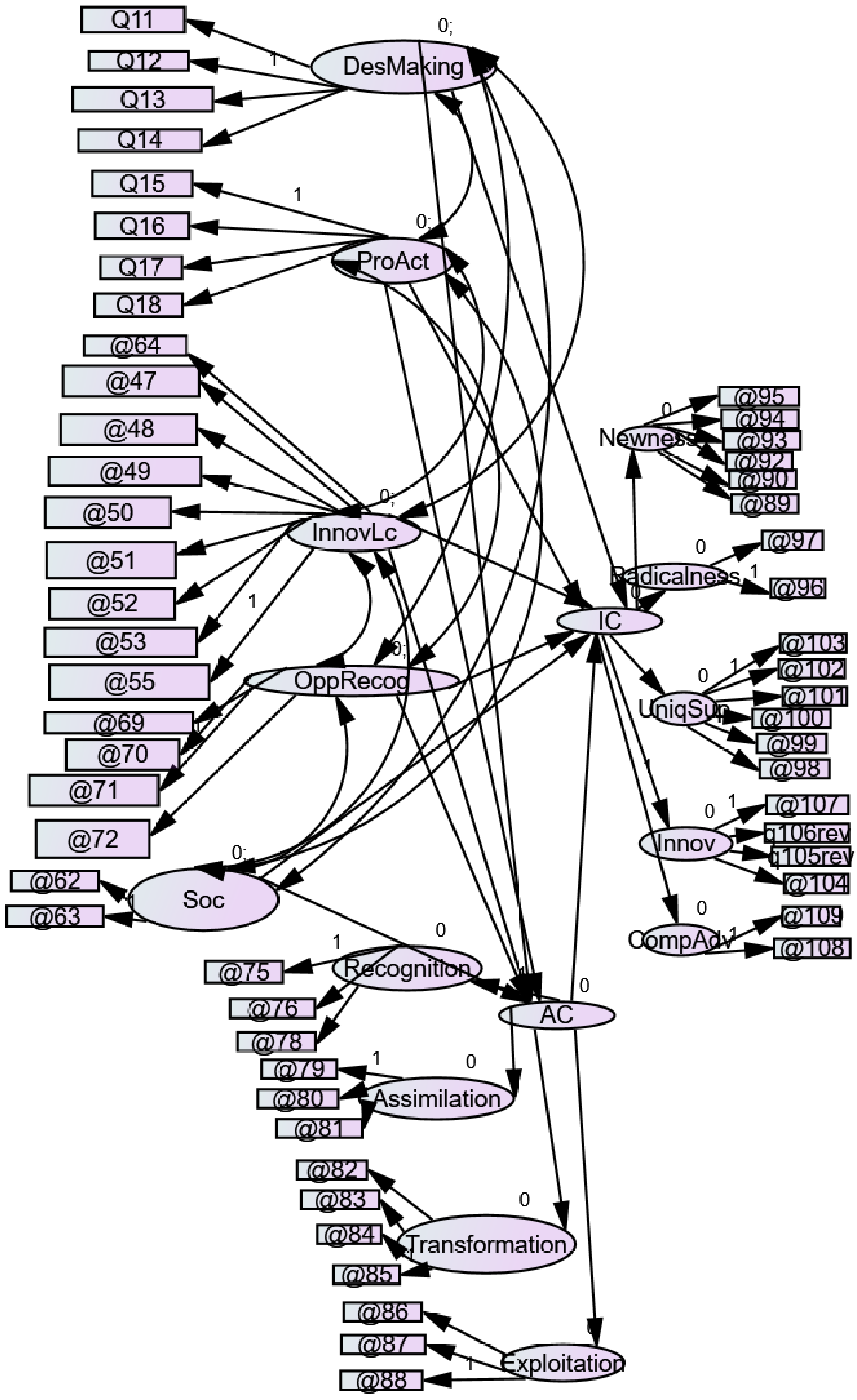


Figure 7.6: SEM model 1.1 as postulated with respect to cognitive competencies

In Figure 7.6, CEC is presented by five latent constructs, while EACAP is represented as a second-order factor by four latent constructs, and IC as a second-order factor by five latent variables. EC: Decision-making is represented by four items (Q11-Q14), proactiveness by four items (Q15-Q18), innovation/innovating by nine items (Q64, Q47-50 and Q51-53, and Q55), opportunity recognition by four items (Q69-72) and use of social support (resilience), by two items (Q62 and Q63). EACAP: recognition is represented by three items (Q75, Q76 and Q78), assimilation is represented by three items (Q79-81), transformation is represented by four items (Q82-Q85) and exploitation is represented by three items (Q86-88). IC: newness was represented by six items (Q89-Q90, Q92-Q95), radicalness is represented by two items (Q96 and Q97), uniqueness and superiority is represented by six items (Q98-Q103), innovation is represented by four items (Q104-Q107), and competitive advantage is represented by two items (Q108 and Q109). Since the model is represented by two or more factors, a minimum of two items per factor is justified for use of social support, radicalness and competitive advantage (Hair *et al.*, 2019; Kline, 2015:201).

Furthermore, the figure depicts the covariance relationships that were specified between the CECs. Table 7.1 provides goodness-of-fit indices of the structural model 1 and improved model 2.

Table 7.1: Goodness-of-fit indices: SEM model 1.1

Model	CMIN (χ^2)	df	P	CMIN/ df	RMSEA	CFI	TLI	IFI	AIC	BCC	SRMR
Model 1	3714.560	1456	0.000	2.551	0.059	0.865	0.858	0.866	4106.560	4163.270	0.0718
Model 2	2929.254	1344	0.000	2.180	0.051	0.901	0.895	0.902	3319.253	3373.420	0.0678
Indicate acceptable fit	-	-	-	<3 or <5	$\leq$ 0.08	$\geq$ 0.90	$\geq$ 0.90	$\geq$ 0.90			<0.08

When the structural model was fitted to the data, the model did not adequately fit the data according to the set of constructs. The RMSEA was good at 0.059, but the CFI (0.865), TLI (0.858) and IFI (0.866) were not above 0.90, indicating that the model fit was not adequate. However, CMIN/df (2.551) fitted the data under the threshold of <3 (Schumacker & Lomax, 2004).

Potential improvement on the model can be made by: (1) deleting items (observed variables) with loadings less than 0.5; (2) deletion of non-statistically significant paths; and (3) studying the modification indices for potential additional covariances, with the condition that these need to be theoretically justified as well. However, it is critically important that these changes are not made purely to improve the model fit statistics and that the model used still portrays the core theoretical model postulated. As no loadings were below 0.5, modification indices were studied, and were theoretically justified (Hair *et al.*, 2014:559). The justification for the error covariances included in model 2 will be discussed after Table 7.3. Item Q82 was removed as a result of a high error covariance value with item Q83 and a better fit result when Q83 remained in the model and Q82 was removed.

When SEM model 2 was fitted to the data, the goodness-of fit supported the structural model. The RMSEA (0.051) indicated acceptable model fit. The CFI (0.901) and IFI (0.902) were all larger than 0.09, and TLI (0.895) very close to that, which provides evidence that the model fitted the data. The CMIN/df value of 2.180 was smaller than 3, which also indicated an acceptable fit and with SRMR (0.0678) below the threshold of <0.08. SEM model 2 provides an improvement over SEM model 1 in representing the relationships between CEC, EACAP and IC of entrepreneurs, as the model fitted the data. Therefore, the relationships indicated in SEM model 2 (Figure 7.6) were interpreted and also represented in the research hypothesis that was set for conceptual framework 1 (see Table 5.7, summary of the research hypothesis).

Based on the probability level of 0.05, the C.R. needs to be >± 1.96 before the hypothesis that the estimate equals zero can be rejected. According to Byrne (2016:85), estimates with non-significant CR values need to be considered for deletion. For the purpose of this study, an individual item loading of >0.5 for the latent constructs is regarded as acceptable (Byrne, 2016:256).

The unstandardised and standardised regression weights (structural path estimates) of SEM model 2 are presented in Table 7.2.

Table 7.2: Structural path coefficients: Structural model 2 (with CEC)

Relationships			Standardised regression weights	P	Label
AC	<---	Decision-making	-0.052	0.448	
AC	<---	Proactiveness	0.154	0.070	A
AC	<---	Innovation/Innovating	0.554	***	
AC	<---	Opportunity recognition	0.311	***	
AC	<---	Use of social support	0.069	0.080	A
IC	<---	AC	0.058	0.680	
IC	<---	Decision-making	-0.207	0.064	A
IC	<---	Proactiveness	0.045	0.741	
IC	<---	Innovation/Innovating	0.268	0.053	A
IC	<---	Opportunity recognition	0.250	0.007	**
IC	<---	Use of social support	-0.034	0.591	

*** Significance at 0.1% level of significance (p-value < 0.001)

** Significant at 1% level of significance (p-value < 0.01)

* Significant at 5% level of significance (p-value < 0.05)

'A' Significant at 10% level of significance (p-value < 0.1)

The results reported in Table 7.2 indicate that the relationship between proactiveness and AC (in short for EACAP) is positively weak and statistically significant only at the 10% level of significance (β= 0.154; p < 0.1). The relationship is positive and large (strong) between innovation and AC (β = 0.554; p < 0.001) and highly statistically significant with a positive and modest effect of opportunity recognition on AC (β = 0.311; p < 0.001). The relationship between use of social support and AC (β = 0.069; p < 0.1) is positive and weak and statistically significant only at the 10% level of significance on AC. However, decision-making had a negative, very weak relationship with AC and the relationship was not statistically significant (β = -0.052; p = 0.448). This indicates that four of the five CECs had a statistically significant positive effect on entrepreneurial absorptive capacity.

The relationship between AC on IC was positive, but very weak and not statistically significant (β = 0.058, p = 0.680).

The effect of the CECs on IC was statistically significant for three of the five CECs. The sizes and direction of the coefficients decision-making indicated a negative, weak relationship with IC, but statistically significant at the 10% level of significance (β = -0.207, p < 0.1); there was an insignificant and modest negative relationship between the use of social support coefficient and IC (β = -0.034, p = 0.591), a positive weak relationship between proactiveness and IC (β = 0.045, p = 0.741), and statistically significant at the 10% level of significance, and modest relationships between innovation/innovating (β = 0.268, $p < 0.1$), opportunity recognition (β = 0.250, $p < 0.01$) and IC.

Table 7.3 depicts the correlations between the variables for SEM model 2, which included a total of 10 tested covariances between the latent competencies and five added covariances.

Table 7.3: Structural parameter estimates: correlations of the final SEM model 1.1

Correlations			Estimate
Decision-making	<-->	Proactiveness	0.813
Decision-making	<-->	Innovation/innovating	0.442
Decision-making	<-->	Opportunity recognition	0.310
Use of social support	<-->	Decision-making	0.164
Proactiveness	<-->	Innovation/innovating	0.616
Proactiveness	<-->	Opportunity recognition	0.357
Use of social support	<-->	Proactiveness	0.269
Innovation/innovating	<-->	Opportunity recognition	0.707
Use of social support	<-->	Innovation/innovating	0.372
Use of social support	<-->	Opportunity recognition	0.230
e47	<-->	e46	0.478
e48	<-->	e49	0.351
e16	<-->	e15	0.271
e24	<-->	e22	-0.495
e14	<-->	e15	0.315

Table 7.3 shows that the residual error terms in Model 2, e47 and e46 (0.478); e48 and e49 (0.351); e16 and e15 (0.271); e24 and e22 (-0.495); and e14 and e15 (0.315) were correlated.

The corresponding items of e47 and e46 were Q101 ("In terms of quality, the product/service provides a more reliable service (fewer fail points)" and Q100 ("In terms of quality, the product/service provides a faster or more efficient service"). Both items refer to the quality of the product/service and were part of the original uniqueness and superiority construct. It is therefore reasonable to co-vary these error terms.

The same argument could be followed for e48 and e49, which correspond to items Q102 ("It has developed a 'high quality' image") and Q103 ("In terms of quality, it has better value than previously available products/services"). In the questionnaire, both items are measured under the construct "uniqueness and superiority".

The corresponding items of e16 and e15 were Q53 ("I improve existing products and services") and Q52 ("I generate new innovations that differ from competitors' offering"). In this case, both items refer to innovation, thus the correlated errors seem sensible.

The corresponding items e24 and e22 were negatively correlated/not correlated (-0.49 5) with Q78 ("I easily identify what new knowledge is most valuable for the business") and Q76 ("I intentionally search for knowledge in many different domains by looking 'outside the box'"). Both items are categorised under EACAP – recognition.

Lastly, corresponding constructs e14 and e15 were Q51 ("Originality is very important to me") and Q52 ("I generate new innovations that differ from competitor's offering"). In the original questionnaire, Q51 was originally measured under the construct "creative problem-solving and imaginativeness" after the items were combined with "innovation/innovating". However, both items refer to innovation, explaining the correlation between the items. It may therefore be argued that there is theoretical justification for the covariance between the error terms in the structural model.

Based on the goodness-of-fit indices presented in Table7.1, structural model 2 had an adequate fit. Overall, it could therefore be concluded that the observed data fits the structural model.

7.3.2 SEM Model 1.2: Relationship between FEC, EACAP and IC

In the previous section, the results of SEM model 1.1 suggested that a relationship existed between CEC, EACAP and IC. In this section, the interrelationship between functional competencies (FEC), EACAP and IC was considered. The visual portrayal of the hypothesised path diagram for FEC is illustrated in Figure 7.7.

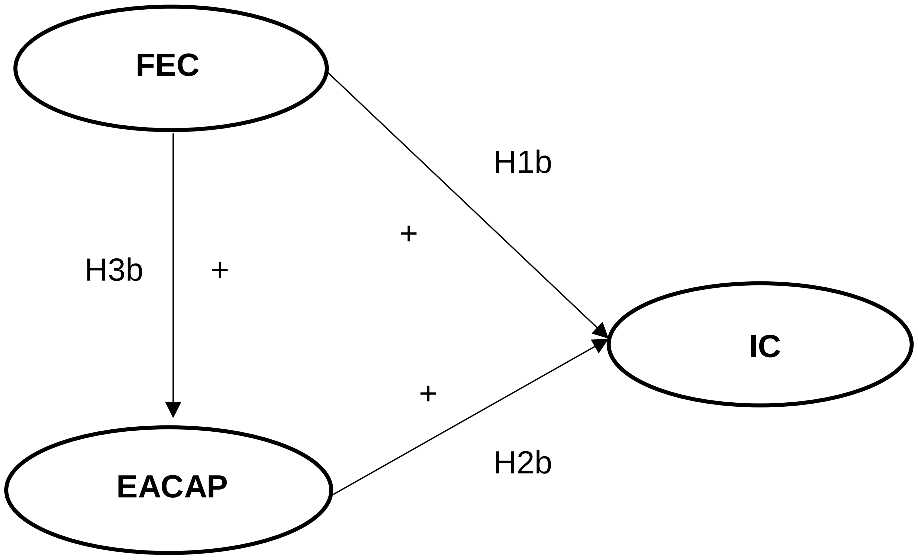


Figure 7.7: Hypothesised path diagram (Functional competencies – Model 1.2)

Figure 7.8 illustrates the relationships that were indicated between FEC, EACAP and IC. Furthermore, the figure depicts the relationships that were specified between these latent competency variables. The model was then evaluated by the goodness-of-fit indices to test whether the proposed model emulates the sample matrix (Hair *et al.*, 2014:579; Raykov & Marcoulides, 2000:36).

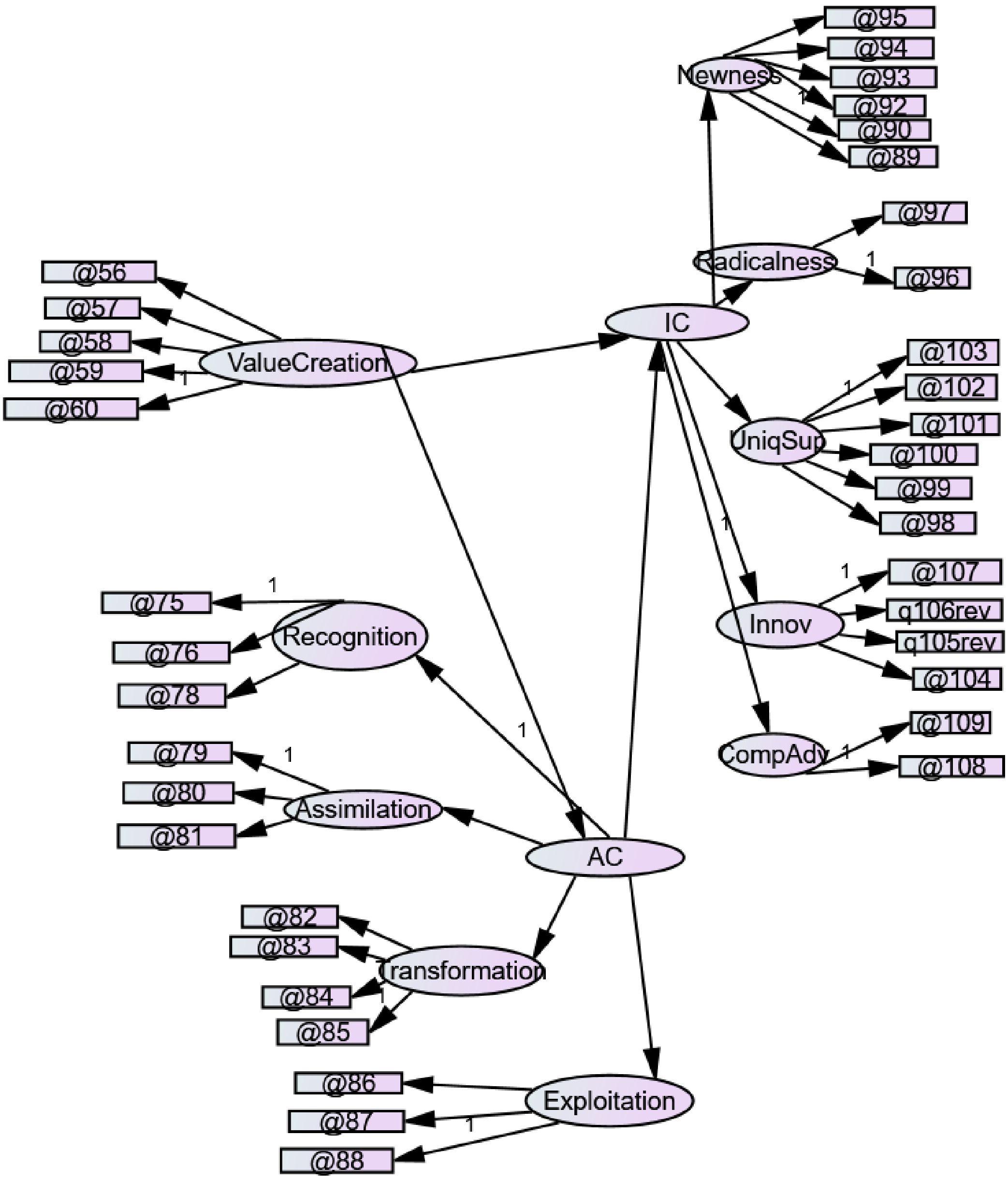


Figure 7.8: SEM Model 1.2 as postulated with respect to functional competencies

In Figure 7.8, the model presenting FEC is presented by one latent variable, while EACAP is represented as a second-order factor by four latent variables and IC as a second-order factor by five latent variables. EC: Value creation, a single factor which requires at least three indicators (Kline, 2015:201), is represented by five items (Q56-Q60). EACAP: recognition is represented by three items (Q75, Q76 and Q78), assimilation is represented by three items (Q79-81), transformation is represented by four items (Q82-85) and exploitation is represented by three items (Q86-88). IC: newness is represented by six items (Q89,Q90, Q92-Q95), radicalness is represented by two items (Q96 and Q97), uniqueness and superiority is represented by six items (Q98-Q103), innovation is represented by four items (Q104-Q107), and competitive advantage is represented by two items (Q108 and Q109) (Hair *et al.*, 2019:668; Kline, 2015:201). Since the model is represented by two or more factors, a minimum of two items per factor is justified for radicalness and competitive advantage (Hair *et al.*, 2019; Kline, 2015:201). Table 7.4 provides goodness-of-fit indices of the structural Model 1.2.

Table 7.4: Goodness-of-fit indices: SEM Model 1.2

Model	CMIN (χ^2)	df	P	CMIN/df	RMSEA	CFI	TLI	IFI	AIC	BCC	SRMR
Model 1	2109.739	653	0.000	3.231	0.070	0.876	0.867	0.877	2285.739	2647.74	0.0702
Model 2	1725.805	649	0.000	2.659	0.061	0.908	0.901	0.909	1909,805	1927.222	0.0678
Indicate accept-able fit	-	-	-	<3 or <5	$\leq$ 0.08	$\geq$ 0.90	$\geq$ 0.90	$\geq$ 0.90			<0.08

When SEM Model 1 was fitted to the data, the goodness-of fit indices did not support the structural model adequately. The RMSEA (0.070) and SRMR (0.0702) indicated acceptable model fit. The CFI (0.876), TLI (0.867) and IFI (0.877) did not provide evidence that the model fitted the data as they were below the threshold of 0.9. The CMIN/df value of 3.231 was larger than 3, but still smaller than 5 (Schumacker & Lomax, 2004).

Improvement on the model was made by adding additional covariances, with the condition that these needed to be theoretically justified, with the core theoretical model still postulated. As no loadings were below 0.5, modification indices were studied, and were theoretically justified (Hair *et al.*, 2014:559). The justification for the error covariances included in Model 2 will be discussed after Table 7.6.

In Table 7.4, it is evident that, for Model 2, the RMSEA was good at 0.061, which is below the threshold of 0.08. The CMIN/df value of 2.659 is less than the recommended value of 3. CFI (0.908), TLI (0.901) and IFI (0.909) values for this model are more than the recommended 0.90. The SRMR (0.0678) tested below the recommended threshold of 0.08. Therefore, this model is deemed an acceptable model fit and adequately fitted the data according to the set of constructs. The results of the standardised regression weights (path coefficients), indicating the strengths of the individual relationships, are illustrated in Table 7.5.

Table 7.5: Structural path coefficients: Structural Model 2 (with FEC)

Relationships			Standardised regression weights	P	Label
AC	<---	Value Creation	0.812	***	
IC	<---	AC	0.113	0.268	
IC	<---	Value Creation	0.358	0.001	**

*** Significance at 0.1% level of significance (p-value < 0.001)

** Significant at 1% level of significance (p-value < 0.01)

* Significant at 5% level of significance (p-value < 0.05)

'A' Significant at 10% level of significance (p-value < 0.1)

An individual item loading of >0.5 to the latent constructs was achieved and is regarded as acceptable (Byrne, 2016:256).

The relationship between value creation, the only FEC, and AC (short for EACAP) was statistically significant, indicating a positive very strong relationship (β= 0.812, p < 0.001). The relationship between AC and IC was not statistically significant and indicated a positive very weak relationship (β = 0.113, p = 0.268). The relationship between value creation and IC was statistically significant, with a positive and moderate effect of value creation on IC (β = 0.358, p = < 0.01).

Table 7.6 depicts the correlations between the variables for SEM Model 2, which included a total of four added error covariances between the latent competencies and four added covariances.

Table 7.6: Structural parameter estimates: correlations of the final SEM Model 1.2

Correlations			Estimate
e70	<-->	e71	0.464
e47	<-->	e46	0.477
e29	<-->	e28	0.588
e48	<-->	e49	0.351

Table 7.6 showed that the residual error terms e70 and e71 (0.474), e47 and e46 (0.477), e29 and e28 (0.588), and e48 and e49 (0.351) were correlated.

The covariances showed that the measurement errors e70 and e71 were correlated. The corresponding items were Q89 (“The customers/potential customers are totally new to the business”) and Q90 (“The class of the product/service is totally new to the business”). Both items refer to the newness of a product/service, as the one refers to new customers and the other to the newness to the business. The correlated errors therefore seem sensible.

The corresponding items e47 and e46 (Q101 and Q100) and e48 and e49 (Q102 and Q103) were previously explained in SEM Model 1.1, again indicating correlations between these items.

Lastly, corresponding items e29 and e28 were Q83 (“I attend meetings with people from different departments to come up with new ideas”), and Q82 (“I often sit together with employees to come up with good ideas”). Both items refer to the transformation of knowledge in the ACAP process, thus the correlated errors seem sensible.

Based on the goodness-of-fit indices presented in Table 7.4, measurement Model 2 provided an adequate model fit. Overall, it could be concluded that the observed data fits the structural model.

7.3.3 SEM Model 1.3: Relationship between SEC, EACAP and IC

In the previous section, the results of SEM Model 1.2 suggested that a relationship existed between FEC, EACAP and IC. In this section, the interrelationship between social competencies (SEC), EACAP and IC were considered. The visual portrayal of the hypothesised path diagram for SEC is illustrated in Figure 7.9.

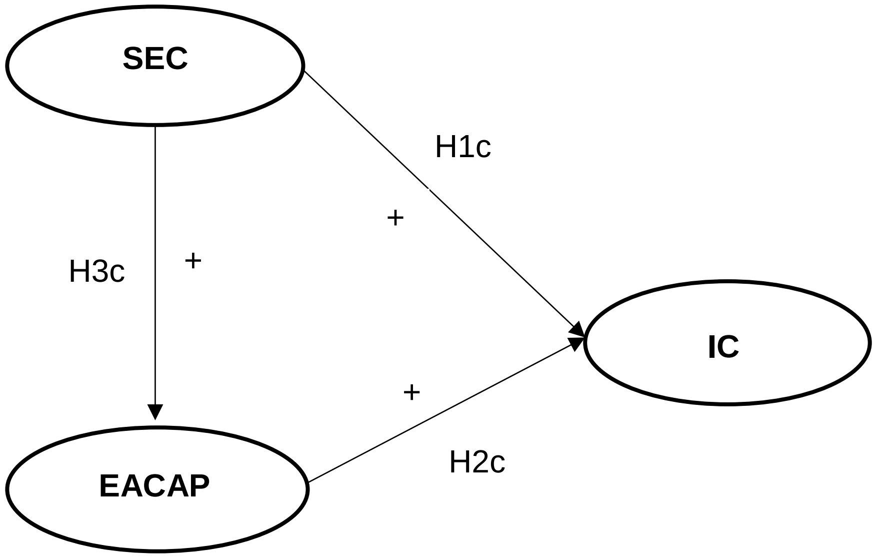


Figure 7.9: Hypothesised path diagram (Social competencies – Model 1.3)

Figure 7.10 illustrates the interrelationships that were indicated between SEC, EACAP and IC. Furthermore, the figure depicts the covariance relationships that were specified between these latent competency variables. The model was then evaluated by the goodness-of-fit indices to test whether the proposed model emulates the sample matrix (Hair *et al.*, 2014:579; Raykov & Marcoulides, 2000:36).

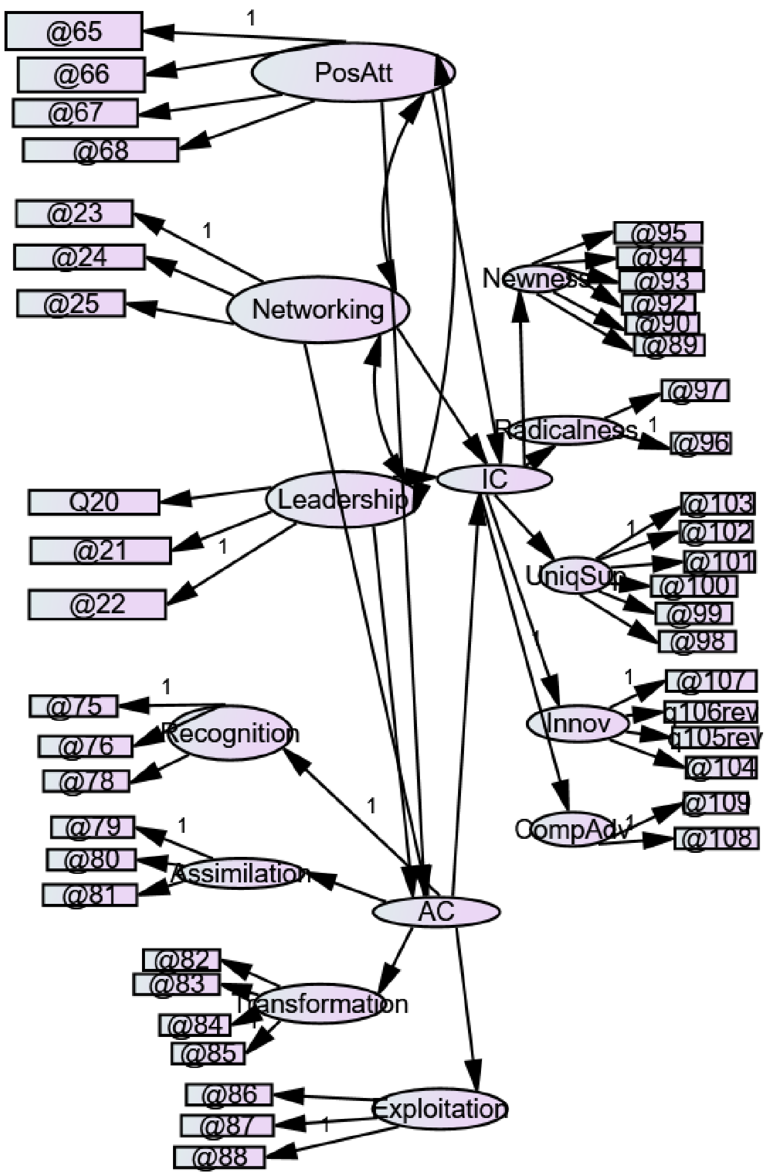


Figure 7.10: SEM Model 1.3 as postulated with respect to social competencies

In Figure 7.10, SEC is presented by three latent variables, while EACAP is represented as a second-order factor by four latent variables and IC as a second-order factor with five latent variables. EC: positive attitude is represented by four items (Q65-Q68), networking by three items (Q23-Q25), leadership by three items (Q20-Q22). Opportunity recognition EACAP: recognition is represented by three items (Q75, Q76 and Q78), assimilation is represented by three items (Q79-81), transformation is represented by four items (Q82-Q85), and exploitation is represented by three items (Q86-88). IC: newness is represented by six items (Q89,Q90,Q92-Q95), radicalness is represented by two items (Q96 and Q97), uniqueness and superiority is represented by six items (Q98-Q103), innovation is represented by four items (Q104-Q107), and competitive advantage is represented by two items (Q108 and Q109) (Hair *et al.*, 2019:668; Kline, 2015:201). Since the model is represented by two or more factors, a minimum of two items per factor is justified for radicalness and competitive advantage (Hair *et al.*, 2019; Kline, 2015:201).

Table 7.7 provides goodness-of-fit indices of the structural Model 1 and 2. In addition to the error terms represented in Model 1, the figure illustrates the covariance relationships that were specified between the competencies associated with the social competence category.

Table 7.7: Goodness-of-fit indices: SEM Model 1.3

Model	CMIN (χ^2)	df	P	CMIN /df	RMSEA	CFI	TLI	IFI	AIC	BCC	SRMR
Model 1	2218.922	842	0.000	2.635	0.060	0.889	0.881	0.889	2426.922	2449.408	0.0694
Model 2	1860.688	838	0.000	2.220	0.052	0.917	0.911	0.918	2162.688	2195.336	0.0662
Indicate accept-able fit	-	-	-	<3 or <5	≤ 0.08	≥ 0.90	≥ 0.90	≥ 0.90			<0.08

Model 1 was fitted to the data and did not fit the data adequately. Although the RMSEA (0.060) and the SRMR (0.0694) tested below the threshold value of 0.08, the CFI (0.889), TLI (0.881) and IFI (0.889) did not test above 0.9. The SRMR was acceptable at 0.0694, testing below the threshold of <0.08.

Improvement on the model was made by adding additional covariances. As no loadings were below 0.5, modification indices were studied, and were theoretically justified (Hair *et al.*, 2014:559). The justification for the error covariances included in Model 2 will be discussed after Table 7.9.

The model showed adequate fit as indicated by the goodness-of-fit indices in Table 7.7. The RMSEA (0.052) tested below the recommended threshold of <0.08, indicating acceptable model fit, as well as the SRMR (0.0662). The CFI (0.912), TLI (0.911) and IFI (0.918) were above 0.90, which fitted the model adequately. The CMIN/df value of 2.220 was smaller than 3 (Schumacker & Lomax, 2004), which indicated model fit.

Therefore, when all these fit indices were considered, SEM Model 2 presented satisfactory fit with the observed data.

Table 7.8 indicates the structural parameter estimates, namely the standardised regression weights for the relationships between SECs, EACAP and IC of Model 1.3.

Table 7.8: Structural path coefficients: Structural Model 2 (with SEC)

Relationships			Standardised regression weights	P	Label
AC	<---	Positive attitude	0.416	***	
AC	<---	Networking	0.229	0.001	**
AC	<---	Leadership	0.294	0.001	**
IC	<---	AC	0.339	***	
IC	<---	Positive attitude	0.072	0.331	
IC	<---	Networking	0.219	0.015	*
IC	<---	Leadership	-0.161	0.160	

*** Significance at 0.1% level of significance (p-value < 0.001)

** Significant at 1% level of significance (p-value < 0.01)

* Significant at 5% level of significance (p-value < 0.05)

'A' Significant at 10% level of significance (p-value < 0.1)

The relationships of the SECs with AC (short for EACAP) were all statistically significant and positive. Positive attitude had a positive moderate relationship with AC (β = 0.416, $p < 0.001$) and was highly statistically significant, networking (β = 0.229, $p < 0.01$) and leadership (β = 0.229, $p < 0.01$) were statistically significant and had modest and positive relationships with AC. The effect of AC on IC was highly significant and modest (β = 0.339, $p < 0.001$). The relationships between the competencies positive attitude and leadership were not statistically significant, with positive attitude having a positive and weak relationship with IC (β = 0.072, $p = 0.331$) and leadership had a negative and weak relationship with IC (β = -0.161, $p = 0.160$). Networking was statistically significant and indicated a positive modest relationship with IC (β = 0.22, $p < 0.05$).

Table 7.9 depicts the correlations between the variables for SEM Model 2, which included a total of three tested covariances between the latent competencies and four added error covariances.

Table 7.9: Structural parameter estimates: correlations of the final SEM Model 1.3

Correlations			Estimate
Leadership	<-->	Networking	0.647
Positive attitude	<-->	Networking	0.270
Leadership	<-->	Positive attitude	0.512
e70	<-->	e71	0.464
e47	<-->	e46	0.477
e29	<-->	e28	0.542
e48	<-->	e49	0.351

Table 7.9 showed that the residual error terms e70 and e71 (0.464); e47 and e46 (0.477); e29 and e28 (0.542); and e48 and e49 (0.351) were correlated. These were the same corresponding items as found in SEM Model 1.2 with FECs, and the theoretical justification was discussed in 7.2.1.

7.3.4 SEM Model 1.4: Relationship between MEC, EACAP and IC

In the previous section, the results of SEM Model 1.3 suggested that a relationship existed between SEC, EACAP and IC. In this section, the interrelationship between meta competencies (MEC), EACAP and IC was considered. The visual portrayal of the hypothesised path diagram for MEC is illustrated in Figure 7.11.

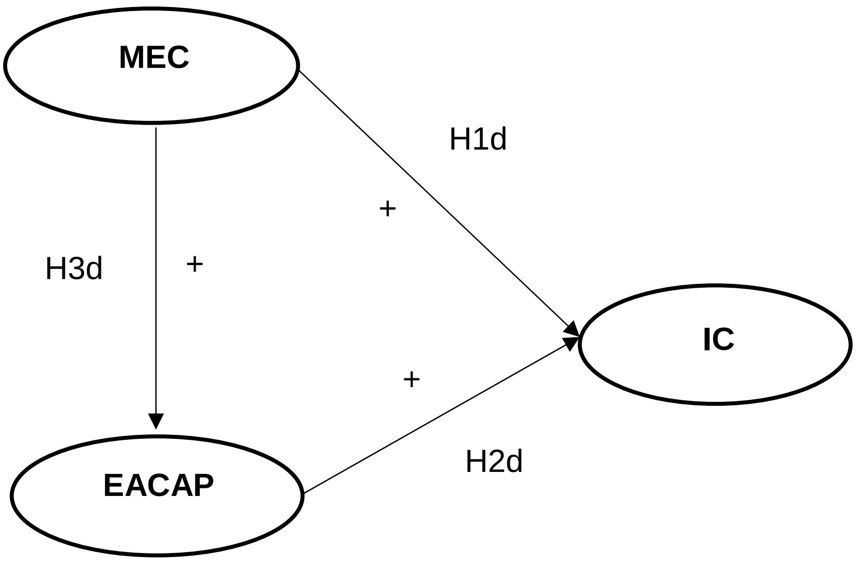


Figure 7.11: Hypothesised path diagram (Meta competencies – Model 1.4)

Figure 7.12 illustrates the interrelationships that were indicated between MEC, EACAP and IC. Furthermore, the figure depicts the covariance relationships that were specified between these latent competency variables. The model was then evaluated by the goodness-of-fit indices to test whether the proposed model emulates the sample matrix (Hair *et al.*, 2014:579; Raykov & Marcoulides, 2000:36).

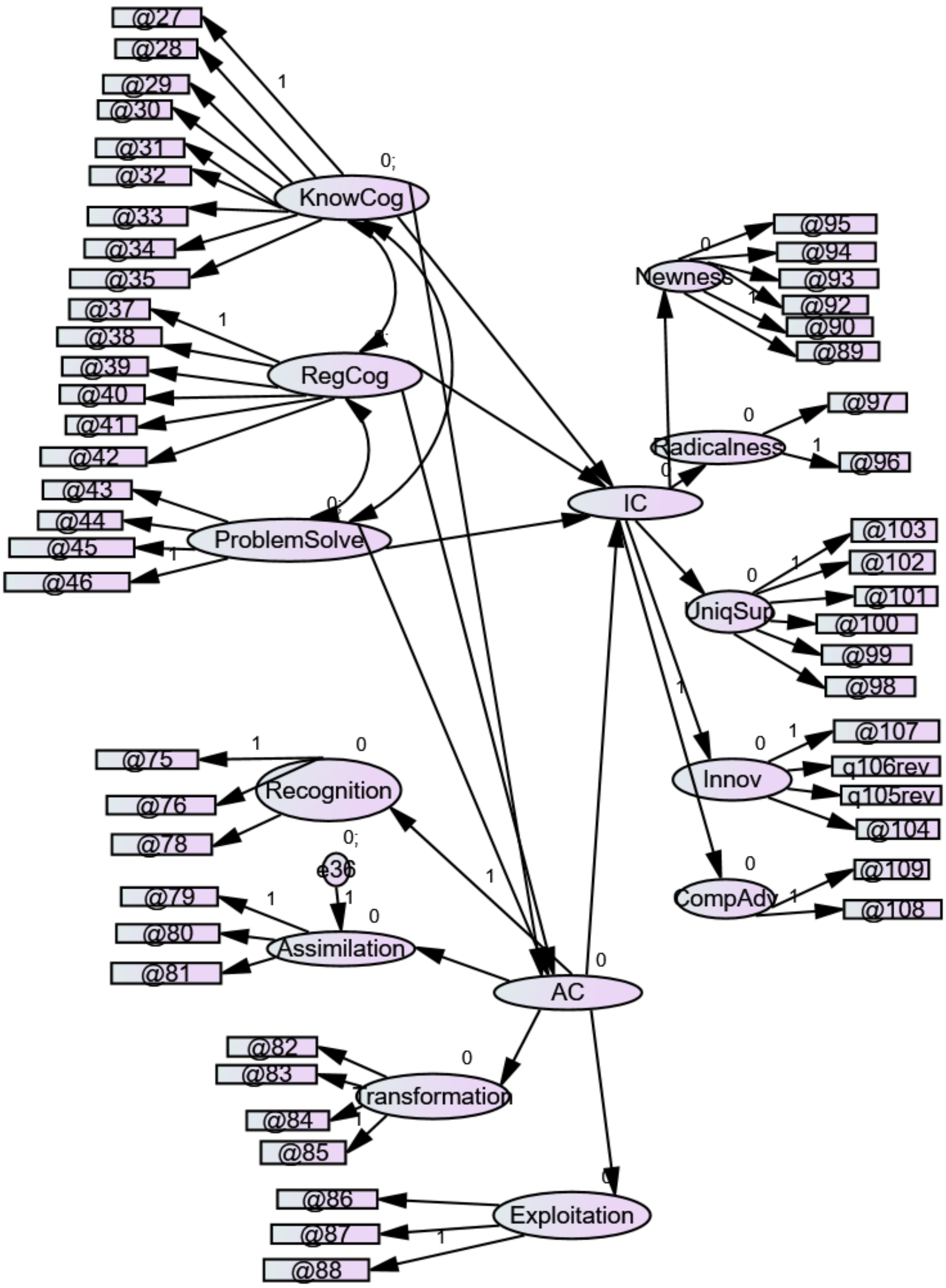


Figure 7.12: Original SEM Model 1.4 as postulated with respect to meta competencies

The original model was tested and resulted in an adequate fit. Studying the standardised regression weights, there was none with a weight lower than 0.5. Subsequently, modification indices were studied for possible inclusion. Adding one resulted in a null model's RMSEA of 0.157 and the RMSEA of the default model 0.056. Subsequent adding of three error covariances resulted in a solution that was not admissible. This could be a result of the potential multicollinearity between the two cognitive constructs (0.772). In addition, Kenny (2014) acknowledges the fact that if the RMSEA of the null model is less than 0.158, an incremental measure of fit may not be that informative. Therefore, it was decided to merge the cognitive construct.

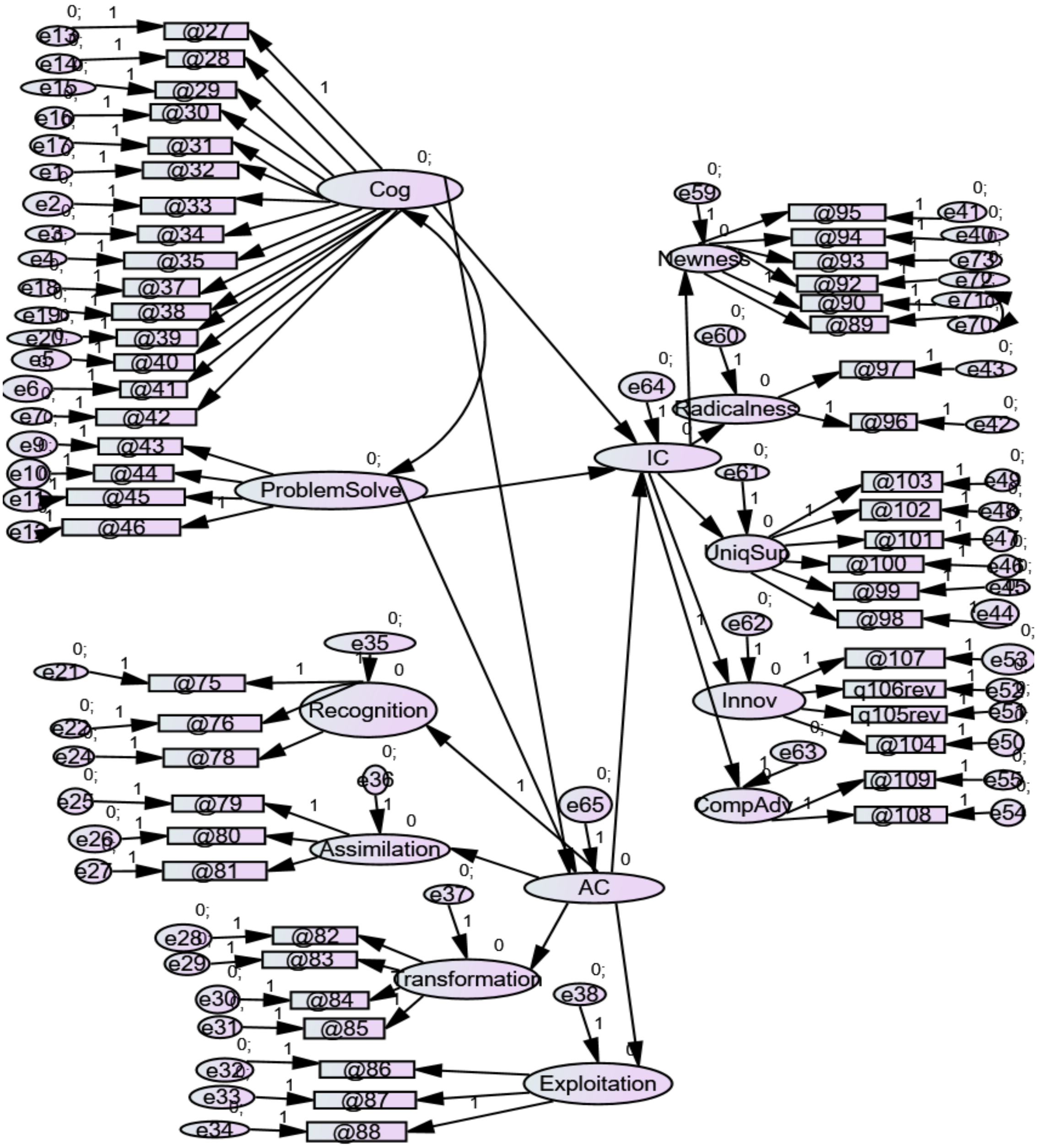


Figure 7.13: SEM Model 1.4 as postulated with respect to meta competencies

In Figure 7.13, MEC is presented by two latent variables, while EACAP is represented as a second-order factor by four latent variables and IC is represented as a second-order factor by five latent variables. EC: cognitive ability is represented by fifteen items (Q27-Q35 and Q37- Q42); Q36 did not load and problem-solving is represented by four items (Q43-Q46). EACAP: recognition is represented by three items (Q75, Q76 and Q78), assimilation is represented by three items (Q79-81), transformation is represented by four items (Q82 -Q85), and exploitation is represented by three items (Q86-88). IC: newness is represented by six items (Q89, Q90, Q92-Q95), radicalness is represented by two items (Q96 and Q97), uniqueness and superiority is represented by six items (Q98-Q103), innovation is represented by four items (Q104-Q107), and competitive advantage is represented by two items (Q108 and Q109). All the specified requirements for the minimum number of indicators for each factor were met (Hair *et al.*, 2019:668; Kline, 2015:201). Table 7.10 provides goodness-of-fit indices of structural Models 1, 2 and 3.

Table 7.10: Goodness-of-fit indices: SEM Model 1.4

Model	CMIN (χ^2)	df	P	CMI N/df	RMSEA	CFI	TLI	IFI	AIC	BCC	SRMR
Model 1	3308.792	1259	0.000	2.628	0.060	0.861	0.854	0.862	3650.792	3696.335	0.0670
Model 2	3212.599	1258	0.000	2.554	0.059	0.868	0.861	0.868	3556.599	3602.408	0.0669
Model 3	2655.781	1204	0.000	2.206	0.052	0.900	0.894	0.901	3001781	3046.874	0.0654
Indicate accept-able fit	-	-	-	<3 or <5	$\leq$ 0.08	$\geq$ 0.90	$\geq$ 0.90	$\geq$ 0.90			<0.08

When the first structural model was fitted to the data, although RMSEA (0.060) was below the threshold of 0.08, CFI (0.861), TLI (0.854) and IFI (0.862) were not within the recommended threshold. The CMIN/df (2.628) fitted the data well and tested below the threshold of <3 (Schumacker & Lomax, 2004), as well as the SRMR (0.0670), testing below 0.08. However, the model did not indicate adequate fit.

When the second structural model was fitted to the data, the model also did not fit the data well. An error covariance was added in Model 2 to improve the model fit and is discussed after Table 7.12. RMSEA (0.059) was below the 0.08 threshold and the SRMR (0.0669) was smaller than 0.08, which indicated acceptable fit; but CFI (0.868), TLI (0.861) and IFI (0.868) were not above 0.90, indicating inadequate fit. Although the model did not show a satisfactory fit according to the test indices, the goodness-of-fit indices of Models 1 and 2 are shown and discussed for comparative purposes in Table 7.10.

In order to improve SEM Model 2, modification indices were studied, and were theoretically justified (Hair *et al.*, 2019:559). Item Q41 (0.445) tested below the indicator path coefficient threshold of 0.5, and was therefore removed (Hair *et al.*, 2019:30). When SEM Model 3 was fitted to the data, the goodness-of fit supported the structural model. The RMSEA (0.052) as well as the SRMR (0.0654) indicated acceptable model fit. The CFI (0.900) and ILI (0.901) were both larger than 0.09, and TLI (0.894) was close to the threshold of 0.90, which provides evidence that the model fitted the data well. The CMIN/df value of the first model, 2.554 reduced even more with the second model to 2.206. SEM Model 3 provides an improvement over SEM Models 1 and 2 in representing the relationships between MEC, EACAP and IC of entrepreneurs, as the model fitted the data. Therefore, the relationships indicated in SEM Model 3 were interpreted and also represented in the research hypothesis that was set for conceptual framework 1 (see Table 5.7, summary of the research hypothesis).

The standardised regression weights (structural path estimates) of SEM Model 3 are presented in Table 7.11.

Table 7.11: Structural path coefficients: Structural Model 3 (with MEC)

Relationships			Standardised regression weights	P	Label
AC	<---	Cognitive ability	0.698	***	
AC	<---	Problem solving	0.166	0.016	*
IC	<---	AC	0.603	***	
IC	<---	Cognitive ability	-0.230	0.070	A
IC	<---	Problem solving	-0.018	0.850	

*** Significance at 0.1% level of significance (p-value < 0.001)

** Significant at 1% level of significance (p-value < 0.01)

*Significant at 5% level of significance (p-value<0.05)

‘A’ Significant at 10% level of significance (p-value < 0.1)

Considering the relationships between MEC, EACAP and IC, the structural paths between cognitive ability and AC (short for EACAP) were highly statistically significant with a moderately strong positive relationship (β = 0.698, p = < 0.001) and problem-solving was statistically significant and had a positive weak relationship with AC (β = 0.166, $p < 0.05$). The relationship between AC and IC was highly statistically significant, indicating a positive moderately strong relationship with IC (β = 0.603, $p < 0.001$). The relationship between cognitive ability and IC indicated as statistically significant at the 10% level of significance and was modest, but negative (β = -0.230, $p < 0.1$). No significant relationship was found between problem-solving and IC (β = -0.018, $p = 0.850$).

Table 7.12 depicts the correlations and covariances between variables for SEM Model 2 and 3. The final model, Model 3, included one covariance and a total of five added error covariances.

Table 7.12: Structural parameter estimates: correlations of the final SEM Model 1.4

Correlations Model 2			Estimate
Cognitive ability	<-->	Problem solving	0.773
e70	<-->	e71	0.464

Correlations Model 3			Estimate
Cognitive ability	<-->	Problem solving	0.777
e70	<-->	e71	0.464
e47	<-->	e46	0.478
e29	<-->	e28	0.578
e18	<-->	e19	0.363
e48	<-->	e49	0.352

Table 7.12 showed that the residual error terms e70 and e71 (0.773) in Model 2 were correlated. These were the same corresponding items found in SEM Model 1.3.

Table 7.12 indicated further that the residual error terms e70 and e71 (0.777) (the same corresponding items found in Model 2; e47 and e46 (0.478); e29 and e28

(0.578); and e48 and e49 (0.352) were correlated. These were the same corresponding items found in SEM Model 1.3 (SEC), except for e18 and e19 (0.363).

The corresponding items e18 and e19 were Q37 ("I ask myself periodically if I am meeting my goals") and Q38 ("I ask myself if I considered all options when solving a problem"). Both items are phrased in the same manner and relate to the regulation of cognition. It is therefore reasonable to co-vary these error terms.

7.3.5 Clarification of additional hypotheses statements

Due to the complexity of the four SEM models, with four categories of ECs (CEC, FEC, SEC, MEC) and 11 individual competencies, it is important to indicate each individual result based on significant relationships.

The main hypothesis statement in Chapter 5 (Table 5.7) was based on the significant positive relationships between ECs and IC (H1). However, each of the four categories was tested individually (H1a–H1d). Based on the results, each individual EC within each category was also tested and therefore each H1a–H1d was given a number where applicable. The specified sub-hypotheses resulted in:

Added hypotheses for each competency:

- Hypothesis 1a added: $H1a_1$, $H1a_2$, $H1a_3$, $H1a_4$, $H1a_5$
- Hypothesis 1c added: $H1c_1$, $H1c_2$, $H1c_3$
- Hypothesis 1d added: $H1d_1$, $H1d_2$

The main hypothesis statement in Chapter 5 (Table 5.7) was based on the significant positive relationships between EACAP and IC (H2). However, each of the four categories was tested individually ($H2_1$–$H2_4$). Each category tested (CEC, FEC, SEC, MEC) was therefore given a number. The specified sub-hypotheses resulted in:

Added hypotheses for each EC category:

- Hypothesis 2 added: $H2_1$, $H2_2$, $H2_3$, $H2_4$

The main hypothesis statement in Chapter 5 (Table 5.7) was based on the significant positive relationships between ECs and EACAP (H3). However, each of the four categories was tested individually (H3a–3d). Based on the results, each individual EC within each category was also tested and therefore each H3a–H3d was given a number where applicable. The specified sub-hypotheses resulted in:

Added hypotheses for each competency:

- Hypothesis 3a added: $H3a_1$, $H3a_2$, $H3a_3$, $H3a_4$, $H3a_5$
- Hypothesis 3c added: $H3c_1$, $H3c_2$, $H3c_3$
- Hypothesis 3d added: $H3d_1$, $H3d_2$

The main hypothesis statement in Chapter 5 (Table 5.7) was based on EACAP as mediator between EC and IC (H4). However, each of the four categories was tested individually (H4a-H4d). Based on the results, the ECs for the MECs in H4d were given a number where applicable. The specified sub-hypotheses resulted in:

Added hypotheses for each competency:

- Hypothesis 4d added: $H4d_1$, $H4d_2$

The main hypothesis statement in Chapter 5 (Table 5.7) was based on EACAP as moderator between EC and IC (H5). However, two categories were tested individually. Each category tested (CEC, FEC) was therefore given a number. The specified sub-hypotheses resulted in:

Added hypotheses for EC categories:

- Hypothesis 5 added: $H5_1$, $H5_2$

The main hypothesis statement in Chapter 5 (Table 5.7) was based on EC as moderator between EACAP and IC (H6). However, each of the four categories was tested individually (H6a–H6d). Based on the results, each individual EC within each category was also tested for moderation and therefore each H6a–H6d was given a number where applicable. The specified sub-hypotheses resulted in:

Added hypotheses for each competency:

- Hypothesis 6a added: $H6a_1$, $H6a_2$, $H6a_3$, $H6a_4$, $H6a_5$
- Hypothesis 6c added: $H6c_1$, $H6c_2$, $H6c_3$
- Hypothesis 6d added: $H6d_1$, $H6d_2$

7.3.6 Conceptual framework 1: Results of the hypotheses

Based on the results of the SEM Models, the hypotheses that were set for conceptual framework 1 were evaluated. For a hypothesis to be supported through SEM, different criteria must be met. The first criterion is to establish model fit, followed by an assessment of the variance explained (R^2). Only once the requirements of model fit and variance explained are satisfied, is it possible to arrive at conclusions regarding the significance and direction of relationships which are based on the *p*-values calculated. These steps were performed for each of the four models (1.1-1.4). Table 7.13 provides a summary of the results of the hypotheses (H1a–H1d, $H2_1$ and $H2_2$, H3a–H3d). Based on these SEM models, as shown in Figures 7.6, 7.8, 7.10 and 7.13 and presented in Table 7.13, it is essential to put the hypothesised relationships into perspective and draw inferences from results of this analysis. Hence, the hypotheses relating to the four competence categories, CEC, FEC, SEC and MEC, EACAP and IC are considered in this section. It indicates for each of the relationships as shown in the hypothesised model its associated hypotheses. It goes further to show the path coefficients and p-values for each relationship. The p-values indicate whether the structural path is statistically significant in predicting the endogenous variable at a 0.001, 0.05 and 0.1 level (two-tailed).

Table 7.13: Conceptual framework 1: Summary of the results and hypotheses

SEM model	Competencies			Standardised regression weights (r^2)	P-value		Label
1.1	IC	<---	Decision Making (CEC)	**-0.207**	**0.064**	A	H1a1
	IC	<---	Proactiveness (CEC)	0.045	0.741		H1a2
	IC	<---	Innovation/Innovating (CEC)	**0.268**	**0.053**	A	H1a3
	IC	<---	Opportunity Recognition (CEC)	**0.250**	**0.007**	**	H1a4
	IC	<---	Use of social support (CEC)	-0.034	0.591		H1a5
1.1	IC	<---	AC (CEC)	0.058	0.680		H21
1.1	AC	<---	Decision-Making (CEC)	-0.052	0.448		H3a1
	AC	<---	Proactiveness(CEC)	**0.154**	**0.070**	A	H3a2
	AC	<---	Innovation/Innovating (CEC)	**0.554**	***		H3a3
	AC	<---	Opportunity Recognition (CEC)	**0.311**	***		H3a4
	AC	<---	Use of Social support (CEC)	**0.069**	**0.080**	A	H3a5
1.2	IC	<---	Value Creation (FEC)	**0.358**	**0.001**	**	H1b
1.2	IC	<---	AC (FEC)	0.113	0.268		H22
1.2	AC	<---	Value Creation (FEC)	**0.812**	***		H3b
1.3	IC	<---	Positive Attitude (SEC)	0.072	0.331		H1c1
	IC	<---	Networking (SEC)	**0.219**	**0.015**	*	H1c2
	IC	<---	Leadership (SEC)	-0.161	0.160		H1c3

1.3	IC	<---	AC (SEC)	**0.339**	***		H23
1.3	AC AC AC	<--- <--- <---	Positive Attitude (SEC) Networking (SEC) Leadership (SEC)	**0.416** **0.229** **0.294**	*** **0.001** **0.001**	 ** **	H3c1 H3c2 H3c3
1.4	IC IC	<--- <---	Cognitive ability (MEC) Problem Solving (MEC)	**-0.230** -0.018	**0.070** 0.850	A	H1d1 H1d2
1.4	IC	<---	AC (MEC)	**0.603**	***		H24
1.4	AC AC	<--- <---	Cognitive ability (MEC) Problem Solving (MEC)	**0.698** **0.166**	*** **0.016**	 *	H3d1 H3d2

*** Significance at 0.1% level of significance (p-value < 0.001)

** Significant at 1% level of significance (p-value < 0.01)

*Significant at 5% level of significance (p-value<0.05)

'A' Significant at 10% level of significance (p-value<0.1)

The results reported in Table 7.13 provide a summary of the main findings regarding model hypotheses of conceptual framework 1 (H1–H3), and are summarised below:

- The relationship of the CECs, decision-making (H1a$_1$), innovation (H1a$_3$), and opportunity recognition (H1a$_4$) with IC, as presented by the structural path estimates were statistically significant, although negative for decision-making. The relationships of proactiveness and use of social support were not statistically significant. The hypothesis regarding the relationships between CECs and IC (H1a) was consequently not supported for the three competencies decision-making (H1a$_1$) proactiveness (H1a$_2$) and use of social support (H1a$_5$). The hypotheses that are supported for H1a are therefore indicated below:

    - H1a: There is a relationship between each of the CECs and IC
        - H1a$_3$: There is a significant positive relationship between the CEC: innovation/innovating and IC.
        - H1a$_4$: There is a significant positive relationship between the CEC: opportunity recognition and IC.

- The relationship of FEC: value-creation with IC as presented by the structural path estimates was statistically significant. The hypothesis regarding the relationships between FECs and IC (H1b) was consequently supported:
    - H1b: There is a significant positive relationship between the FEC: value creation and IC.

- The relationship of the SECs: networking ($H1c_2$) with IC as presented by the structural path estimates was statistically significant. Positive attitude ($H1c_1$), and leadership ($H1c_3$) were not significant. The hypothesis regarding the relationships between networking and IC ($H1c_2$) was consequently supported but not supported for the competencies positive attitude ($H1c_1$), and leadership ($H1c_3$). The hypotheses that are supported for H1c are therefore indicated below:
    - H1c: There is a significant positive relationship between each of the SECs and IC.
        - $H1c_2$: There is a significant positive relationship between the SEC: networking and IC.
- The relationship of the MEC: cognitive ability ($H1d_1$) with IC as presented by the structural path estimates was statistically significant, although negative. The relationship between problem-solving ($H1d_2$) and IC was not significant. The hypothesis regarding the relationships between cognitive ability and IC, supported ($H1d_1$) problem-solving ($H1d_2$) and IC was consequently not supported.
- The relationship between EACAP and IC (within the four EC categories), as presented by the structural path estimates was statistically significant for the relationship between EACAP and IC that includes the SECs ($H2_3$): SEM Model 1.3. A significant relationship was also found between EACAP and IC that includes the MECs (H2d/$H2_4$): SEM Model 1.4. The relationship between EACAP and IC that included the CECs ($H2_1$), SEM Model 1.1 and FEC ($H2_2$), SEM Model 1.4 was not significant. The hypothesis regarding the relationships between EACAP and IC in the SEC ($H2_3$) and MEC ($H2_4$) models was supported, but subsequently not supported in the CEC ($H2_1$) and FEC ($H2_2$) models. The hypotheses that are supported for H2 are therefore indicated below:

    - H2: There is a relationship between EACAP and IC.
        - $H2_3$: There is a significant positive relationship between EACAP and IC within the SEC model (1.3).

        - $H2_4$: There is a significant positive relationship between EACAP and IC within the MEC model (1.4).

- The relationship of the CECs: proactiveness ($H3a_2$), innovation/innovating ($H3a_3$), opportunity recognition ($H3a_4$) and use of social support ($H3a_5$) with EACAP as presented by the structural path estimates was statistically significant and positive. Decision-making ($H3a_1$) was not significant. The hypothesis regarding the relationships between the CECs and EACAP (H3a) was consequently not supported for the competency decision-making ($H3a_1$). The hypotheses that are supported for H3a are therefore indicated below:

    - H3a: There is a relationship between each of the CECs and EACAP.
        - $H3a_2$: There is a significant positive relationship between the CEC: proactiveness and IC.
        - $H3a_3$: There is a significant positive relationship between the CEC: innovation/innovating and IC.
        - $H3a_4$: There is a significant positive relationship between the CEC: opportunity recognition and IC.
        - $H3a_5$: There is a significant positive relationship between the CE: use of social support and IC.
- The relationship of the FEC: value creation with EACAP as presented by the structural path estimates was statistically significant. The hypotheses were therefore supported.
    - H3b: There is a significant positive relationship between the FEC: value creation and EACAP.
- The relationship of the SECs: positive attitude ($H3c_1$), networking ($H3c_2$), and leadership ($H3c_3$), with EACAP as presented by the structural path estimates was statistically significant and positive. The hypotheses for all three SECs were therefore supported.

    - H3c: There is a relationship between each of the SECs and EACAP.
        - $H3c_1$: There is a significant positive relationship between the SEC: positive attitude and EACAP.

- H3c$_2$: There is a significant positive relationship between the SEC: networking and EACAP.
- H3c$_3$: There is a significant positive relationship between the SEC: leadership and EACAP.

- The relationship of the MECs: cognitive ability (H3d$_1$) and problem-solving (H3d$_2$) with EACAP as presented by the structural path estimates were statistically significant and positive. The hypotheses were therefore supported.
  - H3d: There is a significant positive relationship between the MECs and EACAP.
    - H3d$_1$: There is a significant positive relationship between the MEC: cognitive ability and EACAP.
    - H3d$_2$: There is a significant positive relationship between the MEC: problem-solving and EACAP.

The following section reports the results of the research hypotheses regarding the mediating effect of the EACAP construct in conceptual framework 2, SEM Model 2 (H4a-H4d) and the moderating effect (H5).

7.4 RESULTS OF SEM: CONCEPTUAL FRAMEWORK 2

In Conceptual framework 2, EACAP was postulated as a potential mediator and moderator in the relationship between the four EC categories and IC.

The mediation results will be discussed first in sections 7.4.1–7.4.4. Mediation, as an indirect relationship, commonly appears in structural models. A model that proposes mediation that exhibits good fit provides evidence that the mediation exists (Hair *et al.*, 2019:745). Mediation therefore requires statistically significant standardised regression weights among all three constructs (Hair *et al.*, 2019:745), with statistical significance at 0.05 level (Hair *et al.*, 2019:747).

7.4.1 SEM Model 1.1: EACAP as mediator between CEC and IC

The visual portrayal of the SEM model consists of the measurement and structural Model 1.1 (Hypothesis Model 2). The measurement and structural Model 1.1, including the hypotheses for conceptual framework 2, are illustrated in Figure 7.6.

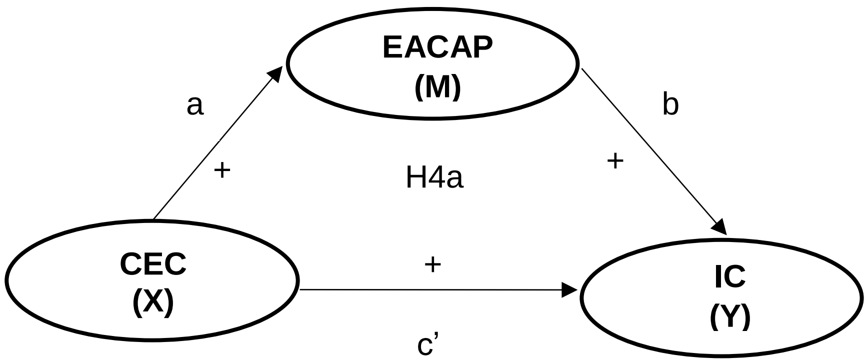


Figure 7.14: Hypothesised path diagram (Cognitive competencies – SEM Model 1.1)

The full SEM, presented in Figure 7.6 and illustrated in the hypothesised path diagram Figure 7.14, describes a mediating model to assess the research hypothesis H4a in this study, namely whether EACAP mediates the relationship between CEC and IC. The stimulus variable (cognitive competencies), which captures CECs, was measured by opportunity recognition, decision-making, proactiveness, use of social support and innovation/innovating, while the EACAP variable is measured by the processes of recognition, assimilation, transformation and exploitation. The IC variable was measured by five variables, namely newness, radicalness, uniqueness and superiority, innovation and competitive advantage. The CECs as an exogenous latent variable lead to EACAP and IC as two endogenous variables.

The execution of the SEM results was already discussed in section 7.2.1. The method used is bias-corrected bootstrapping and was obtained from the SEM Model 1.1 output. Bias-corrected bootstrapping of the intervals for indirect effects involves taking multiple repeated samples with replacement from the data set in question (Leth-Steensen & Gallitto, 2016:340) and is regarded as the best method for testing indirect effects (Shrout & Bolger, 2002). For each bootstrapped sample, the SEM (for latent variables) or the path (for observed variables) is refitted and estimates for all parameters retained. For indirect effects, this entails a multiplication of the corresponding fitted path coefficients. The set of values obtained for each effect of interest is sorted, and lower and upper percentile values on each sorted set of values are determined. For a standard 95% confidence interval, these values represent the 2.5th and 97.5th percentile values, whereas a bias-corrected confidence interval involves a slight adjustment of these percentile values. This is dependent on the proportion of bootstrapped values that are less than or equal to the original sample value (Leth-Steensen & Gallitto, 2016:341). However, by using this approach, determining whether the resulting (1 – α) % confidence interval for an indirect effect does contain 0, is equivalent to a two-sided, α-level hypothesis test for whether the original sample value for that indirect effect significantly differs from 0. Goodness of fit was illustrated in section 7.2.1 (Table 7.1).

Table 7.14: Structural parameter estimates: EACAP as mediator between CEC and IC of SEM Model 1.1

Relationships			Indirect effect Standardized Regression weights	Lower (lower level confidence interval)	Upper (upper level confidence interval)	P	Label
IC	<---	Decision-Making	-0.003	B	0.015	0.367	Not significant
IC	<---	Proactiveness	0.009	-1.023	B	0.363	Not significant
IC	<---	Innovation/Innovating	0.032	-0.096	2.213	0.521	Not significant
IC	<---	Opportunity recognition	0.018	-0.060	0.179	0.495	Not significant
IC	<---	Use of social support	-0.004	-0.012	B	0.446	Not significant

*** Significance at 0.1% level of significance (p-value < 0.001)

** Significant at 1% level of significance (p-value < 0.01)

* Significant at 5% level of significance (p-value < 0.05)

Note: ‘B’ as indicated that due to very close to zero values, lower or upper bound values could not be computed

In order to test H4a, the indirect effect is examined employing bootstrapping as a non-parametric method for generating more robust inferences (Hair *et al.*, 2019:746). The results (Table 7.14) are based on 1000 bootstrap samples and a 95% bias-corrected confidence interval.

As shown in Table 7.14, none of the indirect effects were statistically significant. This is also evident from the bias-corrected 95% confidence intervals which include zero for innovation and opportunity recognition.

EACAP is thus not a mediator between all of the CECs and IC.

7.4.2 SEM Model 1.2: EACAP as mediator between FEC and IC

The visual portrayal of the SEM model consists of the measurement and structural Model 2. The measurement and structural Model 1.2, including the hypotheses for conceptual framework 2, is illustrated in Figure 7.15.

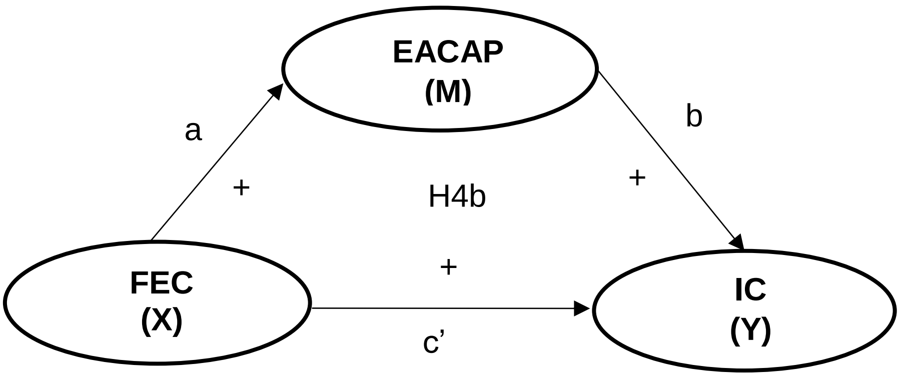


Figure 7.15: Hypothesised path diagram (Functional competencies – SEM Model 1.2)

The full SEM, presented in Figure 7.8 and illustrated in the hypothesised path diagram (Figure 7.9), describes a mediating model to assess the research hypothesis H4b in this study, namely whether EACAP mediates the relationship between FEC and IC. The stimulus variable (functional competencies), which captures FECs, was measured by value creation, while the EACAP variable is measured by the processes of recognition, assimilation, transformation and exploitation. The IC variable was measured by five variables, namely newness, radicalness, uniqueness and superiority, innovation and competitive advantage. The FECs, as an exogenous latent variable, lead to EACAP and IC as two endogenous variables.

The execution of the SEM results was discussed in section 7.2.2.

Table 7.15: Structural parameter estimates: EACAP as mediator between FEC and IC with SEM Model 1.2

Relationships			Indirect effect Standardized Regression weights	Lower (lower level confidence interval)	Upper (upper level confidence interval)	P	
IC	<---	Value Creation	-0.092	-0.072	0.269	0.259	Not significant

*** Significance at 0.1% level of significance (p-value < 0.001)

** Significant at 1% level of significance (p-value < 0.01)

* Significant at 5% level of significance (p-value < 0.05)

As shown in Table 7.15, the indirect effect was not statistically significant. This is also evident from the bias-corrected 95% confidence intervals, which include zero for value creation. EACAP is thus not a mediator between value creation and IC.

7.4.3 SEM Model 1.3: EACAP as mediator between SEC and IC

The visual portrayal of the SEM model consists of the measurement and structural model 1.3. The measurement and structural model 1.3, including the hypotheses for conceptual framework 2, is illustrated in Figure 7.16.

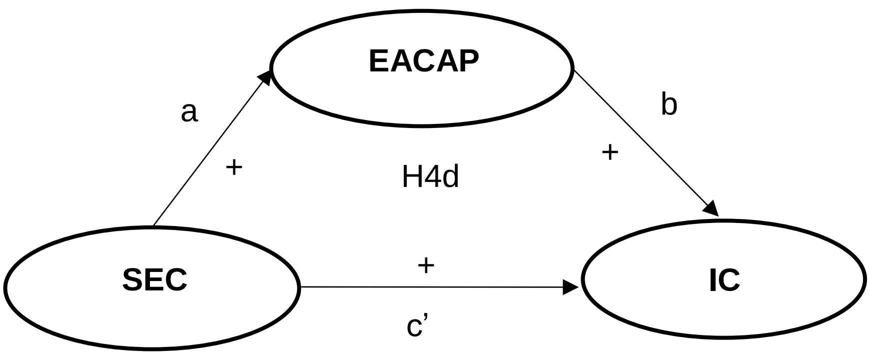


Figure 7.16: Hypothesised path diagram (Social competencies – SEM model 1.3)

The full SEM, presented in Figure 7.10 and illustrated in the hypothesised path diagram (Figure 7.16), describes a mediating model to assess the research hypothesis H4c in this study, namely whether EACAP mediates the relationship between SEC and IC. The stimulus variable (social competencies), which captures SECs, was measured by positive attitude, networking and leadership, while the EACAP variable is measured by the processes of recognition, assimilation, transformation and exploitation. The IC variable was measured by five variables, namely newness, radicalness, uniqueness and superiority, innovation and competitive advantage. The SECs, as an exogenous latent variable, leads to EACAP and IC as two endogenous variables.

The execution of the SEM results was discussed in section 7.2.3.

Table 7.16: Structural parameter estimates: EACAP as mediator between SEC and IC with SEM Model 1.3

Relationships			Indirect effect Standardized Regression weights	Lower (lower level confidence interval)	Upper (upper level confidence interval)	P	Label
IC	<---	Positive attitude	0.141	0.058	0.261	0.002	**
IC	<---	Networking	0.078	0.019	0.173	0.021	
IC	<---	Leadership	0.100	0.022	0.297	0.002	**

*** Significance at 0.1% level of significance (p-value < 0.001)

** Significant at 1% level of significance (p-value < 0.01)

* Significant at 5% level of significance (p-value < 0.05)

The results (Table 7.16) are based on 1000 bootstrap samples and a 95% bias-corrected confidence interval. Results of the mediation analysis confirmed the mediating role of EACAP in the relationship between SEC and IC.

As shown in Table 7.16, all the indirect effects were statistically significant. This is also evident from the bias corrected 95% confidence intervals, which do include zero for all three competencies. EACAP is thus a mediator in the relationship between each of the three SECs and IC.

7.4.4 SEM Model 1.4: EACAP as mediator between MEC and IC

The visual portrayal of the SEM model consists of the measurement and structural Model 1.4. The measurement and structural Model 1.4, including the hypotheses for conceptual framework 2, is illustrated in Figure 7.17.

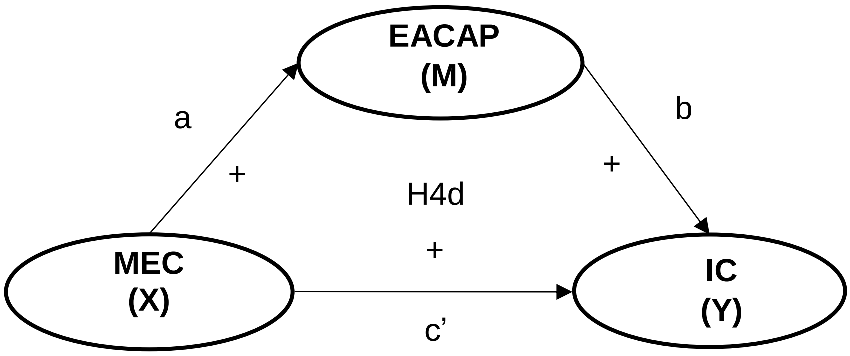


Figure 7.17: Hypothesised path diagram (Meta competencies – SEM Model 1.4)

The full SEM, presented in Figure 7.13 and illustrated in the hypothesised path diagram (Figure 7.17) describes a mediating model to assess the research hypothesis H4d in this study, namely whether EACAP mediates the relationship between MEC and IC. The stimulus variable (meta competencies), which captures MECs, was measured by cognitive ability and problem-solving, while the EACAP variable is measured by the processes of recognition, assimilation, transformation and exploitation. The IC variable was measured by five variables, namely newness, radicalness, uniqueness and superiority, innovation and competitive advantage. The MECs, as an exogenous latent variable, lead to EACAP and IC as two endogenous variables.

The execution of the SEM results was discussed in section 7.2.4.

Table 7.17: Structural parameter estimates: EACAP as mediator between MEC and IC with SEM Model 1.4

Relationships			Indirect effect Standardized Regression weights	Lower (lower level confidence interval)	Upper (upper level confidence interval)	P	Label
IC	<---	Cognitive ability	0.421	0.224	0.790	0.002	**
IC	<---	Problem solving	0.100	-0.089	0.333	0.341	Not significant

*** Significance at 0.1% level of significance (p-value < 0.001)

** Significant at 1% level of significance (p-value < 0.01)

* Significant at 5% level of significance (p-value < 0.05)

The indirect effect is examined employing bootstrapping as a non-parametric method for generating more robust inferences. The results (Table 7.17) is based on 1000 bootstrap samples and a 95% bias-corrected confidence interval.

As shown in Table 7.17, the indirect effects were statistically significant for the cognitive ability competency ($H4d_{1}$), but not the problem-solving competency ($H4d_{2}$). This is also evident from the bias corrected 95% confidence intervals, which do include zero for problem solving but not for the cognitive competency.

EACAP is thus not a mediator between problem solving and IC, but is a mediator between the cognitive ability competency and IC.

The next section reports on the outcome of the research hypothesis regarding the moderating effect of EACAP in SEM Model 1.1 (H5a–H5d).

7.4.5 SEM Model 1.1: EACAP as moderator between EC and IC

In SEM Model 1.1, since EACAP was not found to be a mediator between the two competence categories, CEC (H4a) and FEC (H4b) and IC, EACAP was therefore postulated as a potential moderator in the relationship between these two competence categories and IC. According to the statistical rules for moderation, the following statistical hypotheses were applied (Jose, 2013:11) to the additional hypotheses formulated:

4) Hypothesis 1: The EC-IC (X-Y) relationship (testing for β1)
5) Hypothesis 2: The EACAP-IC (M-Y) relationship (testing for β2)
6) Hypothesis 3: The EC/EACAP (XM-Y) relationship (testing for β3)

The moderation effects of the moderator variable EACAP in the model occur if Hypothesis 3 (β3) is statistically significant and Hypothesis 2 (β2) is not statistically significant. As for Hypothesis 1 (β1) there are two possibilities that can occur:

3) If Hypothesis 1 is not statistically significant, “complete moderation” occurs.
4) If Hypothesis 1 is statistically significant, “partial moderation” occurs.

The role of EACAP in the relationship between CEC and IC as applied in SEM Model 1.1 and the relationship between FEC and IC as presented in SEM model 1.2 is presented according to the statistical rules for moderation. In Table 7.18 the results of the structural model hypotheses ($H5_{1}$ and $H5_{2}$) are provided.

The visual portrayal of the SEM model consists of the measurement and structural Model 1.1 and 1.2. The measurement and the hypothesised model for conceptual framework 2 are illustrated in Figure 7.18.

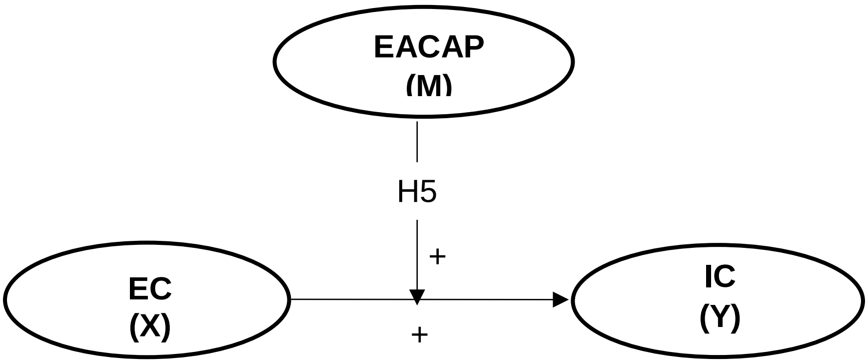


Figure 7.18: Hypothesised path diagram (EACAP as moderator)

The Multi-Group CFA has been used as the method for assessing the effect of moderating variables in the model. The path of interest where the moderator variable is to be assessed is constrained with parameter = 1 and the model is termed the constrained model. The procedure will estimate two models separately. One is the constrained model while the other is the unconstrained model. If the differences between Chi-Square values of the constrained and unconstrained model is more than 3.84, then moderation has occurred in the model (Awang, 2012).

Table 7.18: EACAP as moderator between EC and IC

Competencies	Path	Groups	Constrained	Unconstrained	Chi-Square (χ^2) Difference
Cognitive competencies					**H51**
Opportunity Recognition	Opportunity recognition to IC	Low AC	1357.8	1337.5	20.3*
	Opportunity recognition to IC	High AC	1391.5	1375.7	15.8*
Decision-making	Decision making to IC	Low AC	1360.6	1337.5	23.1*
	Decision making to IC	High AC	1393.8	1375.7	18.1*
Proactiveness	Proactiveness to IC	Low AC	1345	1337.5	7.5*
	Proactiveness to IC	High AC	1405.3	1375.7	29.6*

Use of social support	Use of social support to IC	Low AC	1359.8	1337.5	22.3*
	Use of social support to IC	High AC	1411.1	1375.7	35.4*
Innovation/Innovating	Innovation to IC	Low AC	1346.9	1337.5	9.4*
	Innovation to IC	High AC	1380.1	1375.7	4.4*
Functional competencies					**H52**
Value creation	Value creation to IC	Low AC	568.6	554.1	14.5*
	Value creation to IC	High AC	548.9	541	7.9*

* Moderation is indicated by a value above 3.84

The results in Table 7.18 indicate that for innovative entrepreneurs EACAP is a statistically significant moderator in the relationship between all five of the CECs and IC (opportunity recognition, decision-making, proactiveness, use of social support, innovating and IC). Results further indicate that EACAP is a statistically significant moderator in the relationship between FEC and IC.

In summary, the moderation effects of the moderator variable EACAP in the model occurred where Hypothesis 3 (β3) is statistically significant and Hypothesis 2 (β2) is not statistically significant. As for Hypothesis 1 (β1), which is statistically significant, "complete moderation" occurred for CEC and FEC.

7.4.6 Conceptual framework 2: Results of the hypotheses

Based on the results in the SEM Models 1.1-1.4, the hypotheses that were set for conceptual framework 2 were evaluated.
The main findings regarding the structural model hypotheses regarding EACAP as mediator and moderator are summarised below. The main findings regarding EACAP as mediator between the four EC categories and IC (H4a–H4d) indicate that:

- The hypothesis regarding EACAP as mediator between CECs and IC (H4a) is consequently not supported, as none of the indirect effects were statistically significant.
- The hypothesis regarding EACAP as mediator between FECs and IC (H4b) is consequently not supported, as none of the indirect effects were statistically significant.

- The hypothesis regarding EACAP as mediator between SECs and IC (H4c) is consequently supported, as the indirect effects were statistically significant for all three competencies.
- The hypothesis regarding EACAP as mediator between MECs and IC (H4d) is consequently supported for the competency: cognitive ability, as the indirect effects were statistically significant, but not for problem-solving. EACAP is thus only a mediator between the MEC, cognitive ability and IC.

The main findings regarding EACAP as moderator between EC and IC ($H5_1$ and $H5_2$) indicate that:

- The hypothesis regarding EACAP as moderator between CEC and IC ($H5_1$) is consequently supported for all five competencies.
- The hypothesis regarding EACAP as moderator between FEC and IC ($H5_1$) is consequently supported.

7.5 RESULTS OF SEM: CONCEPTUAL FRAMEWORK 3

7.5.1 SEM Model 1.1-1.4: EC as moderator between EACAP and IC

In SEM Model 1.1–1.4, the four competence categories (ECs) were postulated as potential moderators in the relationship between EACAP and IC. In Table 7.19 the results of the structural model hypotheses (H6a-H6d) are provided.

The visual portrayal of the SEM model consists of the measurement and structural Model 1.1–1.4. The measurement and the hypothesised model for conceptual framework 3 are illustrated in Figure 7.19.

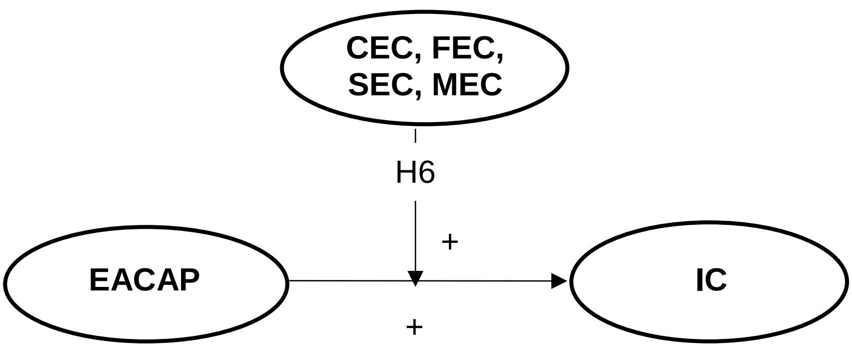


Figure 7.19: Hypothesised path diagram

The Multi-Group CFA has been used as the method for assessing the effect of moderating variables in the model. The path of interest where the moderator variable is to be assessed is constrained with parameter = 1 and the model is termed as the constrained model. The procedure will estimate two models separately. One is the constrained model while the other is the unconstrained model. If the differences between Chi-Square (χ^2) Values of the constrained and unconstrained model are more than 3.84, then moderation has occurred in the model (Awang, 2012).

Following the multigroup CFA approach to test moderation, the results are indicated in Table 7.19.

Table 7.19: Multigroup moderation tests

Competencies	Path	Group	Constrained	Un-constrained	Chi-Square (χ^2) Difference
Cognitive competencies					
Opportunity Recognition	AC TO IC	Low opportunity	957.7	944.7	13*
	AC TO IC	High opportunity	874.5	873.2	1.3
Decision-making	AC TO IC	Low decision-making	1046.3	1035.9	10.4*
	AC TO IC	High decision-making	788.4	787.7	0.7
Proactiveness	AC TO IC	Low proactiveness	1095.5	1081.7	13.8*
	AC TO IC	High proactiveness	755.8	755.8	0
Use of social support	AC TO IC	Low use of social support	1011.7	990.8	20.9*
	AC TO IC	High use of social support	899.2	898.5	0.7
Innovation/ Innovating	AC TO IC	Low innovation/innovating	1026.6	1007.4	19.2*
	AC TO IC	High innovation/innovating	821.4	821.4	0
Functional competencies					
Value creation	AC TO IC	Low value creation	1066.8	1058	8.8*
	AC TO IC	High value creation	795.3	793	2.3
Social competencies					
Positive attitude	AC TO IC	Low positive attitude	972.6	960.38	12.22*
	AC TO IC	High positive attitude	818.2	817.5	0.7
Networking	AC TO IC	Low networking	961	938.3	22.7*
	AC TO IC	High networking	1024.9	1024.8	0.1
Leadership	AC TO IC	Low leadership	1022.2	1004.2	18*
	AC TO IC	High leadership	957.5	956.9	0.6
Meta competencies					
Problem-solving	AC TO IC	Low problem solving	1064	1048.9	15.1*
	AC TO IC	High problem solving	794.3	794.3	0
Cognitive ability	AC TO IC	Low cognitive ability	950.3	938.2	12.1*
	AC TO IC	High cognitive ability	896.1	896.1	0

* Moderation is indicated by a value above 3.84

The results from the multigroup CFA indicated inconclusive evidence for moderation for innovative entrepreneurs' ECs, cognitive, functional, social and meta in the relationship between EACAP and IC, with one of the values above 3.84 and one less than 3.84.

Therefore the PROCESS macro in SPSS was utilised to determine moderation, as illustrated in Table 7.20.

Table 7.20: PROCESS macro moderation test

Competencies	P-value for the interaction effect	Label	
Cognitive competencies			
Opportunity Recognition	0.1076	Not statistically significant	H6a1
Decision-making	0.5027	Not statistically significant	H6a2
Proactiveness	0.5487	Not statistically significant	H6a3
Use of social support	**0.0252***	*	H6a4
Innovation/Innovating	0.0879	Not statistically significant	H6a5
Functional competencies			
Value creation	0.2836	Not statistically significant	H6b
Social competencies			
Positive attitude	0.1374	Not statistically significant	H6c1
Networking	**0.0041****	**	H6c2
Leadership	0.4771	Not statistically significant	H6c3
Meta competencies			
Problem-solving	0.1988	Not statistically significant	H6d1
Cognitive ability	**0.0317**	*	H6d2

*** Significance at 0.1% level of significance (p-value < 0.001)

** Significant at 1% level of significance (p-value < 0.01)

* Significant at 5% level of significance (p-value < 0.05)

The results from the PROCESS macro test in SPSS indicate that for innovative entrepreneurs, three of the competencies: (CEC): use of social support (H6a4); SEC: networking (H6c2); MEC: cognitive ability (H6d2) were statistically significant moderators in the relationship between AC and IC.

7.5.2 Conceptual framework 3: Results of the hypotheses

Based on results of SEM Models 1.1–1.4, the hypotheses that were set for conceptual framework 3 were evaluated.

The main findings regarding the structural model hypotheses regarding the four EC categories as moderator are summarised below. The main findings regarding the ECs as moderators between EACAP and IC (H6a–H6d) indicate that:

- The hypothesis regarding CEC as moderator between EACAP and IC (H6a) is consequently supported for use of social support, but not for opportunity recognition, decision-making, proactiveness and innovation/innovating.
- The hypothesis regarding FEC as moderator between EACAP and IC (H6b) is consequently not supported.
- The hypothesis regarding SEC as moderator between EACAP and IC (H6c) is consequently supported for networking, but not supported for positive attitude and leadership.
- The hypothesis regarding MEC as moderator between EACAP and IC (H6d) is consequently supported for cognitive ability but not for problem-solving.

7.6 RESULTS OF SEM MODELS COMPARED WITH THE NEURAL NETWORK MODEL

The previous section outlined the process that was followed to understand the relationships between the constructs of the final SEM models. The outcome of this process offered four SEM models, indicating the structural paths between the four EC categories, EACAP and IC of innovative entrepreneurs. Most studies focusing on ECs (Botha & Taljaard, 2019; Hafer & Jones, 2015; Haynie & Shepherd, 2009; Ko & Lu, 2010; Man *et al.*, 2008; Schraw & Dennison, 1994) as well as ACAP (Chang *et al.*, 2012; Kostopoulos *et al.*, 2011; Leal-Rodríguez, Ariza-Montes, Roldán & Leal-Millán, 2014a) and IC (Leal-Rodríguez *et al.*, 2014b; Liao *et al.*, 2009; Moilanen *et al.*, 2014), have employed variations of the General Linear Model, which includes regression, discriminant validity, and variance analysis, as well as SEM. Other scholars have recently compared ANN to linear regression analysis in terms of the ability of these two techniques to accurately predict entrepreneurial intentions among university graduates and found that ANN performed significantly better (Moremong-Nganunu, Rametse, Al-Muharrami & Sharma, 2018). Similar results were found in using ANN for analysing customer loyalty, satisfaction and perceived value (Ansari & Riasi, 2016) and studying effectual entrepreneurial opportunities (Ghorbel, Hachicha & Boujelbène, 2017). ANN can therefore be fruitfully used to test complex constructs such as IC. It is therefore possible that this construct is better explained (improved model fit) through modelling non-linear relationships (ANN) as opposed to linear (SEM) relationships, leading to the last hypothesis.

The structural models (SEM 1.1–1.4) were tested empirically and the model fit statistics were interpreted (see Figures 7.21–7.25). A neural network is a multilayer perceptron with simple connections between different components. In each layer, one or more processing unit(s) called artificial neurons are present. It performs a simplified version of what human brain's neurons do (Ansari & Riasi, 2016:18). The conceptual model of this study has three layers in order to replicate an artificial network, 1) input layer, 2) hidden layer, and 3) output layer.

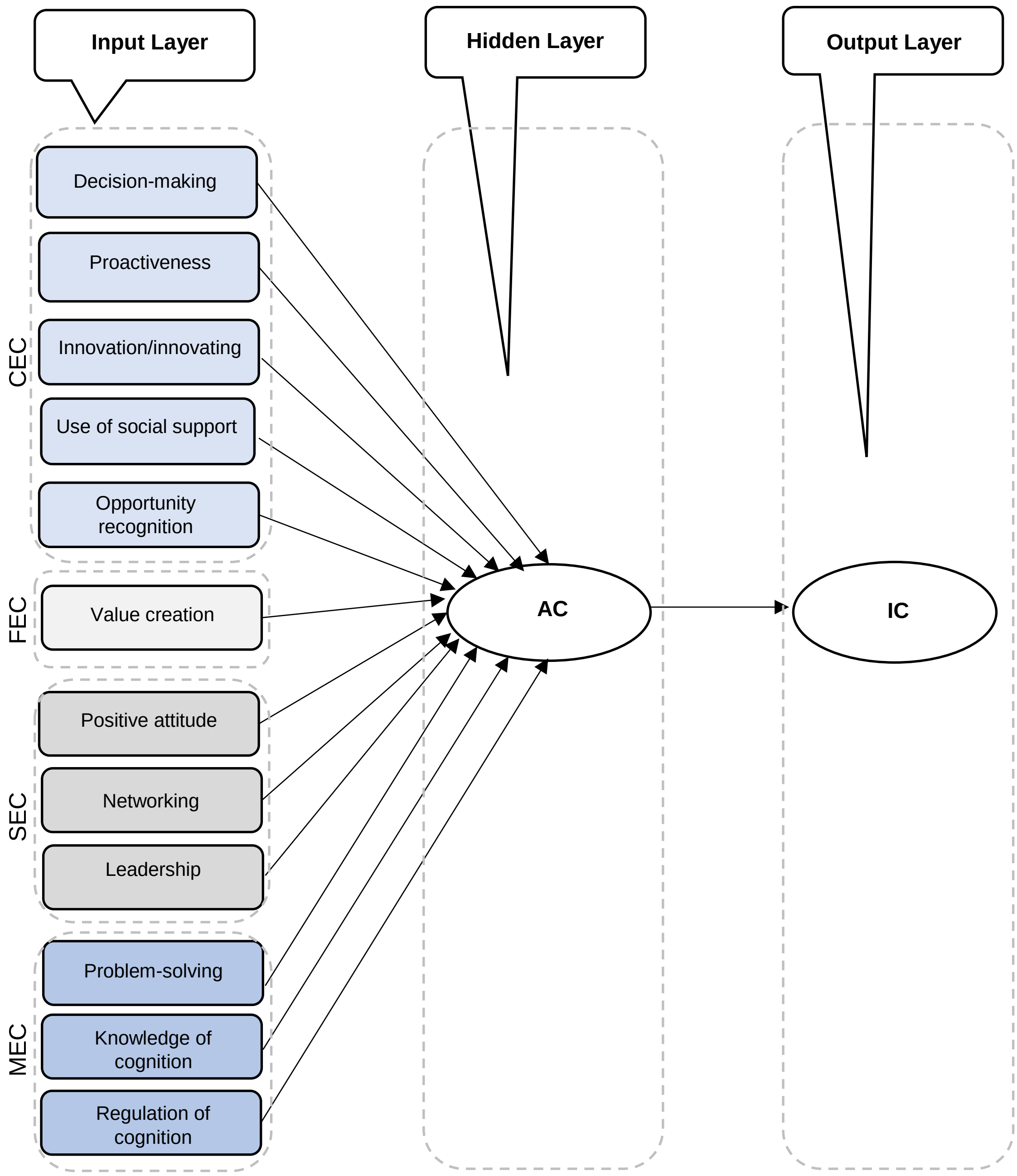


Figure 7.20: NN Conceptual model

In this study, five different neural networks are presented. The first neural network, captures the effect of the five CEC input variables on IC, with the hidden layer containing the neuron AC. The second neural network investigates the effect of the one FEC input variable on IC, with the hidden layer containing the neuron AC. The third neural network investigates the effect of the three SECs input variables on IC, with the hidden layer containing the neuron AC. The fourth neural network studies the effect of the three MEC input variables on IC, with the hidden layer containing the neuron AC. The last neural network captures the effect of AC on IC with the hidden layer containing one neuron.

After using the CECs: decision-making, proactiveness, innovation/innovating, use of social support and opportunity recognition as the independent variables and AC as the dependent variable, it was found that the neural network had five neurons in the input layer, four neurons in the hidden layer, and one neuron in the output layer. Figure 7.21 depicts the first neural network.

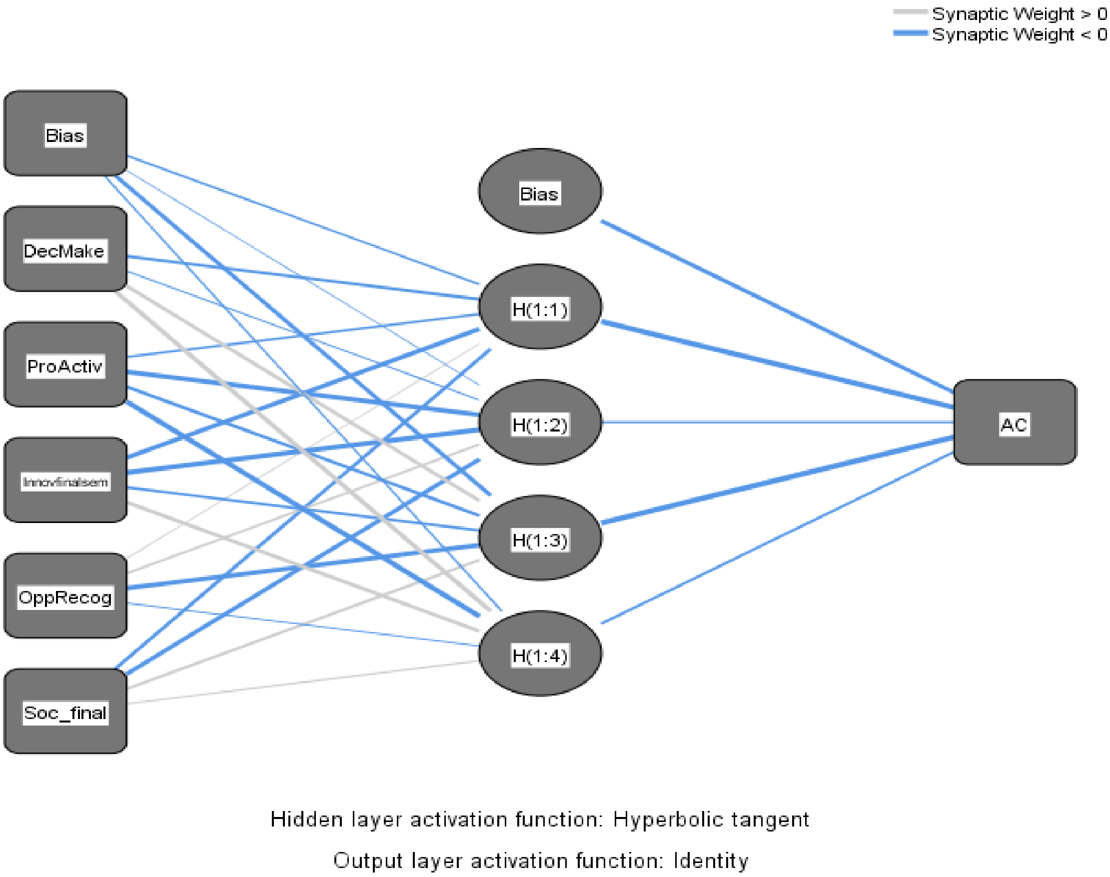


Figure 7.21: Neural Network 1

After using the FEC: value creation as the independent variables and AC as the dependent variable, it was found that the neural network had one neuron in the input layer, one neuron in the hidden layer, and one neuron in the output layer. Figure 7.22 depicts the second neural network.

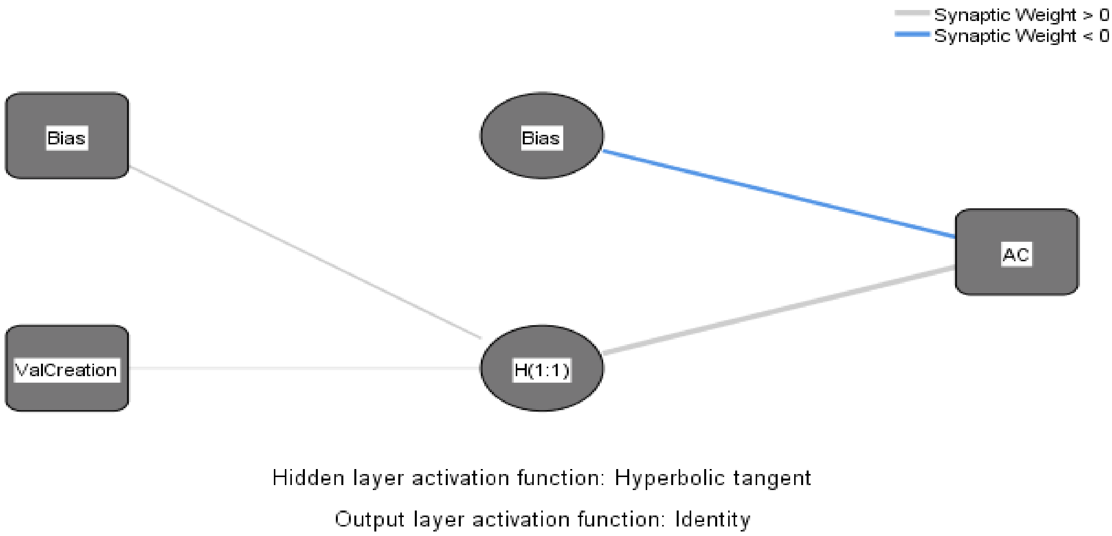


Figure 7.22: Neural Network 2

After using the SECs: positive attitude, networking and leadership as the independent variables and AC as the dependent variable it was found that the neural network had three neurons in the input layer, one neuron in the hidden layer, and one neuron in the output layer. Figure 7.23 depicts the third neural network.

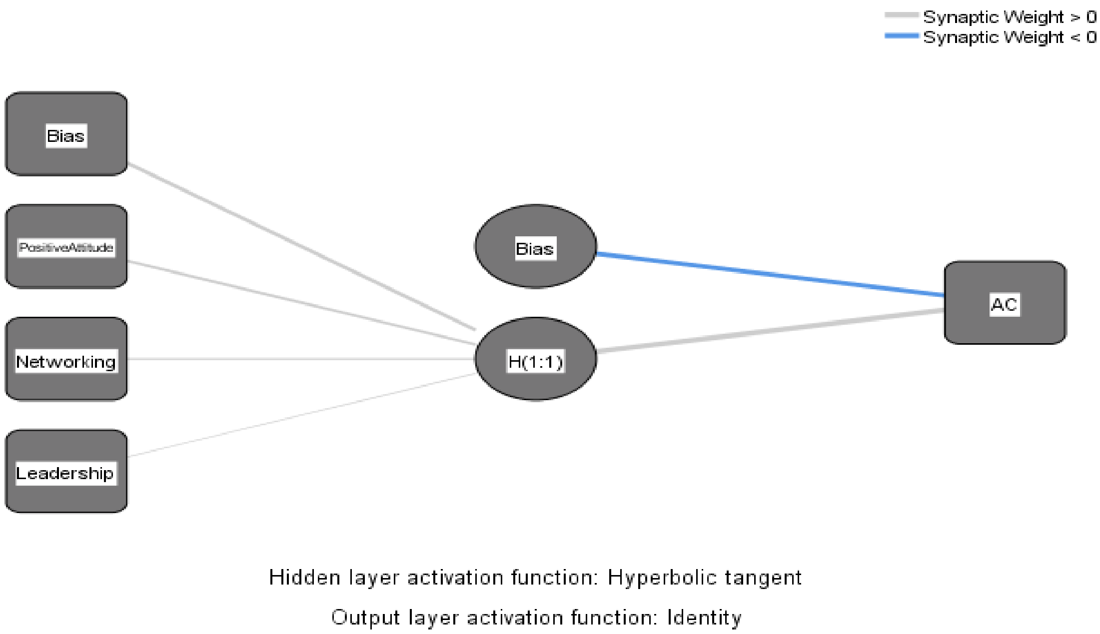


Figure 7.23: Neural Network 3

After using the MECs: problem-solving and cognitive ability as the independent variables and AC as the dependent variable, it was found that the neural network had three neurons in the input layer, four neurons in the hidden layer, and one neuron in the output layer. Figure 7.24 depicts the fourth neural network.

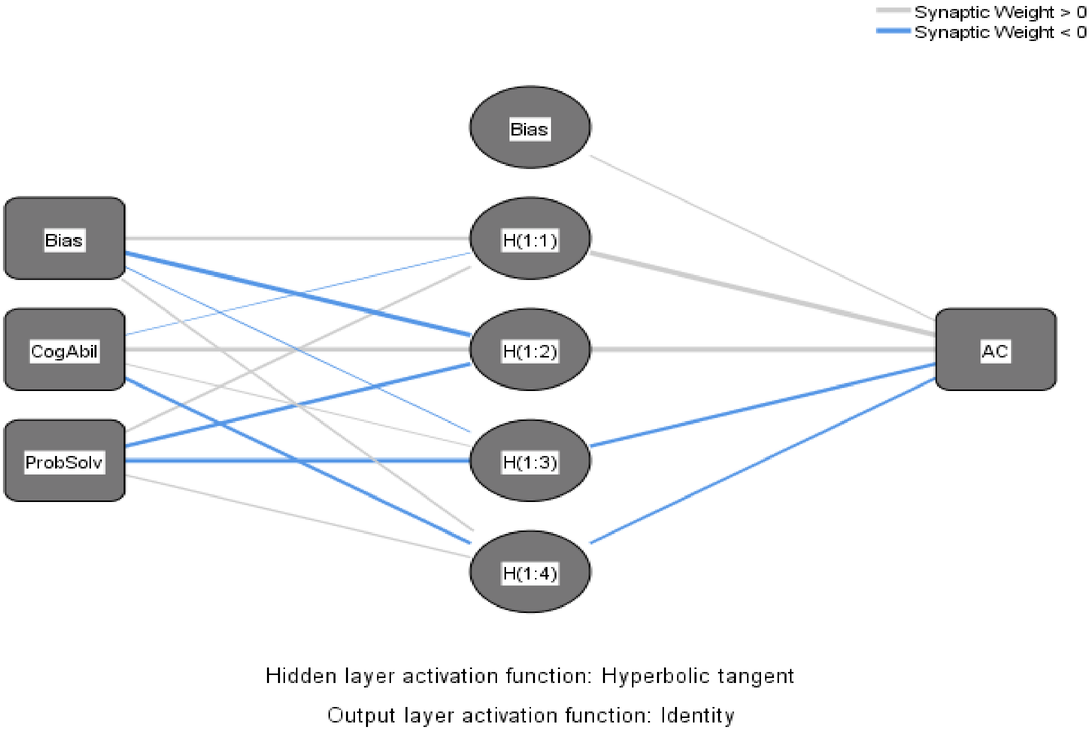


Figure 7.24: Neural Network 4

After using AC as independent variable and IC as the dependent variable, it was found that the last neural network had one neuron in the input layer, two neurons in the hidden layer, and one neuron in the output layer. Figure 7.25 depicts the fifth and final neural network.

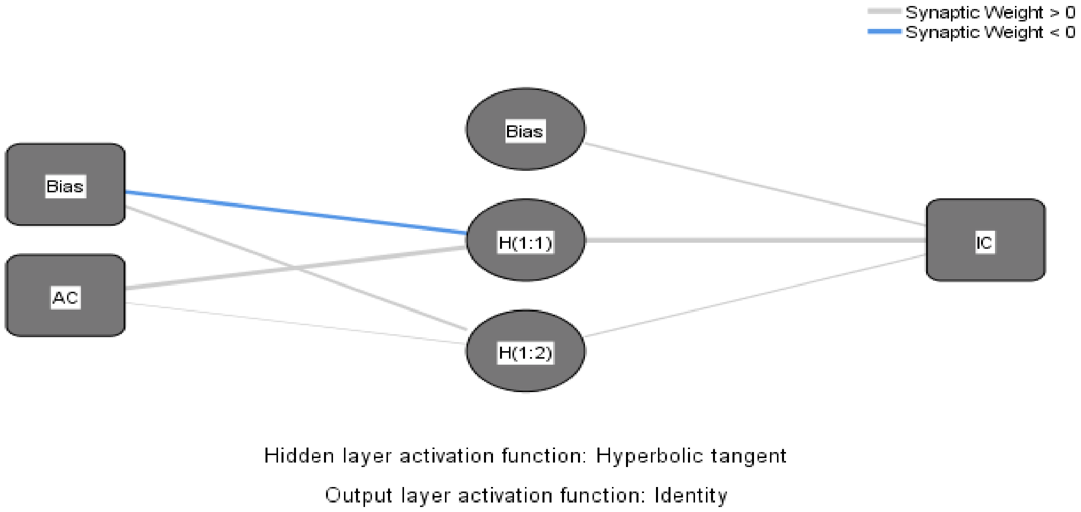


Figure 7.25: Neural Network 5

7.6.1 Comparing the Results of the Neural Network Models and the SEM Squared Multiple Correlations

The relative error (training and testing) as well as the squared multiple correlations of SEM compared with the (1-relative error) testing for NN is presented in Table 7.21.

Table 7.21: Summary of the comparison between SEM Squared Multiple Correlations and Neural Network models

NN	Independent variables	Number of units in hidden layer 1	Dependent variables	Relative error: Training	Relative error: Testing	SEM Squared Multiple Correlations	1 - Relative error: NN Testing
Cognitive Competencies							
Neural Network 1	Decision-Making Proactiveness Innovation/ innovating Use of social support Opportunity Recognition	4	AC	0.492	0.506	0.812	0.494
Functional Competencies							
Neural Network 2	Value Creation	1	AC	0.558	0.557	0.659	0.443
Social Competencies							
Neural Network 3	Positive Attitude Networking Leadership	1	AC	0.555	0.497	0.575	0.503
Meta Competencies							
Neural Network 4	Problem Solving Cognitive ability	4	AC	0.466	0.452	0.695	0.548
Neural Network 5	Absorptive capacity	2	IC	0.814	0.846	0.158	0.154

Source: Own compilation

The main findings regarding the squared multiple correlations for SEM compared with the percentage variance explained (1-Relative error for testing sample) testing for NN found that all the squared multiple correlations for SEM tested higher than the relative errors of NN for Model 1 (SEM = 0.812, NN = 0.494), Model 2 (SEM = 0.659, NN = 0.443), Model 3 (SEM = 0.575, NN = 0.503), (SEM = 0.695, NN = 0.548), and Model 5 (SEM = 0.158, NN = 0.154). Therefore, based on this comparison, NN did not provide improved model fit over SEM.

Based on the results of the SEM Models 1.1–1.4 and NN models 1–5 summarised in Table 7.21, hypothesis H7 was tested.

H7: Neural Networking (through testing non-linear relationships) provided an improved model fit to that provided by Structural Equation Modelling (SEM) through linear relationships.

The hypothesis regarding NN providing an improved model fit over SEM is therefore not supported for all five NN models.

7.7 CONCLUSION

The first two stages of the data analysis (refer to Figure 6.1), the descriptive statistics and the factor analysis were presented in Chapter 6. The analysis and discussion of SEM results (stage 3) and final NN models were presented in this chapter (refer to Figure 7.4). The process assisted in presenting four SEM models and provided more insights into the interrelationships within and across each of the three conceptual frameworks:

- Conceptual framework 1: The four SEM Models (1.1–1.4) represented the relationships between the four competence categories, CEC, FEC, SEC and MEC with EACAP and IC.
  - The relationships between ECs and IC

    In SEM Model 1.1, the hypotheses regarding the significant positive relationships between CECs and IC (H1a) were consequently not supported for the three competencies: decision-making ($H1a_1$), proactiveness ($H1a_2$) and use of social support ($H1a_5$), but were supported for innovation ($H1a_3$) and opportunity recognition ($H1a_4$). The SEM model (model 2) with additional covariances added provided the most acceptable model fit (see Table 7.1). In SEM Model 1.2, the relationship of FEC: value-creation with IC as presented by the structural path estimates was statistically significant and positive. The hypothesis regarding the relationships between FECs and IC (H1b) was consequently supported. The SEM model (model 2) with additional covariances added provided the most acceptable model fit (see Table

7.4). In SEM Model 1.3, the hypothesis regarding the significant positive relationships between networking and IC ($H1c_2$) was consequently supported, but not supported for the competencies: positive attitude ($H1c_1$), and leadership ($H1c_3$). The SEM model (model 2) with additional covariances added provided the most acceptable model fit (see Table 7.7). In SEM Model 1.4, the hypothesis regarding the significant positive relationships between cognitive ability and IC ($H1d_2$) and problem-solving ($H1d_1$) and IC was not supported. The SEM model (model 3) with additional covariances added and an item deleted that tested below the indicator path coefficient threshold of 0.5, provided the most acceptable model fit (see Table 7.10).

  - The relationship between EACAP and IC

    The hypotheses regarding the significant positive relationships between EACAP and IC in the SEC (H2c) and MEC (H2d) models were supported, but consequently not supported in the CEC (H2a) and FEC (H2b) models.

  - The relationships between ECs and EACAP

    In SEM Model 1, the hypothesis regarding the significant positive relationships between the CECs and EACAP (H3a) was consequently not supported for the competency: decision-making ($H3a_1$), but supported for the other four competencies: proactiveness ($H3a_2$), innovation/innovating ($H3a_3$), opportunity recognition ($H3a_4$) and use of social support ($H3a_5$). In SEM Model 1.2, the hypothesis regarding the relationship between the FEC: value creation (H3b) was supported. In SEM Model 1.3, the hypotheses regarding the relationships between all three SECs: positive attitude ($H3c_1$), networking ($H3c_2$), and leadership ($H3c_3$) with EACAP were supported. In SEM Model 1.4, the hypotheses regarding the relationships between the two MECs: cognitive ability ($H3d_1$) and problem-solving ($H3d_2$) were supported.

- Conceptual framework 2: EACAP as mediator and moderator between EC and IC
  - The hypotheses regarding EACAP as mediator between ECs and IC were not supported for CEC (H4a) (SEM Model 1.1) and FEC (H4b) (SEM Model 1.2), as none of the indirect effects were statistically

significant, but were supported for SEC (H4c) (SEM Model 1.3) and MEC (H4d) (SEM Model 1.4). Consequently, EACAP was tested as moderator between the competence categories CEC and FEC and IC, as they were not found to play a mediation role in this relationship.

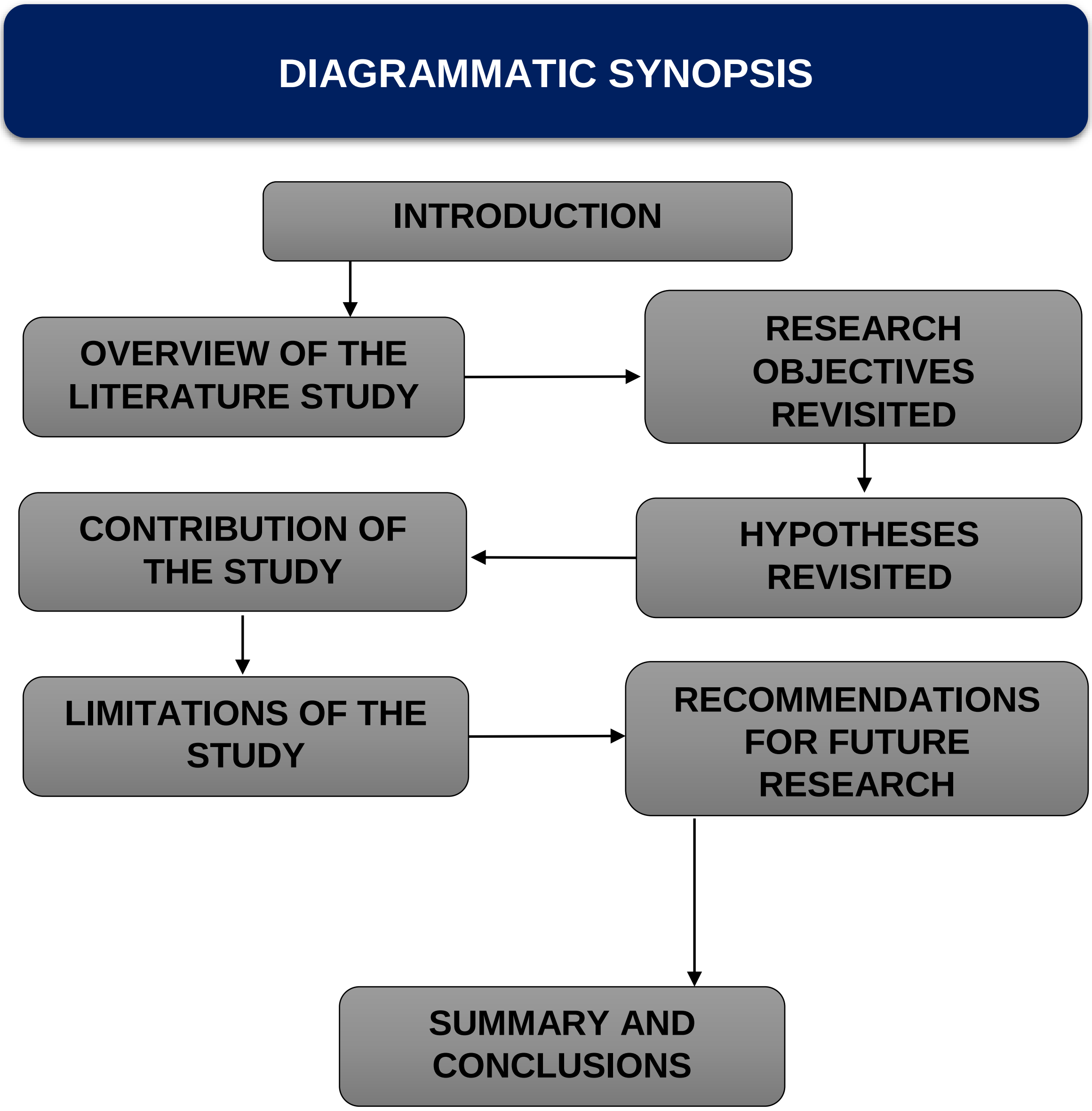
    - The hypotheses regarding EACAP as moderator between both CEC (decision-making, proactiveness, innovation/innovating, opportunity recognition, use of social support) (H5a) (SEM Model 1.1) and FEC (value creation) (H5b) (SEM Model 1.2) with IC were consequently supported.

- Conceptual framework 3: EC as moderator between EACAP and IC
  EC is a statistically significant moderator in the relationship between three of the eleven competencies with IC (CEC: use of social support; SEC: networking; MEC: cognitive ability).
- Results of the SEM models compared with NN models
  The hypotheses regarding NN providing an improved model fit over SEM was not supported for all five NN models.

The interpretation and implication of these results as well as final conclusions, recommendations and limitations of the study are presented in the final chapter (Chapter 8). The recommendations for future research are also discussed in Chapter 8, which offers scholars new avenues of investigation regarding the constructs and interrelationships found in this study.

CHAPTER 8:

CONCLUSIONS AND RECOMMENDATIONS



8.1 INTRODUCTION

In order to ensure that a country is taking advantage of what industry 4.0 (I4.0) has to offer (Ferreira, Fernandes, Raposo, Thurik & Faria, 2016), entrepreneurs are seen as a key instrument, as they link innovation and opportunity-seeking to ensure that they gain competitive advantage (Mazzei, 2018; Vendrell-Herrero, González-Pernía & Peña-Legazkue, 2014). While research into the area of entrepreneurial competency is growing, one aspect into which little research has been conducted is that of assessing ECs for entrepreneurs of the fourth industrial revolution (4IR). Even more so, whether EACAP and ECs increase these entrepreneurs' capacity to innovate.

The primary objective of this study was to determine whether there is a relationship between entrepreneurial competencies (EC) – within the four competence categories, entrepreneurial absorptive capacity (EACAP) and innovation capacity (IC) of innovative entrepreneurs in South Africa. A mixed-method approach was used for the data collection. The first part of the study was qualitative and was used to obtain evidence of the ECs that entrepreneurs in South Africa require in order to innovate in the 4IR and to determine which 4IR ECs were common with those ECs already identified in existing competency frameworks. The second part of the data collection comprised a quantitative approach to corroborate the ECs resulting from the qualitative aspect of this study. A research instrument (survey) was used to test the links between EC, EACAP and IC using a sample of 452 innovative entrepreneurs in South Africa.

In order to investigate the interrelationships between the constructs, a linear SEM approach was used to test the individual relationships. To bring more clarity into the roles that ECs and EACAP play in IC, a non-linear ANN approach was additionally investigated in order to determine whether a non-linear approach would provide an improved model fit when compared to the SEM.

This chapter provides an overview of the literature study, while the objectives and hypotheses are revisited and interpreted. The next section addresses the hypothesis statements: whether they are supported or not supported based on the statistical techniques executed in Chapter 7. Furthermore, the contribution of the study, its limitations, recommendations and opportunities for future research are outlined. The summary and conclusion constitute the final elements of the study.

8.2 OVERVIEW OF THE LITERATURE STUDY

The literature review was covered in Chapters 2, 3 (*Phase 1 and 2*) and 4 (*Phase 3*). Research objectives were formulated from the literature review and the measuring instrument was developed. The study sought to determine the relationships between three constructs: entrepreneurial competencies (ECs), entrepreneurial absorptive capacity (EACAP) and innovation capacity (IC). Empirical work and theoretical predictions as outlined in these chapters suggested that further work from a novel perspective was needed to bring clarity to the relationships under investigation. It is contended that research designs sometimes fail to recognise that both EC and EACAP may interact to increase the level of invention and the potential for innovation of entrepreneurs. Therefore, capturing such interaction effects using a pre-specified model would have been impractical, particularly when the effects are complex. The following is a short overview of the literature:

This study began with a discussion on 4IR and the ever-changing skills required for today's workforce – in particular, competencies required for entrepreneurs in order to steer this new industrial revolution. The study further revealed that ECs have to be forward-looking, as competency frameworks require change over time in order to be accurate predictors of performance. The study specifically focused on innovative entrepreneurs in South Africa.

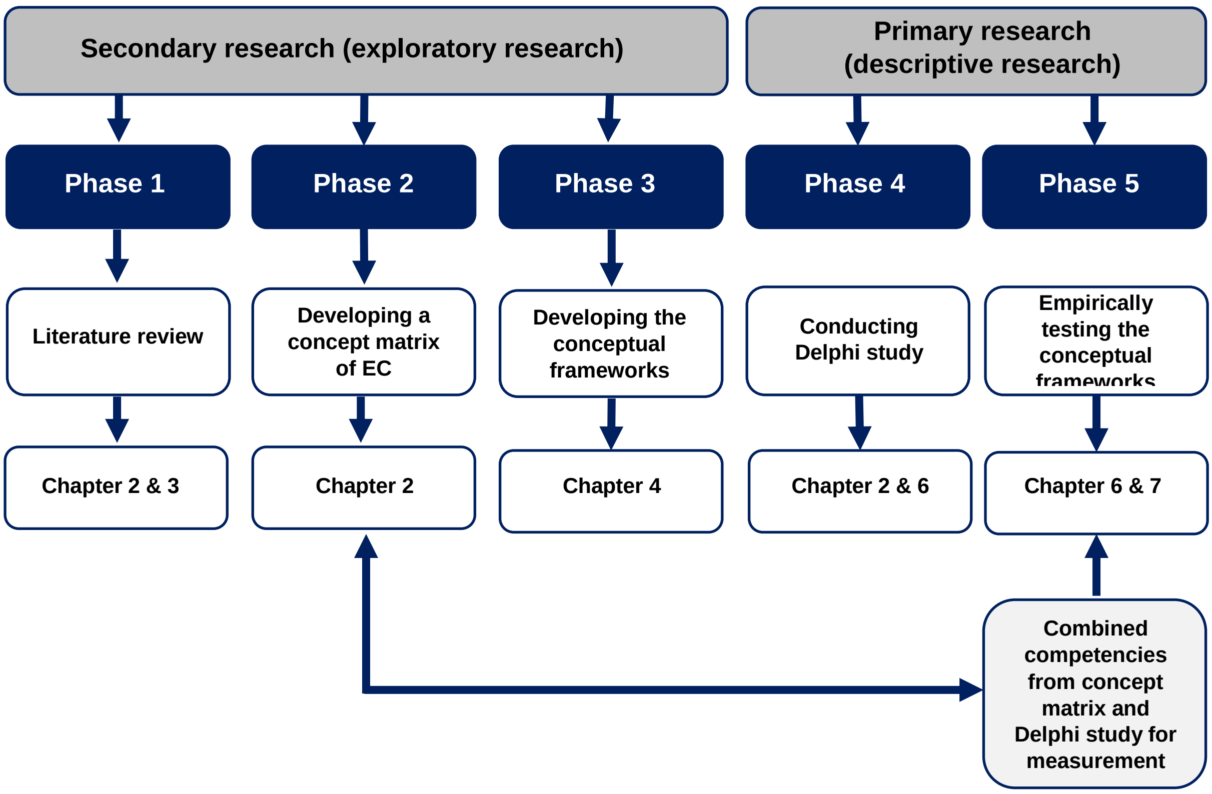


Figure 8.1: Methodological procedure of this study (including chapter outline)

As indicated previously and in Figure 8.1, in *phase 1* the body of knowledge on EC for 4IR and innovation is outlined in Chapter 2. In this section the main findings and conclusions from the literature review on existing EC research are summarised. While there has been much debate on predictors of innovative performance, the relationship between EC and IC is highlighted in the literature review – in particular, how this link between EC and IC is grounded in person-entrepreneurial fit theory. The chapter concluded by revealing the results of the ECs identified through the Delphi study conducted and the concept matrix (*phase 2)* from secondary research, and finally clustering the ECs for 4IR and innovation into four competence categories, as recommended by Winterton *et al.* (2006) and Le Deist and Winterton (2005).

Further in *phase 1*, the body of knowledge on absorptive capacity (ACAP) and IC was outlined in Chapter 3. In this chapter, a thorough investigation was conducted on the different constructs of ACAP and IC and how they are both linked to innovation. The first section of the chapter investigated literature on ACAP and the importance of ACAP as a capability to create innovative outputs in the form of new products and services. The grounding theories on which ACAP is built were discussed, and the link between

EC and ACAP was explained in the knowledge spillover theory. Conceptual models of ACAP were illustrated, where the four main dimensions for EACAP were revealed as recognition, assimilation, transformation and exploitation of new external knowledge. Not only does ACAP involve this interrelated flow of knowledge, but also contains antecedents (inputs), which involve prior knowledge diversity, network diversity and cognitive style, relating to individual ACAP. The contingency factors for individual ACAP involve power relationships and activation triggers, of which the ultimate outcome for individual ACAP is individual innovative performance. Based on the literature review of ACAP, it became evident that innovation is seen as an output of EACAP.

Chapter 3 further flowed into a second section, where IC was discussed. In order to determine how IC is measured, innovation was defined and broken down. The innovation process and individual innovation were discussed, leading to the unfolding of IC as a construct. For the purpose of this study, IC was defined as: "A concept that measures the level of invention and the potential for innovation". Measuring IC was therefore determined by taking into consideration various aspects from previous research, such as constructs used in the modelling of innovation and innovativeness. In measuring the level of innovation and innovativeness, the elements of innovation, such as the types of innovation and innovation degrees, were also investigated. The final elements used to measure IC were ultimately based on six constructs, namely newness, radicalness, uniqueness and superiority, innovation, competitive advantage and market pioneering.

Based on the literature review presented in chapters 2 and 3, three conceptual frameworks focusing on EC, EACAP and IC were developed in Chapter 4 (*phase 3*). The development of the conceptual frameworks endeavoured to unfold a deeper understanding of the entrepreneur for this emerging industrial revolution, and what is required to increase their IC as an entrepreneur. This would bring into the equation EACAP and ECs as measures in increasing an entrepreneur's level of invention that would inevitably predict the potential for innovation. The frameworks revolved around three grounding theories, namely the knowledge spillover theory, absorptive capacity theory and person entrepreneurship-fit theory. The literature revealed a need for the development of a model exploring the interrelationships between EACAP and ECs in the prediction of IC.

Prior to analysing the results obtained from the empirical part of the study, it is important to understand the demographic profile of the sample in order to contextualise the results obtained (refer to Chapter 6). The demographics of the innovative entrepreneurs included in the sample were analysed using descriptive statistics. Overall, it will be recalled, the sample consisted of a majority of male entrepreneurs with higher than average levels of education. The innovative entrepreneurs included in the sample consisted largely of established businesses with an average of less than R150 000 turnover per year, with the majority based in the Gauteng province and mostly experienced in general management. For most of the entrepreneurs, high levels of ECs were observed, particularly for decision-making, proactiveness, creative problem-solving and imaginativeness and problem-solving. The majority of the innovative entrepreneurs indicated good absorptive capacity capability and innovation capacity.

In *phase 5,* the conceptual frameworks were empirically tested. The hypotheses were tested through SEM analysis, which represented proposed theory resulting in four SEM models, specifying relationships (Hair *et al.*, 2019) between four categories of competencies, EACAP and IC. Additionally, the investigation of non-linear relationships as a potentially fruitful avenue for enhancing the understanding of IC was identified. Hence, ANN was used as a novel approach to resolve these challenges and resulted in five neural network (NN) models, which were compared with the SEM models. More specifically, the objective was to compare the explanatory power of ANN to SEM analysis in predicting IC.

8.3 RESEARCH OBJECTIVES REVISITED

The primary and secondary research objectives are revisited and presented below.

8.3.1 Primary objectives revised

The primary research objective of the study was to determine whether there is a significant positive relationship between entrepreneurial competencies (within the four competence categories), entrepreneurial absorptive capacity and innovation capacity of innovative entrepreneurial businesses in South Africa.

The primary objective of the research was achieved by measuring the various relationships in all the study's hypotheses.

8.3.2 Secondary objectives revisited

From the primary objective, the secondary objectives of the study were formulated, namely to determine:

1. The specific entrepreneurial competencies significant for innovation within the 4IR context in South Africa
   The first secondary objective was met by identifying twelve competencies that resulted from the Delphi study and concept matrix.

Furthermore, whether there was a significant positive relationship between:

2. The four categories of entrepreneurial competencies and innovation capacity
   The second secondary objective was met by measuring the four categories of ECs and IC in hypotheses H1a–H1d.
3. Entrepreneurial absorptive capacity and innovation capacity
   The third of the secondary objectives was met by measuring EACAP and IC in H2.
4. The four categories of entrepreneurial competencies and entrepreneurial absorptive capacity
   The fourth secondary objective was met by measuring the four categories of EC and EACAP in H3a–H3d.

   To determine whether:
5. Entrepreneurial absorptive capacity has a mediating effect on the relationship between the four categories of entrepreneurial competencies and innovation capacity
   The fifth secondary objective was met by measuring whether EACAP mediates the relationship between the four categories of EC and IC in H4a–H4b.
6. Entrepreneurial absorptive capacity has a moderating effect on the relationship between entrepreneurial competencies and innovation capacity

The sixth secondary objective was met by measuring whether EACAP moderates the relationship between EC and IC in H5.

7. The four categories of entrepreneurial competencies have a moderating effect on the relationship between entrepreneurial absorptive capacity and innovation capacity

   The seventh secondary objective was met by measuring whether the four categories of competencies have a moderating effect on the relationship between EACAP and IC in H6a–H6d.

8. Neural Networking (through testing non-linear relationships) provides an improved model fit to that provided by Structural Equation Modelling through linear relationships

   The final secondary objective was met by testing whether Neural Networking provided an improved model fit when compared to/with SEM in H7.

From the above it is clear that the primary and secondary objectives of the study as outlined within the scope of Chapter 1 were met.

8.4 HYPOTHESES REVISED

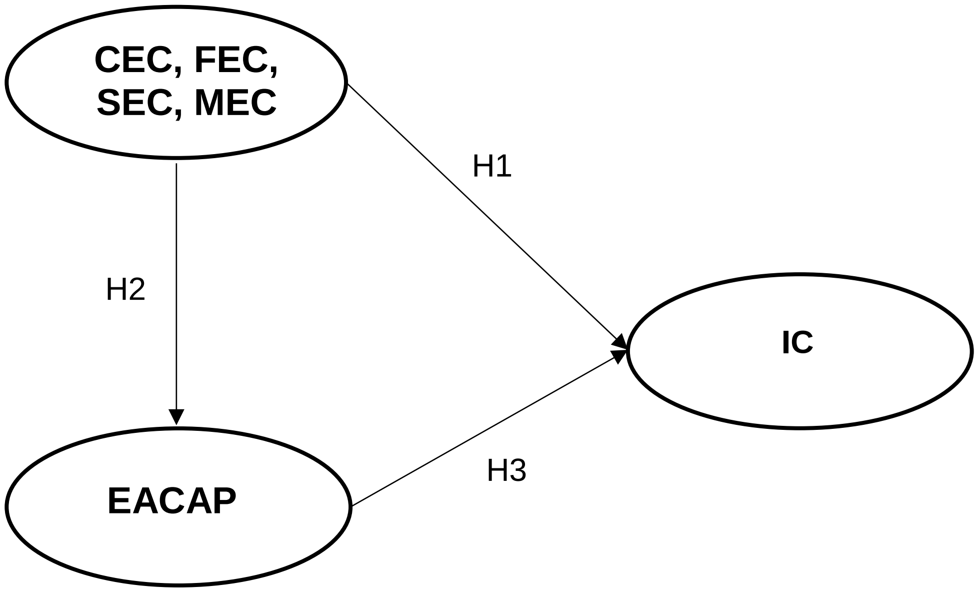
8.4.1 Measurement models and research hypotheses

The assessment of measurement model reliability and validity was conducted using CFA procedures. The findings suggested that the measurement models used in the study had an acceptable construct validity and reliability. All the measurement scales showed evidence of convergent validity in that each item had a statistically significant loading on its specified factor (Van Dyne & LePine, 1998).

8.4.2 Summary of results relating to tested hypotheses

In this study, the primary research objective is to determine whether there is a relationship between EC (within the four categories), EACAP and IC of innovative entrepreneurs in South Africa. The research hypotheses to be tested were grounded on sound EC, EACAP and IC theory as earlier elaborated. Table 8.1 provides a summary of the tested hypotheses regarding whether they are supported or not supported. Based on the main hypotheses stated in Chapter 5, additional hypotheses were added as indicated in Chapter 7, section 7.3.5 in order to indicate the specific significant relationships within the 11 ECs and the four EC categories (where it was applicable). Out of the 61 hypotheses to be tested, 28 were supported and 33 were not supported. The hypotheses were tested using SEM. Results from such empirical testing are used to either support or not support the hypotheses set out in Table 8.1–8.3.

8.4.2.1 Hypotheses surrounding relationships between EC, EACAP and IC



EACAP = Entrepreneurial Absorptive Capacity

IC = Innovation Capacity

CEC = Cognitive Entrepreneurial Competencies

FEC = Functional Competencies

SEC = Social Competencies

MEC = Meta Competencies

Figure 8.2: Hypothesised model based on conceptual framework 1

Objective 1: A research objective of the study was to determine whether there is a significant positive relationship between the four categories of ECs and IC.

Objective 2: A research objective of the study was to determine whether there is a significant positive relationship between EACAP and IC.

Objective 3: A research objective of the study was to determine whether there is a significant positive relationship between the four categories of ECs and EACAP.

The research hypotheses that were put forward in Chapter 5 (Table 5.7) and restated with sub-hypotheses as indicated in Chapter 7 (section 7.3.5) were incorporated. In this regard the following hypotheses were stated:

Table 8.1: Summary of results relating to tested hypotheses: relationships between EC, EACAP and IC

Hypotheses Tested		Supported/Not supported
H1:	There is a significant positive relationship between Entrepreneurial Competencies and Innovation Capacity	Not supported
H1a:	There is a significant positive relationship between Cognitive Competencies and Innovation Capacity	Not supported
H1a1	There is a significant positive relationship between the cognitive competency, decision-making and IC	Not supported
H1a2	There is a significant positive relationship between the cognitive competency, proactiveness and IC	Not supported
H1a3	There is a significant positive relationship between the cognitive competency, innovation/innovating and IC	Supported
H1a4	There is a significant positive relationship between the cognitive competency, opportunity recognition and IC	Supported
H1a5	There is a significant positive relationship between the cognitive competency, use of social support and IC	Not supported
H1b:	There is a significant positive relationship between Functional Competencies and Innovation Capacity	Supported
H1c:	There is a significant positive relationship between Social Competencies and Innovation Capacity	Not supported
H1c1	There is a significant positive relationship between the social competency, positive attitude and IC	Not supported
H1c2	There is a significant positive relationship between the social competency, networking and IC	Supported
H1c3	There is a significant positive relationship between the social competency, leadership and IC	Not supported
H1d:	There is a significant positive relationship between Meta Competencies and Innovation Capacity	Not supported

H1d1	There is a significant positive relationship between the meta competency, cognitive ability and IC	Not supported
H1d2	There is a significant positive relationship between the meta competency, problem-solving and IC	Not supported
H2:	There is a significant positive relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H21	There is a significant positive relationship between EACAP and IC within the CEC Model (1.1)	Not supported
H22	There is a significant positive relationship between EACAP and IC within the FEC Model (1.2)	Not supported
H23	There is a significant positive relationship between EACAP and IC within the SEC Model (1.3)	Supported
H24	There is a significant positive relationship between EACAP and IC within the MEC Model (1.4)	Supported
H3:	There is a significant positive relationship between Entrepreneurial Competencies and Entrepreneurial Absorptive Capacity	Not supported
H3a:	There is a significant positive relationship between Cognitive Competencies and Entrepreneurial Absorptive Capacity	Not supported
H3a1	There is a significant positive relationship between the cognitive competency, decision-making and IC	Not supported
H3a2	There is a significant positive relationship between the cognitive competency, proactiveness and IC	Supported
H3a3	There is a significant positive relationship between the cognitive competency, innovation/innovating and IC	Supported
H3a4	There is a significant positive relationship between the cognitive competency, opportunity recognition and IC	Supported
H3a5	There is a significant positive relationship between the cognitive competency, use of social support and IC	Supported
H3b:	There is a significant positive relationship between Functional Competencies and Entrepreneurial Absorptive Capacity	Supported
H3c:	There is a significant positive relationship between Social Competencies and Entrepreneurial Absorptive Capacity	Supported
H3c1	There is a significant positive relationship between the social competency, positive attitude and EACAP	Supported
H3c2	There is a significant positive relationship between the social competency, networking and EACAP	Supported
H3c3	There is a significant positive relationship between the social competency, leadership and EACAP	Supported

H3d:	There is a significant positive relationship between Meta Competencies and Entrepreneurial Absorptive Capacity	Supported
$H3d_1$	There is a significant positive relationship between the meta competency, cognitive ability and EACAP	Supported
$H3d_2$	There is a significant positive relationship between the meta competency, problem-solving and EACAP	Supported

Source: Own compilation

The results reported in Table 8.1 provide the outcome of the hypotheses for conceptual framework 1 (SEM Models 1.1–1.4).

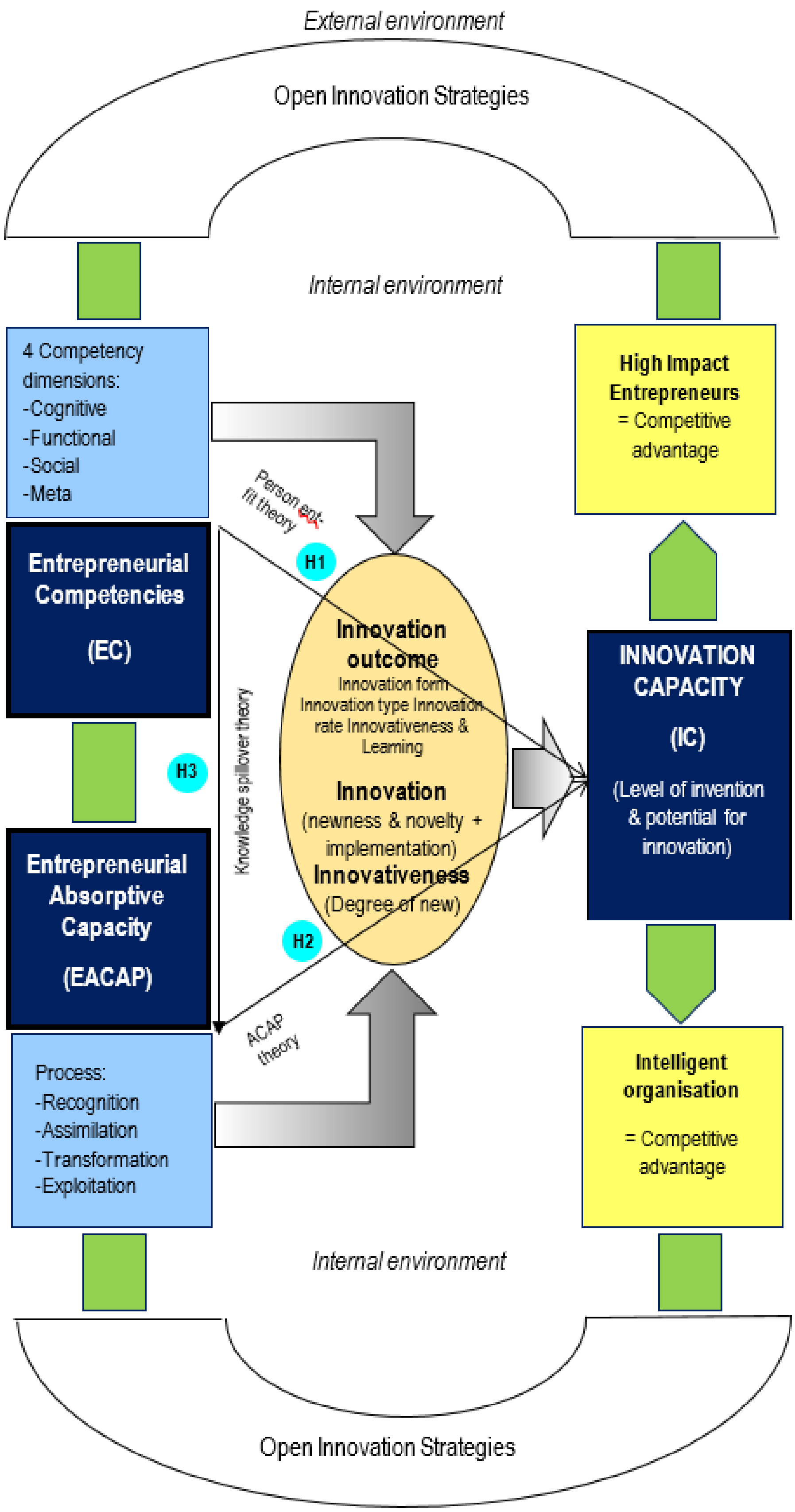


Figure 8.3: Conceptual framework 1: Relationships (Hypotheses 1, 2, 3)

Source: Own compilation

The main findings regarding the structural model hypotheses H1a–H3d are summarised below and were discussed in Chapter 7, section 7.3.5.

- *The relationships between EC and IC*

H1: There is a significant positive relationship between Entrepreneurial Competencies and Innovation Capacity

A research objective of the study was to determine whether there was a relationship between the four categories of ECs and IC. The literature supports the notion that competencies are seen as observable behaviours that are more tied to performance than other entrepreneurial characteristics such as intentions, personality traits, and motivations (Bird, 1995; Man *et al.*, 2002b) (refer to section 4.2.1). Accordingly, the regression weights reported for H1a–H1d indicate that innovation/innovating, opportunity recognition (CEC), value creation and (FEC) networking (SEC) contributed positively towards explaining some degree of the variance in the IC of entrepreneurs. However, only one of the four hypotheses tested (H1b) demonstrated significant positive relationships between all the competencies and IC, which was for FEC.

Following on from this conclusion, the next step is to understand the relationship that exists between EACAP and IC (H2).

- *The relationships between EACAP and IC*

H2: There is a significant positive relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity

A research objective of the study was to determine whether there was a significant positive relationship between EACAP and IC. The results from the structural model yielded positive statistically significant relationships between EACAP and IC with SEM models including SECs and MECs and yielded no statistically significant relationships between EACAP and IC with CECs and FECs. Therefore, EACAP contributed positively towards explaining some degree of the variance in the IC of entrepreneurs within the SEC model, including positive attitude, networking and leadership and the MEC model, including cognitive ability and problem-solving.

- *The relationships between EC and EACAP*

H3: There is a significant positive relationship between Entrepreneurial Competencies and Entrepreneurial Absorptive Capacity

A research objective of the study was to determine whether there was a significant positive relationship between the four categories of ECs and EACAP. According to the findings for H3a–H3d, the regression weights reported indicated that proactiveness, innovation/innovating, opportunity recognition, use of social support (CEC), value creation (FEC) positive attitude, networking, leadership (SEC), cognitive ability and problem-solving (MEC) contributed positively towards explaining some degree of the variance in the EACAP of entrepreneurs. However, two of the four hypotheses tested (H3c and H3d) demonstrated significant relationships between all the competencies and IC, which were for SEC and MEC.

Upon closer investigation, the findings of this study built upon prior studies that have considered ECs and EACAP that have an effect on IC. This is the case with the person-entrepreneurship-fit theory, suggesting that identifying entrepreneurial success is determined by the competencies required for creating a new venture (Markman & Baron, 2003), supporting the EC–IC relationship notion. This notion is further supported in evidence suggesting that skills and capabilities are key factors in the creation of a high-productivity, high-wave economy, while at the same time contributing to organisational innovations (Smith, Courvisanos, Tuck & McEachern, 2011:83). ECs have also been found to be closely related to SME performance (Man, Lau & Snape, 2008). Not only is it suggested that IC be built upon ECs, but also utilising existing knowledge as efficiently as possible (Brix, 2019:21), which was found to be credible in this study. In further support of the EACAP–IC relationship, Dahlstrand and Stevenson (2010:10) have identified knowledge building and sharing as a driver of innovation.

Interestingly, five of the ECs (CEC: opportunity recognition, innovation/innovating; FEC: value creation; SEC: networking; MEC: cognitive ability) indicated significant relationships with both IC and EACAP. Based on the CECs, opportunity recognition is a typical competency that explains why entrepreneurial behaviour increases the probability to generate novel ideas for an innovative venture, but is also dependent on investments in new knowledge in the form of human capital and R&D (Dyer, Gregersen & Christensen, 2008:317). The notion of the importance of opportunity recognition is further supported where it is linked to SME performance (Man *et al*., 2008:257). To sense and identify new opportunities is also a crucial ability for absorbing novel knowledge (Todorova & Durisin, 2007:783), which occurs during the first “recognition” process of EACAP. Furthermore, it is known that innovation springs from the creative application of knowledge, which consists of creativity and the stock of knowledge (Yusuf, 2007), explaining its contribution towards some degree of variance in the IC and EACAP of entrepreneurs. This notion is supported by Liao, Wu, Hu and Tsuei (2009:164), who found a positive relationship with knowledge acquisition, ACAP and IC. It therefore takes an entrepreneur with a superior capability to know how to do something, such as innovate, rather than just knowing something can be done (Miller & Morris, 2008:75). This explains why CECs specifically play such an important role in an entrepreneur’s capacity to innovate, as knowledge is captured by cognitive competence (Winterton *et al.,* 2006:41).

With regard to the significant positive relationship between innovation/innovating and IC, the findings of this study are consistent with Antonites (2017); Steiner (2009) and Barth (1993). The findings of the relationship between innovation/innovating and EACAP further concur with the literature that someone with an innovative and creative anchor can transfer knowledge and ideas (Barth, 1993; Dixon, Meier, Brown & Custer, 2005), taking into consideration that creativity was merged with innovation/innovating after concluding the Delphi study results in Chapter 2 (section 2.6). Although no significant relationship was found between decision-making and EACAP, but between EC and IC, yet negative, Holcomb, Ireland, Holmes Jr and Hitt (2009:182) argue that experienced entrepreneurs tend to choose actions that relate to those that have succeeded in the past. Thereby, by exploiting prior knowledge and strengthening existing associations in memory, entrepreneurs’ stronger associations can speed up decision-making.

The only FEC: value creation, which is a competency linked to a specific outcome (Cheetham & Chivers, 1996), such as IC in this study, is supported by the notion that it involves having the capability of developing new products, services, business models (Morris, Webb, Fu & Singhal, 2013) and involves innovation (Priem, 2007). It becomes plausible that greater value creation depends on a firm’s ability to innovate successfully (Adner & Kapoor, 2010).

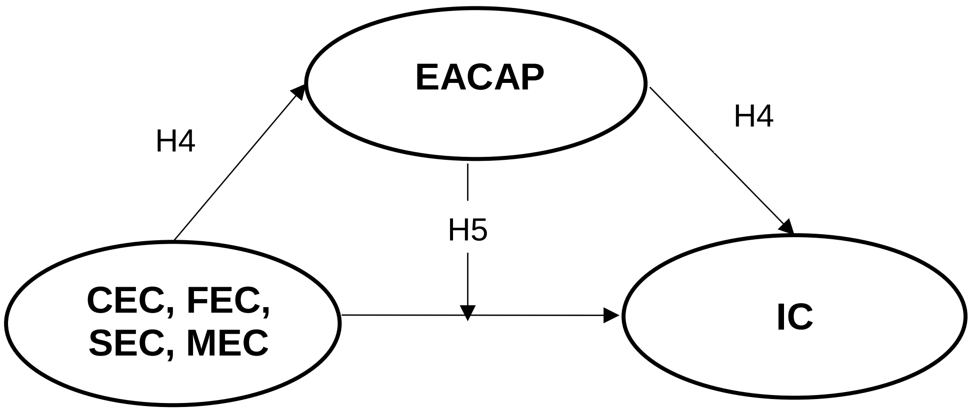
However, the findings regarding the significant relationships between the ECs: proactiveness, use of social support, positive attitude, leadership and problem-solving and IC were not supported, where insignificant relationships were found. Although support is not given in this study, scholars have found support that proactiveness influences the number of innovations generated in innovative firms (Pérez-Luño, Wiklund & Cabrera, 2011). Use of social support, found as a sub factor for resilience (Morris *et al*., 2013), has also been found to lead to innovation (Carayannis, Grigoroudis, Sindakis & Walter, 2014). Positive attitude, which is a SEC comprising attitudes and behaviours, has been identified as a competency that forms part of a lifelong process that contributes to and shapes IC (Smith *et al.,* 2011). Leadership, on the other hand, also categorised as a SEC, is regarded as even more important when innovation is concerned with radical change (Prajogo & Ahmed, 2006). Results regarding the relationships between innovation stimulus factors (leadership, people management, knowledge management, creativity management) and IC factors of innovation management indicated that an excellent innovation stimulus is likely to be demonstrated in an excellent IC (Prajogo & Ahmed, 2006:509). According to Matthews and Brueggemann (2015), problem-solving is an innovative behaviour that brings innovation to light and life.

Based on SEC, the findings regarding networking are evident in previous research, which confirms that external networking leads to higher innovative levels (Hussler & Ronde, 2009:6) and that networking ability appears to be a key characteristic linked to the diffusion of innovation (Dale, Ling & Newman, 2010) and the integration of networks, seen as a key towards IC (Pierre & Fernandez, 2018:156). Networking is also significant and positive in its relationship with EACAP in the sense that it is an antecedent of ACAP (Cohen & Levinthal, 1990; Hayton & Zahra, 2005; Jane Zhao & Anand, 2009), which is conceptualised as one of the micro-foundations that determine the creation of individual and organisational-level routines and capabilities (Abell, Felin & Foss, 2008:489). Therefore, an entrepreneur with a high level of networking ability is more likely to be exposed to a broad range of sources where potential new knowledge can be accessed, which has a positive effect on the recognition of new knowledge in the EACAP process. This explains the importance of developing networking as a SEC, as SECs are of particular importance for specific occupations (Le Deist & Winterton, 2005), such as being an entrepreneur. Networking therefore requires an ability to adopt appropriate, observable behaviours and attitudes in work-related situations (Cheetham & Chivers, 1996:24) as an entrepreneur.

Based on MEC, an individual's cognitive style is considered to be an important antecedent of ACAP, which determines what knowledge is identified and acquired, how it is assimilated and how it is transformed (Hayes & Allinson, 1994:53). Although the relationship was found to be negative, the significant relationship between cognitive ability and EACAP is evident in the sense that an entrepreneur has the ability to generate or use different sets of rules for combining or grouping things in different ways (Gray, 2016). Research conducted on cognitive science and individual learning recognises that the development of new cognitive structures follows assimilation and transformation (Marshall, 1995; Piaget & Cook, 1952) – the second and third dimension in the EACAP process. Further evidence supports the notion that cognitive factors are associated with the ability to innovate (Ahmed, 1998:7).

Based on the above results, it is evident that cognitive, functional, social and meta competencies have an effect on EACAP and IC. Consequently, the SEM and model fit indices indicated adequate model fit for all four competence categories, CEC (Model 1.1), FEC (Model 1.2), SEC (Model 1.3) and MEC (Model 1.4).

8.4.2.2 Hypotheses surrounding EACAP as mediator and moderator
8.4.2.3



EACAP = Entrepreneurial Absorptive Capacity

IC = Innovation Capacity

CEC = Cognitive Entrepreneurial Competencies

FEC = Functional Competencies

SEC = Social Competencies

MEC = Meta Competencies

Figure 8.4: Hypothesised model based on conceptual framework 2

The results reported in Table 8.2 provide the outcome of the hypothesis for conceptual framework 2 (SEM Model 1.1–1.4). The main findings regarding structural model hypotheses of H4–H5 are summarised below.

Table 8.2: Summary of results relating to tested hypotheses: EACAP as mediator and moderator

H4:	Entrepreneurial Absorptive Capacity mediates the relationship between Entrepreneurial Competencies and Innovation Capacity	Not supported
H4a:	Entrepreneurial Absorptive Capacity mediates the relationship between Cognitive Competencies and Innovation Capacity	Not supported
H4b:	Entrepreneurial Absorptive Capacity mediates the relationship between Functional Competencies and Innovation Capacity	Not supported
H4c:	Entrepreneurial Absorptive Capacity mediates the relationship between Social Competencies and Innovation Capacity	Supported
H4d:	Entrepreneurial Absorptive Capacity mediates the relationship between Meta Competencies and Innovation Capacity	Not supported
H4d1:	Entrepreneurial Absorptive Capacity mediates the relationship between the Meta Competency, cognitive ability and Innovation Capacity	Supported
H4d2:	Entrepreneurial Absorptive Capacity mediates the relationship between Meta Competency, problem-solving and Innovation Capacity	Not supported
H5:	Entrepreneurial Absorptive Capacity moderates the relationship between Entrepreneurial Competencies and Innovation Capacity	Supported
H51:	Entrepreneurial Absorptive Capacity moderates the relationship between Cognitive Competencies and Innovation Capacity	Supported
H52:	Entrepreneurial Absorptive Capacity moderates the relationship between Functional Competencies and Innovation Capacity	Supported

Source: Own compilation

The results reported in Table 8.2 provide the outcome of the hypotheses for conceptual framework 2 (SEM Model 1.1–1.4), where the hypotheses regarding EACAP as mediator and moderator between the four competence categories and IC were tested.

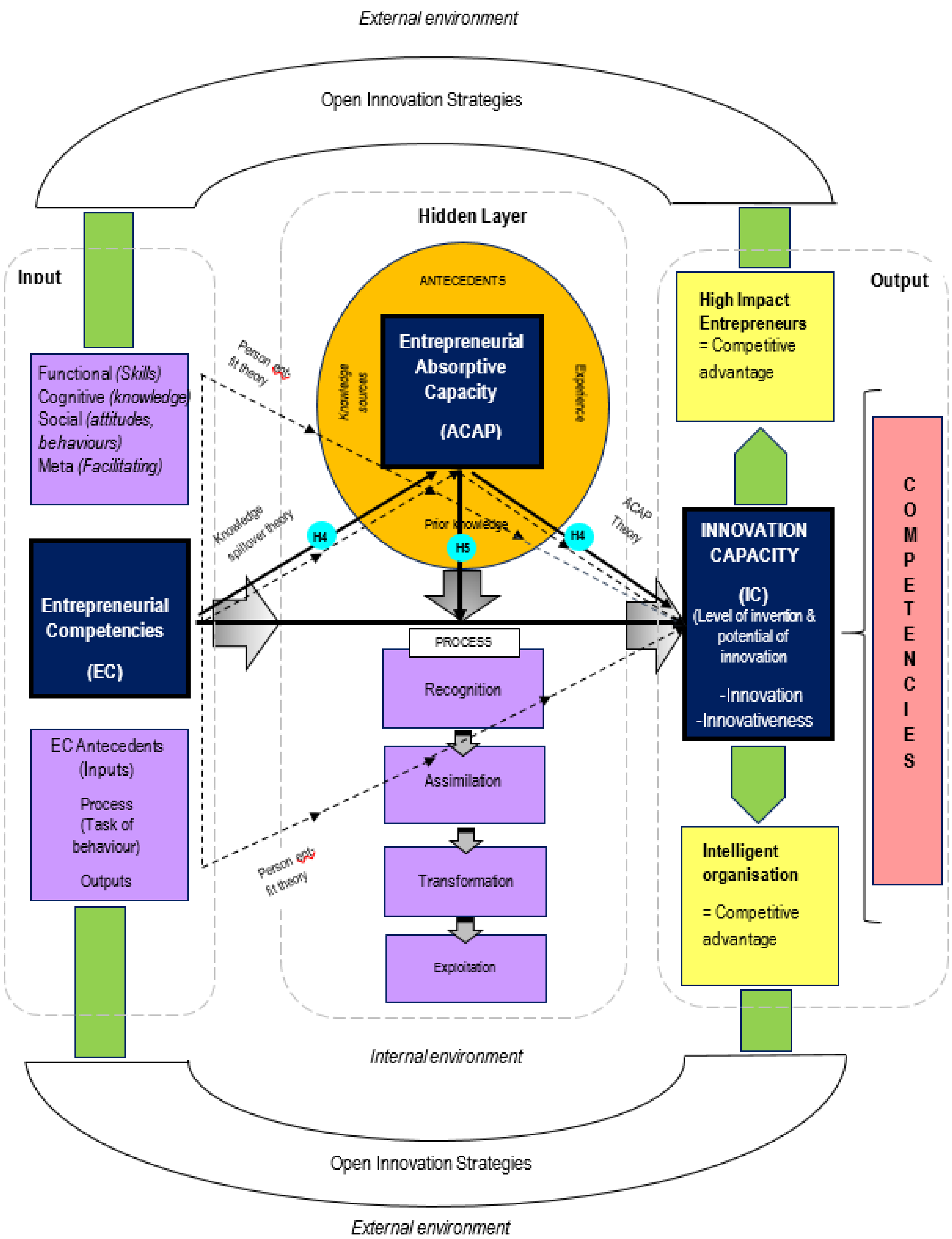


Figure 8.5: Conceptual framework 2: EACAP as moderator and mediator (Hypotheses 4 & 5)

Source: Own compilation

The main findings regarding the structural model hypotheses H4 and H5 are summarised below and were discussed in Chapter 7, section 7.4.4 and section 7.4.5.

- *EACAP as mediator between EC and IC*

H4: Entrepreneurial Absorptive Capacity mediates the relationship between Entrepreneurial Competencies and Innovation Capacity

Table 8.2 indicates that the research hypotheses of H4a (with CEC) and H4b (with FEC) were not supported and H4c was only supported for cognitive ability (MEC). The hypotheses H4c with SECs (positive attitude, networking, leadership) were fully supported. EACAP was therefore found to fully mediate the relationship between SEC and IC. Therefore, the results supported the mediating role of EACAP in IC for four of the eleven ECs. These results indicate that EACAP provides a theoretical explanation for four ECs and the entrepreneur's subsequent capacity to innovate (IC) and explains why a relationship between these constructs exists. These findings concur with the literature review that suggested EACAP as a mediator (Francalanci & Morabito, 2008; Kostopoulos *et al.*, 2011; Leal-Rodríguez *et al.*, 2014b; Liu *et al.*, 2013; Moilanen *et al.*, 2014). Liao *et al.* (2009) specifically found ACAP to be a mediator between knowledge acquisition and innovation capability. The findings of this study and the inferences being drawn are consistent with the work of entrepreneurship theorists, Qian and Acs (2013), where the ACAP theory of knowledge spillover entrepreneurship has connected human capital and entrepreneurship.

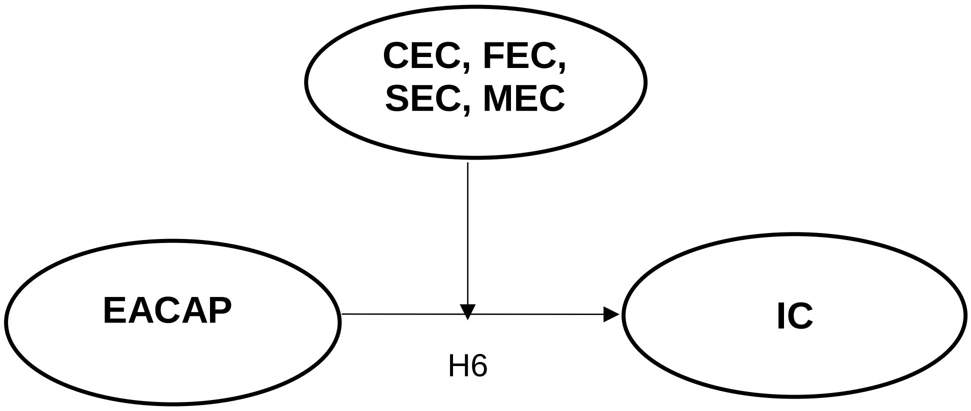
- *EACAP as moderator between EC and IC*

H5: Entrepreneurial Absorptive Capacity moderates the relationship between Entrepreneurial Competencies and Innovation Capacity

The results reported in section 7.4.5, Table 7.18, summarised the results of the moderating effect of EACAP in the relationship between the two EC categories tested, CEC and FEC and IC. Table 8.2 indicates that the research hypotheses H5a for CEC and H5b for FEC were supported. The empirical results supporting the hypotheses, with EACAP as moderator, explain the indirect effect of CECs and FECs on IC, which could possibly be strengthened when entrepreneurs possess more EACAP. The moderation effect of EACAP therefore changes the magnitude of the relationship between the CECs: decision-making, proactiveness, innovation/innovating, opportunity recognition, use of social support, and the FECs: value creation and IC –

or, as such, modifies the causal effect. This notion is supported by Chang *et al.* (2012) and Escribano *et al.* (2009) in the literature review. It is further supported by the notion that the building of ACAP allows an entrepreneur to successfully commercialise new knowledge by starting a new firm within the ACAP theory of knowledge spillover entrepreneurship (Qian & Acs, 2013:193). This helps explain the importance of the role of knowledge in entrepreneurial innovation, or provides better insights into knowledge-based entrepreneurship.

8.4.2.3 Hypotheses surrounding EC as moderator



EACAP = Entrepreneurial Absorptive Capacity

IC = Innovation Capacity

CEC = Cognitive Entrepreneurial Competencies

FEC = Functional Competencies

SEC = Social Competencies

MEC = Meta Competencies

Figure 8.6: Hypothesised model based on conceptual framework 3: EC as moderator

Table 8.3: Summary of results relating to tested hypotheses: EC as moderator

H6:	Entrepreneurial Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6a:	Cognitive Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6a1:	The Cognitive Competency: opportunity recognition, has a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6a2:	The Cognitive Competency: decision-making, has a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6a3:	The Cognitive Competency: proactiveness, has a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6a4:	The Cognitive Competency: use of social support, has a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Supported
H6a5:	The Cognitive Competency: innovation/innovating has a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6b:	Functional Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6c:	Social Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6c1:	The Social Competency: positive attitude, has a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6c2:	The Social Competency: networking, has a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Supported
H6c3:	The Social Competency: leadership, has a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6d:	Meta Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6d1:	The Meta Competency: problem-solving, has a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Not supported
H6d2:	The Meta Competency: cognitive ability, has a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity	Supported

Source: Own compilation

The results reported in Table 8.3 provide the outcome of the hypotheses for conceptual framework 3 (SEM Model 1.1–1.4), where the hypotheses regarding EC as moderator between EACAP and IC were tested.

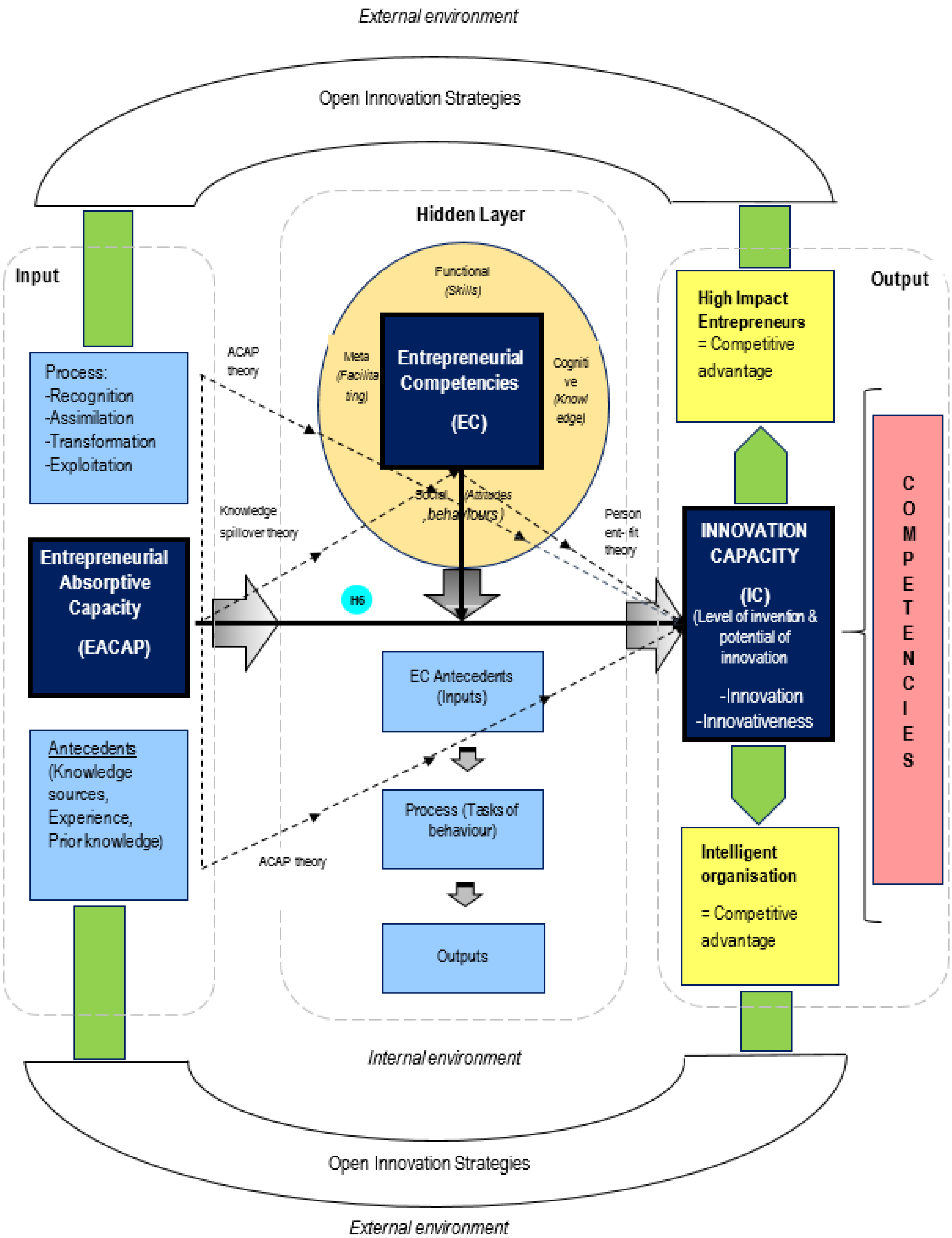


Figure 8.7: Conceptual framework 3: EC as moderator (Hypothesis 6)

Source: Own compilation

The main findings regarding the structural model hypotheses H6 are summarised below and were discussed in Chapter 7, Table 7.20. The results reported in Table 7.20 provided a summary of the moderating effect of EACAP in the relationship between the four competence categories and IC. The statistical rules for moderation (testing for β1, β2 and β3) were used to test the research hypotheses (H6a–H6d).

- *EC as moderator between EACAP and IC*

H6: Entrepreneurial Competencies have a moderating effect on the relationship between Entrepreneurial Absorptive Capacity and Innovation Capacity

Table 8.3 indicated that the research hypotheses of H6a–H6d were only supported for CEC: use of social support ($H6a_4$); SEC: networking ($H6c_2$) and MEC: cognitive ability ($H6d_2$). Although a lack of existing research exists on specific categories of ECs or individual competencies as moderators, support does exist for the findings of this study, where ECs play a moderating role (Botha, 2020; Chandler & Hanks, 1994; Sánchez, 2012). Such findings are specifically found where ECs: opportunity identification and using of resources moderate the relationship between the quality of an opportunity and firm performance (Chandler & Hanks, 1994). Particularly ECs: leadership, innovativeness, curiosity and motivation were found to be crucial in strengthening the relationship between prior entrepreneurial exposure and entrepreneurial action (Botha, 2020).

8.4.2.4 NN and SEM

H7:	Neural Networking (through testing non-linear relationships) provided an improved model fit to that provided by Structural Equation Modelling (SEM) through linear relationships	Not supported

The SEM and ANN models were compared to test H7. The main findings regarding the squared multiple correlations for SEM compared with the percentage variance explained (1-Relative error for testing sample) testing for NN found that all the squared multiple correlations for SEM tested higher than the relative errors of NN. Model 1 (SEM = 0.812, NN = 0.494), Model 2 (SEM = 0.659, NN = 0.443), Model 3 (SEM =

0.575, NN = 0.503), (SEM = 0.695, NN = 0.548), and Model 5 (SEM = 0.158, NN = 0.154).

Therefore, based on this comparison, it can be confirmed that NN did not provide an improved model fit to that provided by SEM and that the nature of the relationship between these variables is linear. The hypothesis regarding NN's providing an improved model fit to that provided by SEM is therefore not supported for all five NN models.

However, other studies have shown conflicting findings. The research done by Ansari and Riasi (2016), who compared the error rates of regression models with those of neural network models, indicated that ANN has a lower estimation error. Hence it was considered a stronger approach towards predicting customer behaviour than linear regression models. Literature further supports the notion that ANN is generally able to learn fast and achieve high classification accuracy with a high-dimensional input space. ANN has been successfully applied in entrepreneurship research in the case of recognising entrepreneurial intentions of students (Zekić-Sušac, Pfeifer & Šarlija, 2014:93; Zekić-Sušac, Šarlija & Pfeifer, 2013:306) and studying effectual entrepreneurial opportunities (Ghorbel *et al.*, 2017:439).

8.4.3 Predicting IC

The SEM models used for predicting IC incorporated four categories of competencies, with a total of 11 competencies and EACAP with IC as the predictor variable. Six of the 11 ECs indicated that they were the best predictors of IC. Among the ECs: decision-making, innovation/innovating, opportunity recognition, value creation, networking and cognitive ability tended to be the best predictors of IC. The rest of the ECs tended to be weak predictors of IC. EACAP was also found to be a good predictor of IC among the SECs and MECs, as were all SECs and all MECs good predictors of EACAP, including individual CECs: proactiveness, innovation, opportunity recognition, use of social support and FEC: value creation. EACAP mediated the effects of both SECs and the individual MEC: cognitive ability on IC, and in turn was also a moderator between CEC and FEC with IC. However, EACAP was not found to be a mediator between the CECs and FECs with IC. Among the CECs, three of the competencies: use of social support (CEC), networking (SEC) and cognitive ability (MEC) were found to be moderators between the EACAP–IC relationship. Overall, the four SEM models showed acceptable measurement reliability and construct validity. With SEM model 1.1: χ^2 = 2929.254, df = 1344, CMIN/df = 2.180, RMSEA = 0.051, CFI = 0.901, TLI = 0.895, IFI = 0.902, and SRMR = 0.0678; SEM model 1.2: χ^2 = 1725.805, df = 649, CMIN/df = 2.659, RMSEA = 0.061, CFI = 0.908, TLI = 0.901, IFI = 0.909, and SRMR = 0.0678; SEM model 1.3: χ^2 = 1860.688, df = 838, CMIN/df = 2.220, RMSEA = 0.052, CFI = 0.917, TLI = 0.0.911, IFI = 0.911, and SRMR = 0.0662; SEM model 1.4: χ^2 = 2655.781, df = 1204, CMIN/df = 2.206, RMSEA = 0.052, CFI = 0.900, TLI = 0.894, IFI = 0.901, and SRMR = 0.0654.

8.5 CONSOLIDATED THEORETICAL FRAMEWORK FOR ENTREPRENEURIAL COMPETENCIES, ENTREPRENEURIAL ABSORPTIVE CAPACITY AND INNOVATION CAPACITY

A consolidated conceptual model is presented in this section to illustrate the nexus of EC, EACAP and IC. Although three conceptual frameworks have been presented, in view of the statistical inferences drawn from the study, changes have been made to reflect a consolidated framework of its findings. Hence, the final conceptual model reveals the support that was found for the hypothesised relationships. Figure 8.8 presents the final conceptual model for the studied innovative entrepreneurs. It is representative of the entire sample of 452 entrepreneurs. In this model, the interrelationships between the constructs are depicted. ECs and EACAP are shown as the predictor variables and IC (measured by newness, radicalness, uniqueness and superiority, innovation and competitive advantage) as the outcome variable. The model further draws attention to the role of open innovation strategies, and antecedents of EC and EACAP, based on the literature. In a sense, this underpins the argument made by Qian and Acs (2013) that not only is human capital a predictor of new knowledge, but also a key determinant of EACAP, which involves competencies, in order to understand technological innovations, recognise its market value, and bringing it into commercialisation. Open innovation is therefore required in order to use purposive inflows and outflows of knowledge to accelerate internal innovation and expand markets for external use of innovation (Chesbrough, 2006:1).

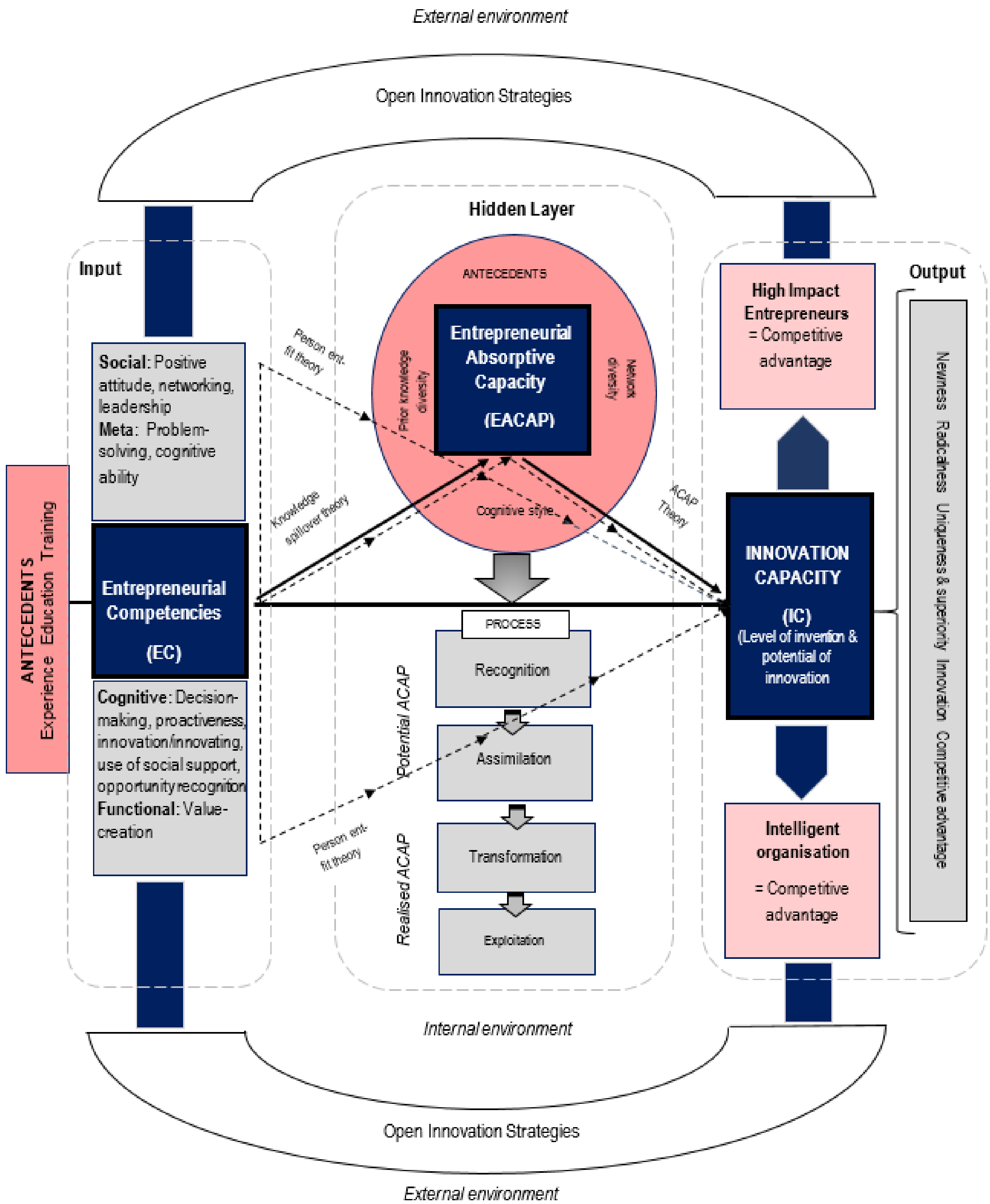


Figure 8.8: Consolidated theoretical framework for EC, EACAP and IC

Source: Own compilation

8.6 CONTRIBUTION OF THE STUDY

In achieving its overall purpose, the study contributes both theoretically and practically to the body of knowledge and the field of entrepreneurship. Ultimately, this study investigated a more complex relationship between the main three constructs, which has received scarce research attention to date.

8.6.1 Theoretical contribution

This study was an exploration of the validity of a model of entrepreneurship that linked EC and EACAP to IC. Previous research on EC, with the exception of those by Botha (2020); Botha and Taljaard (2019); Botha *et al.* (2015a); Nieuwoudt, Henning and Jordaan (2017) and Kruger and Steyn (2020), has been conducted using samples drawn from foreign countries (Man *et al.*, 2008; Morris *et al.*, 2013) (Refer to Table 2.1 for the full list). Only recent studies (Erol *et al.*, 2016; Grzybowska & Łupicka, 2017; Łupicka & Grzybowska, 2018; Prifti *et al.*, 2017) focused on competencies for 4IR and very little on 4IR entrepreneurial competencies (Kruger & Steyn, 2020). Although previous studies identified a range of factors influencing innovative outcomes, an overall understanding of the interrelationships between these constructs is missing. The focus of this study was, for one, to investigate whether the globally recognised conceptualisation of EC required for 4IR and the link to IC could be drawn directly onto the South African experience using innovative entrepreneurs from South Africa. It also operationalised EACAP as a construct that influences ECs and IC. This study therefore attempted to advance research on the conceptualisation of a model of EC for 4IR and expand on models for innovation and competence.

Further, from a theoretical viewpoint, to investigate EC, EACAP and IC has merit, as it has received scant research attention to date. The first contribution lies in the rendering of new insights into the modelling of all three constructs in one relationship which reaffirms the predictions of prior theory. More specifically, the study applied the Absorptive Capacity, Knowledge-spillover and Person-entrepreneurship-fit theories in an entrepreneurial context, and confirmed that there is a relationship between four different categories of competencies (CEC, FEC. SEC. MEC), EACAP and IC factors. Thus, this research suggests new directions for entrepreneurship pedagogy to enhance the level of inventions and potential for innovation, while also carrying broader applicability regarding the development of theories explaining the EC, EACAP and IC relationships.

Despite research on IC, few scholars have explored such notions from an EACAP and 4IR competency stance that is based on the individual entrepreneur. Until now, it remained unclear how ECs may influence IC from a holistic point of view, categorising competencies into cognitive, functional, social and meta and whether EACAP facilitates this process. Building on prior work in this regard (Markman & Baron, 2003; Qian & Acs, 2013; Zahra & George, 2002), and drawing on the Absorptive Capacity Theory, Knowledge-spillover Theory and Person-entrepreneurship-fit theory, models were developed and tested, which explored alternatives to this highly reasoned perspective. Through these theories, the findings of the study indicate the importance of incorporating a unified entrepreneurial competency typology perspective on innovation. In doing so, this study provides several novel insights of theoretical relevance.

First, in an attempt to utilise the multi-holistic competence approach developed by Le Deist and Winterton (2005), the four competence categories were utilised as the foundation for categorising competencies in this study. This approach was taken based on entrepreneurship pedagogy which centres on the development of specific ECs comprising the complex make-up of the entrepreneur. Results from the Delphi study and literature assisted in developing an entrepreneurial competency framework for 4IR as previously illustrated in Figure 2.16. This framework managed to illustrate the specific category of competence that each competency falls under, which was previously very unclear and not specified in most entrepreneurial competence frameworks. Focusing on the entrepreneur as a key factor in Industry 4.0, a broad spectrum of competencies was identified from a cognitive (knowledge), functional (skills), social (attitudes and behaviours) and meta (facilitating learning) perspective.

Secondly, we hypothesised and found some support for our predictions that there is a significant positive relationship between EC and IC. The FEC value creation is a positive predictor of IC, whereas CEC, SEC and MEC are not predictors of IC. However, when looking at the individual competencies, innovation/innovating, opportunity recognition (CEC), value creation (FEC) and networking (SEC)), were positively related to IC. This is of particular importance and an under-researched area, particularly for ECs required for Industry 4.0 in South Africa. When shifting the focus from IC to EACAP, the categories FEC, SEC and MEC are positive predictors of EACAP. Four of the five cognitive competencies were also found to be positively related to EACAP – proactiveness, innovation, opportunity recognition and use of social support. This notion is supported in the literature in that knowledge and competence are an important internal determinant of IC (Lukjanska, 2010:43).

Thus, as a third contribution, this study sheds light on how the four categories of ECs, which included 11 ECs significant for innovation and 4IR, can be used to ameliorate the IC and EACAP levels of entrepreneurs in developing countries. On a smaller scale, the study contributes to the measurement of ECs and individual IC and advocates an adapted 113-item scale to measure entrepreneurial competencies, entrepreneurial absorptive capacity and innovation capacity.

Fourthly, research on the individual dimensions of ACAP in its infancy – particularly EACAP focused on the South African entrepreneur. In response to Löwik's (2013:198) call to extend the conceptual model of ACAP with individuals, individuals' competencies explain differences in levels of individual ACAP and therefore needed to be accounted for. Thus, the variables that represent EACAP as a construct and process (recognition, assimilation, transformation, exploitation) have been tested in order to find that EACAP is a predictor of IC with SECs and MECs. Furthermore, the effect of EC on IC is only mediated by EACAP through SECs – leadership, positive attitude and networking, and MEC: cognitive ability. However, EACAP is a moderator in the relationship between CECs, FEC and IC. This confirms that EACAP both influences the direction and the strength of the EC–IC relationship and explains why this relationship exists.

The fifth contribution lies in establishing a relationship between EACAP and IC. Tests of moderating effects indicate that three competencies (use of social support, networking and cognitive ability) moderate the relationship between EACAP and IC, indicating that our third theoretical model did not remain robust. Empirical support is found for this notion, which importantly highlights the fact that specific competencies are compatible with outcomes (Cheetham & Chivers, 1996). Thus, the results of this study indicate that if an entrepreneur has the ability to make use of social support, is able to network and has cognitive ability, the relationship between EACAP and IC could possibly be strengthened.

From an emerging technology rooted in many disciplines, the study contributes to the debate around the use of NN, specifically in the field of entrepreneurship. As NN was used in other studies in the field of entrepreneurship (Ghorbel *et al.*, 2017; Zekić-Sušac *et al.*, 2014; Zekić-Sušac *et al.*, 2013) and proved to reveal improved model fit, it was deemed significant to use it is this study. However, the NN models tested in this study did not provide evidence of improved model fit over that provided by the SEM models, but NN is still regarded as a procedure that offers additional advantages over traditional statistical procedures in developing pattern recognition (non-linear) models, which performs a simplified version of what human brain neurons do (Ansari & Riasi, 2016).

Relatedly, another contribution is the rendering of new insights into modelling of all three constructs in one relationship, which reaffirms the predictions of prior theory and suggests that there is more to the story in terms of curvilinearity of the predicted relationships – thus suggesting possible new directions for entrepreneurship pedagogy to enhance entrepreneurial IC. The results of this study therefore propose a framework for educating entrepreneurs in utilising certain ECs and EACAP in order to develop their IC. It is important to expose entrepreneurs to new knowledge early on in order to recognise new opportunities, but also at the same time develop their ECs. Having certain ECs can assist in the successful processing of newly identified knowledge, through recognition, assimilation, transformation and exploitation. As an industry 4.0 entrepreneur, it is important to know that these factors (ECs and EACAP) increase an entrepreneur's level of invention and potential for innovation making – one much more equipped for the type of disruptive inventions expected for this fourth industrial revolution.

Several calls have been made for studies to revisit the contribution of ECs in influencing performance outcomes (Bryant & Poustie, 2001; Covin & Miles, 1999; Morris *et al.*, 2013; Sánchez, 2012), specifically 4IR competencies (Gray, 2016; Leopold *et al.*, 2016), and working towards a skills and workforce strategy for the future (CIPC, 2016-2017:35). This study contributes to addressing this gap and, from a South African perspective, it adds to the minimal existing research in this field. This study also addresses the need for creating and expanding specific African knowledge, from a third world country perspective. As a developing country, we are still far behind in terms of 4IR and have much to learn from first world countries which have advanced more progressively in terms of the radicalness of their inventions. In a developing country such as South Africa, entrepreneurs should be promoted at all levels of the system to ensure access to needed information, skills and knowledge (Sandberg, 2018). In terms of international comparability, it is interesting to note that the findings of this study are to a large extent in line with the results of related international findings regarding 4IR competencies. For instance, competencies identified in this study were also identified as 4IR competencies in other countries which investigated this phenomenon, such as decision-making (Grzybowska & Łupicka, 2017; Prifti *et al.*, 2017), problem-solving (Prifti *et al.*, 2017), innovating (Prifti *et al.*, 2017), networking (Erol *et al.*, 2016; Prifti *et al.*, 2017), leadership (Prifti *et al.*, 2017) and cognitive ability (Erol *et al.*, 2016; Prifti *et al.*, 2017). A recent South African study found the following ECs that need to be developed in order to adopt aspects of Industry 4.0: innovation, creativity, integrated business and technology skills, leadership and communication (Kruger & Steyn, 2020).

Lastly, through a range of content, convergent, discriminant, and nomological validity tests, this study presented a preliminary measure which holds promise of empirically capturing an unreasoned pathway to IC. Considering the behavioural approach in studying EC (Bird, 1995), previous research has found a positive impact of ECs on outcomes such as entrepreneurial intentions (Sánchez, 2013), performance (Covin & Miles, 1999), competitiveness (Sánchez, 2012), and entrepreneurial success (Markman & Baron, 2003). The results of this study, however, validate the value of incorporating the person-entrepreneurial fit theory, knowledge-spillover theory and absorptive capacity theory for jointly and respectively investigating ECs and EACAP as factors influencing IC and their interrelationship. Therefore, by modelling all three constructs in one relationship, this study contributed to the unveiling of novel insights into the tested relationships. The theorised models behaved as predicted through a range of direct, indirect, invariance, moderation and mediation tests, thus giving one confidence that the salience placed on desirability relative to feasibility measure is a valid indicator of the focal construct.

This research advanced entrepreneurial research as it provided a platform to guide and support its development, which has been a key focus area both internationally and in South Africa, to address one of the key sustainable development goals, which is economic growth.

8.6.2 Practical contribution

In order to create a society in which opportunities are continuously broadened, we need post-school education, work experience and complementary measures in order to promote knowledge-driven innovation. According to the DA (2013), an effective training and innovation system requires an effective knowledge infrastructure. This can be achieved by equipping entrepreneurs with ECs and the new knowledge (absorptive capacity) they need to identify and use those opportunities and turn them into marketable products.

Thus, from a practical point of view, the results of this study prove useful to entrepreneurship practice, pedagogy and innovative entrepreneurship policy, which is aimed at fostering the start-up of innovative, technology-based and rapidly growing knowledge-based businesses (Dahlstrand & Stevenson, 2010:8). Firstly, by providing an understanding of categorising ECs into cognitive, functional, social and meta, a multi-dimensional holistic approach is used (Le Deist & Winterton, 2005), which is able to distinguish the mechanisms through which knowledge, skills and competence are required and recognised (Cheetham & Chivers, 1996). The importance of these categories lies in entrepreneurship training and development, with a focus on educators in higher education and entrepreneurial institutions such as entrepreneurship centres and incubators. When CECs (cognitive entrepreneurial competencies) are developed, which includes the underpinning of theory and concepts as well as informal tacit knowledge gained experientially, knowledge is underpinned by understanding (Orhei, 2011).

The CECs identified in this study are: decision-making, proactiveness, innovation/innovating, use of social skills and opportunity recognition. FECs (functional entrepreneurial competencies) include skills or know-how, which was identified in this study as value creation. SECs (social entrepreneurial competencies), which involve attitudes and behaviours, are those competencies such as positive attitude, networking and leadership. These competencies identified in this study are relative to persons with characteristics that relate to effective or superior performance and maintaining and establishing relationships (Orhei, 2011). The last category, MECs (meta entrepreneurial competencies), involve the ability to cope with uncertainty, as well as with learning, learning to learn and reflection (Orhei, 2011), which includes cognitive ability and problem-solving. These collective competencies, seen as an important synergetic combination of individual ECs, are therefore critical to develop in order for an entrepreneur to meet a certain level of competence, which is known as the ability to accomplish a work task up to a recognised standard (Matthews & Brueggemann, 2015:11). Innovation capacity, when viewed through the lens of ECs and EACAP, provides entrepreneurs with understanding about how to increase their capacity to innovate. ECs draw awareness to the potential causal connection this might have on an entrepreneur's business success and innovative performance.

The second practical contribution lies in the fact that this study further provides business owners with knowledge about the business's ability to integrate, build and reconfigure internal and external competencies to rapidly changing environments. From a supply-side, competitive advantage can only be achieved if an entrepreneurial organisation has the capabilities and competencies to serve the market more effectively than its competitors. This can be achieved by way of integrating knowledge, rather than just having the knowledge. South African entrepreneurs with the intention of competing in the global market have important practical implications to consider, regarding their capacity to innovate in Industry 4.0.

Thirdly, a good comprehension of the competencies necessary to increase their level of invention and capacity to innovate enables South African entrepreneurs to effectively prepare for this industrial revolution and the next. These competencies involve decision-making, innovation/innovating, opportunity recognition, value creation, networking and cognitive ability. As staying at the top gets tougher and more challenging due to the fast-growing and changing digital technologies and AI-based solutions (Nahavandi, 2019:1), entrepreneurs need to be prepared by utilising human brain power and creativity with intelligent systems for the next industrial revolution (Nahavandi, 2019).

Fourthly, entrepreneurs have the potential to create entirely new ways of providing goods and services through technological innovation with the technological advancements of Industry 4.0 (Feki & Mnif, 2016; Van der Westhuizen & Goyayi, 2020). One of the most essential skills for entrepreneurs to drive economic growth and ensure sustainability is said to be to innovate and have the capacity to adapt to change (Devezas & Sarygulov, 2017). Entrepreneurs will therefore require continuous learning across multiple disciplines to adapt an entire business, innovate in rapidly changing environments and enable effective coordination between components (Hermann, Pentek, Otto, Pentek & Otto, 2015; Vendrell-Herrero *et al.*, 2014). Increasing EACAP will also be useful in successful restructuring of organisational problems (Simon, 1969), improving actions through better understanding (Fiol & Lyles, 1985:803) and understanding a new technology, recognising its market value, and bringing it into commercialisation (Qian & Acs, 2013:193). One way in which EACAP can be increased is to ascertain the level of research and development (R&D), since R&D plays an important role in building and increasing knowledge-sharing and ACAP. However, R&D is not enough on its own; other factors such as training and education are also important for the increase of knowledge transfer and ACAP (Daghfous, 2004:21).

Fifthly, in order to create value from knowledge, also known as innovation, a shift in the environment for knowledge production and utilisation will have to take place in order to impact on the innovation process together with an open innovation policy (Bessant & Trifilova, 2017:1094). ACAP is an important construct to measure since it shifts our attention to how well entrepreneurs or entrepreneurial firms are equipped to search out, select, and implement new knowledge (Bessant & Trifilova, 2017:1098). Building ACAP therefore requires reflection and strategic investment in building key competencies around finding and using knowledge. The challenge remains one of moving from potential to realised opportunity (Zahra & George, 2002), and this will require investment in learning and competence building. Policymakers and educators should therefore be aware that current training programmes have not been influential enough in the development of the ECs required for 4IR and for the enhancement of their ACAP. Given that EACAP and EC are related, it would be useful to formulate teaching curriculums that show the inter-connectivity between EACAP, EC and IC. Furthermore, as South Africa has neglected to match its policy commitment to improved education and skills with a dedicated focus on innovation and design to drive job creating economic growth (DA, 2013), research in entrepreneurship and innovation should be appropriately integrated with initiatives in the private sector.

Lastly, since ANN has an impressive ability in analysing IC, EACAP and EC, it is an efficient alternative analytical technique, other than SEM. Entrepreneurial ventures could use this technique in order to provide the dynamics of invention and identify declining levels of IC as an early warning of future difficulties and decline in innovation levels from a pattern recognition perspective. Where SEM was capable of analysing only compensatory linear relationships, ANN is more robust and is capable of analysing both compensatory linear relationships and non-compensatory and nonlinear relationships (Leong, Hew, Lee & Ooi, 2015:6629).

ANN is also very flexible in use and can be easily manipulated in order to include more or fewer factors. In linear regression/SEM, the performance of the model can only be improved by adding additional variables, whereas ANN can be enhanced even by changing the relationships between the existing variables. Although SEM models are very popular, using new techniques such as ANN can be particularly beneficial for entrepreneurs who aspire to gain competitive advantage over their rivals. This study sets an example of how ANN can be used and could encourage other scholars within the field of entrepreneurship to use the example of this study to pursue their own ANN in their various studies within this field, in predicting desired innovative outcomes as an entrepreneur and as an organisation.

8.7 LIMITATIONS OF THE STUDY

Although this study was conducted with due consideration to optimal research design and methodologies in addressing the research objectives, some limitations were encountered.

Firstly, the inadequacy of studies on 4IR competencies among entrepreneurs in South Africa was limiting in the review of literature and postulating of hypotheses. However, international studies were considered as points of reference as well as ECs and innovative competencies in general IC, as most of the research has been conducted on the organisation as a whole and not the individual.

Secondly, although this study's target population was innovative businesses in South Africa, difficulties were encountered in the quantitative aspect while trying to achieve a high participation rate to get a sufficient sample size for the statistical tests. One possible reason might be that South Africa has not fully embraced Industry 4.0 yet, as 62% of the entrepreneurs were not specifically operating in one of the Industry 4.0 fields, but had innovative businesses, which made finding the most innovative entrepreneurs in South Africa quite difficult. The questionnaire was also quite long; therefore, some respondents might have stopped without completing the survey.

Thirdly, to limit the scope, this study simply investigated EACAP within the four dimensions (recognition, assimilation, transformation and exploitation). Other antecedents such as prior knowledge diversity, network diversity and cognitive style might also be included in measuring EACAP as it might give a better understanding of the micro-foundations that underlie ACAP and dynamic managerial capabilities. In order to understand the functioning of ACAP, contingency factors such as power relationships, activation triggers and regimes of appropriability could be looked into.

Finally, despite the advantages of using ANN for testing non-linear relationships, there are also limitations. Designing an optimal neural network can be time consuming which requires a relatively large data set. In this study, with a sample size of 452 and 22 constructs, one SEM model could not be tested and did therefore not deliver the desired results. However, increasing the sample size to 10 participants for every parameter would have been ideal to test all the constructs' interrelationships in this study in one SEM model.

8.8 RECOMMENDATIONS FOR FUTURE RESEARCH

The results of this study created some avenues for future research. Firstly, the absorptive capacity, knowledge-spillover and person-entrepreneurship-fit theory have largely informed the constructs adopted for this study. Future studies on IC could be investigated through alternative theoretical lenses such as the disruptive innovation theory. Secondly, one could further exploit the research by Zahra and George (2002), by investigating the discrete activities linked to EACAP, such as the idea of "potential" and "realised" EACAP, which helps explain why organisations are sometimes unable to leverage and exploit external information, as well as the antecedents and contingency factors of ACAP. Furthermore, one could examine the ACAP of entrepreneurs based on their previous work experience, as part of their prior knowledge diversity, as accumulated prior knowledge enables the ability to store new knowledge into one's memory and to recall and use it (Cohen & Levinthal, 1990). Prior knowledge diversity encompasses the individual's existing knowledge base, based on education, work and life experience. As such, entrepreneurs differ in the knowledge they accumulate and this is important, giving rise to many interesting questions in entrepreneurship. These differences, in support of Holcomb *et al.* (2009:182), suggest the need to tie heuristics and learning more closely together, especially in efforts to understand how entrepreneurs adapt future behaviours with changes in knowledge over time.

Thirdly, it is also recommended that future research involve a longitudinal data collection approach to enable a better exploration of the way EC and ACAP change over time. As one's experience increases, the business gets more established and the size of the business grows.

Fourthly, future studies can test the proposed conceptual models of this research in other settings in order to examine the robustness of the observed relationships. It is believed that the proposed ANN of this study can be manipulated in order to take additional factors that affect the IC of entrepreneurs into account. It is further suggested that future researchers use fuzzy logic in order to create the surveys or combine neural networks with generic algorithms to see whether any improvements could be achieved (Ansari & Riasi, 2016:27).

The fifth future research avenue could also be focused on testing additional methodological improvements in machine learning that could be valuable for data mining in entrepreneurial education, business and other areas of investigation.

A sixth recommendation is based on this study's comparison of the SEM and NN models, it is evident that the parts of a hybrid SEM-neural network approach do complement each other (Leong *et al.*, 2015:6629). It is therefore recommended that the use of a two-stage predictive-analytical SEM-neural network analysis might provide a more holistic understanding and thus might provide a significant methodological contribution from a statistical point of view. This is evident since the non-compensatory neural network analysis is able to complement the weaknesses of the compensatory and linear SEM analysis (Leong *et al.*, 2015:6629; Sharma, Sharma & Dwivedi, 2019:250). The study would open up a more in-depth new perspective in understanding the impact of ECs and EACAP on IC based on the results of the multiple group analysis.

The study included South-African innovative entrepreneurs only. It is recommended that the study be repeated in developed and other developing economies to compare and confirm results of the final consolidated framework as found in this study.

Lastly, it is recommended that the model be expanded to include different moderating and mediating effects; for example, the age of the business, the size of the business, experience of the entrepreneur and external knowledge. When looking at the ACAP construct, antecedents such as prior knowledge diversity, network diversity and cognitive style may also be tested individually as well as the ACAP contingency factors, which include power relationships, activation triggers and regimes of appropriability. It is important to note that other important competencies identified from the Delphi study and literature not be neglected as possible moderators or factors impacting on IC and EACAP. Other competencies identified from the Delphi study that were not tested included: taking initiative, persistence, perseverance, critical thinking, need for achievement, interpersonal skills, teamwork, relationship building, analytical ability and individual commitment. From the most cited competencies that were not included in this study were: communication, technical-functional competence, organising and leading, learning and research ability.

8.9 SUMMARY AND CONCLUSION

The findings of this study have been summarised in this chapter, drawing it to a conclusion. The chapter commenced with an overview of the literature study and the descriptive statistical analysis of the sample. It revisited the research objectives and hypotheses with the purpose of clarifying the outcomes of the hypothesised relationships and describing its implications. Three conceptual frameworks have been presented, of which four SEM models were tested, which illustrate the findings of this study that show the relationships that have been sorted empirically. The structural models developed to predict innovation capacity of entrepreneurs demonstrated good fit with the data collected from the sample of South African innovative entrepreneurs and also provided a better model fit than NN. Figure 8.9 affords a summary of the statistically significant relationships as established by means of the hypothesis testing using SEM.

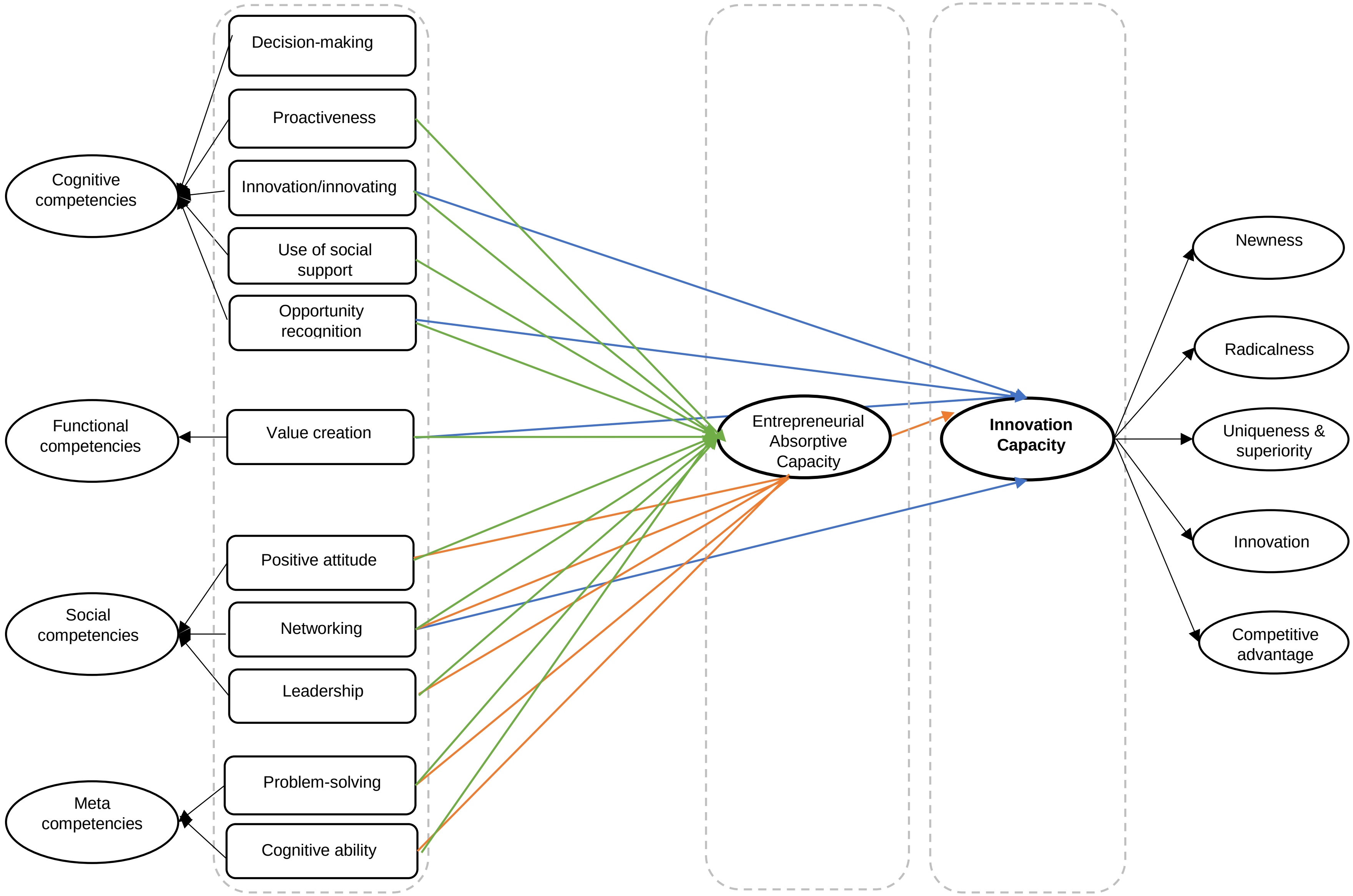


Figure 8.9: Graphic representation of the hypotheses that demonstrated significant positive relationships

Source: Own compilation

Based on the results, it is concluded that the interrelationships between the 11 competencies and EACAP could assist in predicting the IC of entrepreneurs, therefore the level of invention and potential for innovation. It was observed that the IC model modified by incorporating certain cognitive competencies (innovation/innovating, opportunity recognition), functional competencies (value creation) and social competencies (networking) in addition to EACAP, was able to predict an entrepreneur's IC – although significant positive relationships could not be found between CECs: proactiveness, decision-making and use of social support, SECs: positive attitude and leadership, and MECs: problem-solving and cognitive ability and IC. It is therefore advised that entrepreneurs seeking to invent within Industry 4.0 should develop these ECs. In addition to the four competencies that are able to predict IC: proactiveness, use of social support, positive attitude and leadership, a total of ten ECs were found to predict EACAP. From these competencies, the three competencies: use of social support, networking and cognitive ability, were found to be moderators, explaining the direction of the relation between the EACAP and IC variables.

EACAP was further found to mediate the relationship between social competencies (leadership, positive attitude and networking), meta competency (cognitive ability), and IC. Entrepreneurial absorptive capacity was also found to be a moderator between CEC, FEC and IC, suggesting that this relationship between EC and IC is dependent on EACAP and also speaks of how and why this relationship exists.

With regard to the contribution of this study to the body of literature, it has been reported in terms of theory and practice. Amongst others are its theoretical contribution in terms of context, ECs significant for innovation and the 4IR, a holistic approach towards an entrepreneurial competence model with four competence categories and categorising competencies into these specific categories. As well there was an investigation of the EACAP process and a construct impacting on IC as mediator and moderator. Ultimately the study suggested new directions for entrepreneurship pedagogy and explained unreasoned pathways to IC.

This chapter has described the practical contribution of the study, elaborating on the practical contribution of its findings. This is for the benefit of entrepreneurs and business owners moving towards 4IR, as well as educators and entrepreneurial institutions such as entrepreneurship centres and incubators. It is on this basis that suggestions have been made for entrepreneurial education, entrepreneurial practice and policymaking.

In conclusion, although this study has made contributions to the body of knowledge, its limitations have been acknowledged and enumerated. Finally, recommendations for future research on development of entrepreneurial competencies, knowledge-driven innovation and building innovation capacity were considered from a theoretical, methodological and contextual perspective.

REFERENCES

Aaker, D.A., Kumar, V., Day, G.S. & Leone, R.P. 2011. Marketing research, 10. *Aufl. Hoboken (USA): Wiley.*

Abaho, E. 2016. Firm capabilities, entrepreneurial competency and performance of Ugandan SMEs. *Business Management Review,* 19(2):105-125.

Abdullahi, M.S., Abubakar, A., Aliyu, R.L. & Umar, M.B. 2015. Empirical review on the determinants influencing firm performance in developing countries. *International Journal of Scientific and Research Publications,* 5(6):1-10.

Ackoff, R. 2008. *Systems thinking for curious managers.* United Kingdom: Triarchy Press.

Acs, Z.J. & Audretsch, D.B. 1988. Innovation in large and small firms: an empirical analysis. *The American Economic Review*, 78(4):678-690.

Acs, Z.J., Audretsch, D.B. & Lehmann, E.E. 2013. The knowledge spillover theory of entrepreneurship. *Small Business Economics,* 41(4):757-774.

Acs, Z.J., Braunerhjelm, P., Audretsch, D.B. & Carlsson, B. 2009. The knowledge spillover theory of entrepreneurship. *Small Business Economics,* 32(1):15-30.

Adams, N.E. 2015. Bloom’s taxonomy of cognitive learning objectives. *Journal of the Medical Library Association: JMLA,* 103(3):152.

Adner, R. & Kapoor, R. 2010. Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal,* 31(3):306-333.

Afuah, A. & Afuah, A. 2003. *Innovation management: Strategies, implementation and profits.* United Kingdom: Oxford University Press.

Ahmad, N.H., Halim, H.A. & Zainal, S.R.M. 2010. Is entrepreneurial competency the silver bullet for SME success in a developing nation. *International Business Management,* 4(2):67-75.

Ahmad, N.H., Suseno, Y., Seet, P.-S., Susomrith, P. & Rashid, Z. 2018. Entrepreneurial competencies and firm performance in emerging economies: A study of women entrepreneurs in Malaysia. *Knowledge, learning and innovation*. Switzerland: Springer.

Ahmed, P.K. 1998. Culture and climate for innovation. *European Journal of Innovation Management,* 1(1):30-43.

Ahuja, G. 2000. Collaboration networks, structural holes, and innovation: A longitudinal study. *Administrative Science Quarterly,* 45(3):425-455.

Akinruwa, T.E., Awolusi, O.D. & Ibojo, B.O. 2013. Determinants of small and medium enterprises (SMEs) performance in Ekiti State, Nigeria: A business survey approach. *European Journal of Humanities and Social Sciences,* 27(1):1397-1413.

Al Mamun, A., Nawi, N.B.C. & Shamsudin, S.F.F.B. 2016a. Examining the effects of entrepreneurial competencies on students' entrepreneurial intention. *Mediterranean Journal of Social Sciences,* 7(2):119.

Al Mamun, A., Nawi, N.B.C. & Zainol, N.R.B. 2016b. Entrepreneurial competencies and performance of informal micro-enterprises in Malaysia. *Mediterranean Journal of Social Sciences,* 7(3):273-273.

Ali, A., Krapfel, R. & LaBahn, D. 1995. Product innovativeness and entry strategy: Impact on cycle time and break-even time. *Journal of Product Innovation Management,* 12(1):54-69.

Alin, A. 2010. Multicollinearity. *Wiley Interdisciplinary Reviews: Computational Statistics,* 2(3):370-374.

Alipour, M. & Taleghani, M. 2016. The relationship between entrepreneurial skills of managers and organizational effectiveness in small and medium enterprises - Case Study: Representatives of Iran Khodro in Mazandaran province. *Journal of Administrative Management, Education and Training,* 12(2):03-08.

Altman, E.I., Marco, G. & Varetto, F. 1994. Corporate distress diagnosis: Comparisons using linear discriminant analysis and neural networks (the Italian experience). *Journal of Banking and Finance,* 18(3):505-529.

Amabile, T.M. 1988. A model of creativity and innovation in organizations. *Research in Organizational Behavior,* 10(1):123-167.

Ameen, Z., Hameed, T., Bashir, H.R., Bashir, H.F. & Amin, H.A.R. 2015. Integrating strategic management actions and interpersonal skills in entrepreneurship to create Competitive advantage. *American Journal of Marketing Research,* 1(3):189-192.

Amini, Z., Arasti, Z. & Bagheri, A. 2018. Identifying social entrepreneurship competencies of managers in social entrepreneurship organizations in healthcare sector. *Journal of Global Entrepreneurship Research,* 8(1):19.

Amwele, H.N. 2013. An empirical investigation into the factors affecting the performance of SMEs in the retail sector in Windhoek, Namibia. *The Harold Pupkewitz Graduate School of Business,* Masters in International Business.

Anderson, J.R. 1982. Acquisition of cognitive skill. *Psychological Review,* 89(4):369.

Anderson, R., Babin, B., Black, W. & Hair, J. 2010. *Multivariate data analysis: A global perspective.* Pearson Prentice Hall.

Ansari, A. & Riasi, A. 2016. Modelling and evaluating customer loyalty using neural networks: Evidence from startup insurance companies. *Future Business Journal,* 2(1):15-30.

Anthony, S.D., Eyring, M. & Gibson, L. 2006. Mapping your innovation strategy. *Harvard Business Review,* 84(5):104-113, 157.

Antonites, A.J. 2017. *Exploring creativity & innovation: A structured approach for entrepreneurs, managers and other game changers.* Hatfield, Pretoria, South Africa: Van Schaik

Arafeh, L. 2016. An entrepreneurial key competencies' model. *Journal of Innovation and Entrepreneurship,* 5(1):26.

Argyris, C. & Schon, D. 1978. Organizational learning, reading, MA. *Addison-Wesley. Baker, EW, Al-Gahtani, SS, & Hubona, GS (2007). The effects of gender and age on new technology implementation in a developing country. Information Technology and People,* 20(4):352-375.

Arisó, A., Girotto, M. & Fernandez, J.L. 2016. The evaluation of students meta-competencies and management skills in the context of the final year project. In: Aaltio, I. & Eskelinen, M.T. (eds.). *The 11th European Conference on Innovation and Entrepreneurship*, Finland, 15-16 September:50-56.

Arora, A. & Gambardella, A. 1990. Complementarity and external linkages: The strategies of the large firms in biotechnology. *The Journal of Industrial Economics,* 38(4):361-379.

Asumeng, M. 2014. Managerial competency models: A critical review and proposed holistic-domain model. *Journal of Management Research,* 6(4):1-21.

Atkinson, R.D. & Ezell, S.J. 2009. *Innovation economics.* New Haven, CT.: Yale University Press.

Audretsch, D.B. 1995. *Innovation and industry evolution.* Cambridge: Mit Press.

Audretsch, D.B., Keilbach, M. & Lehmann, E. 2005. The knowledge spillover theory of entrepreneurship and technological diffusion. *University Entrepreneurship and Technology Transfer*. Bingley: Mit Press.

Awang, Z. 2012. *A handbook on SEM.* New york: NY: Guilford Press.

Babbie, E.R. 2015. *The practice of social research.* Nelson Education.

Baddeley, A., Hitch, G. & Bower, G. 1977. Human memory, basic processes. *In: Human memory, basic processes*: Academic Press.

Bagozzi, R.P. & Yi, Y. 2012. Specification, evaluation, and interpretation of structural equation models. *Journal of the Academy of Marketing Science,* 40(1):8-34.

Baker, N.R., Green, S.G. & Bean, A.S. 1986. Why R&D projects succeed or fail. *Research Management,* 29(6):29-34.

Baporikar, N. 2015. *Drivers of innovation.* United States: IGI Global.

Barkham, R.J. 1994. Entrepreneurial characteristics and the size of the new firm: A model and an econometric test. *Small Business Economics,* 6(2):117-125.

Baron, R.A. 2006. Opportunity recognition as pattern recognition: How entrepreneurs "connect the dots" to identify new business opportunities. *Academy of Management Perspectives,* 20(1):104-119.

Baron, R.A. & Ensley, M.D. 2006. Opportunity recognition as the detection of meaningful patterns: Evidence from comparisons of novice and experienced entrepreneurs. *Management Science,* 52(9):1331-1344.

Baron, R.A. & Henry, R.A. 2006. Why do some entrepreneurs achieve extraordinary success? Insights from basic research on exceptional performance. *Frontiers of Entrepreneurship Research,* 26(10):3.

Baron, R.M. & Kenny, D.A. 1986. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology,* 51(6):1173.

Barringer, B.R. & Bluedorn, A.C. 1999. The relationship between corporate entrepreneurship and strategic management. *Strategic Management Journal,* 20(5):421-444.

Barth, T.J. 1993. Career anchor theory. *Review of Public Personnel Administration,* 13(4):27-42.

Bartlett, M.S. 1954. A note on the multiplying factors for various χ 2 approximations. *Journal of the Royal Statistical Society. Series B (Methodological)*:296-298.

Bartram, D. 2011. The SHL universal competency framework. *Surrey, UK: SHL White Paper*.

Bartram, D., Robertson, I.T. & Callinan, M. 2002. Introduction: A framework for examining organizational effectiveness. *Organizational effectiveness: The role of psychology*. Chichester, UK: Wiley.

Bassellier, G., Reich, B.H. & Benbasat, I. 2001. Information technology competence of business managers: A definition and research model. *Journal of Management Information Systems,* 17(4):159-182.

Bataineh, M.H. 2012. *Artificial neural network for studying human performance.* The University of Iowa.

Bateman, T.S. & Crant, J.M. 1993. The proactive component of organizational behavior: A measure and correlates. *Journal of Organizational Behavior,* 14(2):103-118.

Battistutti, O.C. & Bork, D. 2017. Tacit to explicit knowledge conversion. *Cognitive Processing,* 18(4):461-477.

Baum, J.R. 1995. The relation of traits, competencies, motivation, strategy, and structure to venture growth. *Frontiers of Entrepreneurship Research,* 5:13-21.

Baum, J.R., Locke, E.A. & Smith, K.G. 2001. A multidimensional model of venture growth. *Academy of Management Journal,* 44(2):292-303.

Baumol, W.J. 2005. Education for innovation: Entrepreneurial breakthroughs versus corporate incremental improvements. *Innovation Policy and the Economy,* 5:33-56.

Baumol, W.J. 2010. *The microtheory of innovative entrepreneurship.* Princeton University Press.

Bayon, M.C., Lafuente, E. & Vaillant, Y. 2016. Human capital and the decision to exploit innovative opportunity. *Management Decision,* 54(7):1615-1632.

Beale, H.D., Demuth, H.B. & Hagan, M. 1996. Neural network design. *PWS Publish Company,* 11:1-47.

Becherer, R.C., Mendenhall, M. & Eickhoff, K.F. 2008. Separated at birth: An inquiry on the conceptual independence of the entrepreneurship and the leadership constructs. *New England Journal of Entrepreneurship,* 11(2):4.

Becker, G.S. 1964. *1993. Human capital.* Chicago: University of Chicago Press.

Begley, T.M. & Boyd, D.P. 1985. Company and chief executive officer characteristics related to financial performance in smaller business. *Frontiers of Entrepreneurship Research,* 2(1):146-165.

Begley, T.M. & Boyd, D.P. 1987. Psychological characteristics associated with performence in entrepreneurial firms and smaller businesses. *Journal of Business Venturing,* 2(1):79-93.

Bell, J., Callaghan, I., Demick, D. & Scharf, F. 2004. Internationalising entrepreneurship education. *Journal of International Entrepreneurship,* 2(1-2):109-124.

Ben-Oz, C. & Greve, H.R. 2015. Short-and long-term performance feedback and absorptive capacity. *Journal of Management,* 41(7):1827-1853.

Bennour, M. & Crestani, D. 2007. Using competencies in performance estimation: From the activity to the process. *Computers in Industry,* 58(2):151-163.

Berg, N. 2005. *Non-response bias*. Paper presented at, Dallas, Texas:1-35. [Online] Available from: https://mpra.ub.uni-muenchen.de/26373/ [Accessed: 06/07/2020].

Berry, B. 1991. *Long wave rhythms in economic development and political behavior USA.* Baltimore MD: Johns Hopkins University Press.

Bessant, J. & Trifilova, A. 2017. Developing absorptive capacity for recombinant innovation. *Business Process Management Journal*, 26(6):1094-1107.

Bharwani, S. & Talib, P. 2017. Competencies of hotel general managers: A conceptual framework. *International Journal of Contemporary Hospitality Management,* 29(1):393-418.

Bird, B. 1995. Towards a theory of entrepreneurial competency. *Advances in Entrepreneurship, Firm Emergence and Growth,* 2(1):51-72.

Bjørnåvold, J. 1999. 1. Identification, assessment and recognition of non-formal learning: European tendencies. *AGORA V Identification, evaluation and recognition of non-formal learning,* 9:13.

Bjørnåvold, J. & Tissot, P. 2000. Glossary on identification, assessment and validation of qualifications and competences, transparence and transferability of qualifications. *Documento de Trabajo CEDEFOP. Salónica*.

Blaxter, L. 2010. *How to research.* United Kingdom: McGraw-Hill Education.

Bliss, C.I. 1967. *Statistics in biology. Statistical methods for research in the natural sciences.* McGraw-Hill Book Company.

Bloem, J., Van Doorn, M., Duivestein, S., Excoffier, D., Maas, R. & Van Ommeren, E. 2014. *The Fourth Industrial Revolution.*

Blumberg, M. & Pringle, C.D. 1982. The missing opportunity in organizational research: Some implications for a theory of work performance. *Academy of Management Review,* 7(4):560-569.

Bonache, J. & Brewster, C. 2001. Knowledge transfer and the management of expatriation. *Thunderbird International Business Review,* 43(1):145-168.

Bonesso, S., Gerli, F., Pizzi, C. & Cortellazzo, L. 2018. Students' Entrepreneurial intentions: The role of prior learning experiences and emotional, social, and cognitive competencies. *Journal of Small Business Management,* 56(sup1):215-242.

Bongomin, O., Gilibrays Ocen, G., Oyondi Nganyi, E., Musinguzi, A. & Omara, T. 2020. Exponential disruptive technologies and the required skills of industry 4.0. *Journal of Engineering,* 2020.

Botha, M. 2020. Prior entrepreneurial exposure and action of women entrepreneurs: Exploring the moderation effects of entrepreneurial competencies in a developing country context. *Frontiers in Psychology,* 11:922.

Botha, M. & Morallane, H. 2019. Cognitive adaptability and narrow personality traits: Proposing a person–entrepreneurship fit for established entrepreneurs in South Africa. *South African Journal of Business Management,* 50(1):1-10.

Botha, M. & Taljaard, A. 2019. The bidirectional relationship between entrepreneurial intention and entrepreneurial competencies for nascent and existing entrepreneurs. *South African Journal of Economic and Management Sciences,* 22(1):1-12.

Botha, M., Van Vuuren, J. & Kunene, T. 2015a. An integrated entrepreneurial performance model focusing on the importance and proficiency of competencies for start-up and established SMEs. *South African Journal of Business Management,* 46(3):55-66.

Botha, M., Van Vuuren, J.J. & Kunene, T. 2015b. An integrated entrepreneurial performance model focusing on the importance and proficiency of competencies for start-up and established SMEs. *South African Journal of Business Management,* 46(3):55-66.

Bower, G.H. & Hilgard, E.R. 1981. *Theories of Learning.* New Jersey: PrenticeHall.

Bower, J.L. & Christensen, C.M. 1995. Disruptive technologies: Catching the wave. *Harvard Business Review*:43-53.

Bowmaker-Falconer & Herrington, M. 2020. *Global Entrepreneurship Monitor South Africa (GEM SA) 2019/2020 report.* South Africa: [Online] Available from: https://www.usb.ac.za/wp-content/uploads/2020/06/GEMSA-2019-Entrepreneurship-Report-web.pdf [Accessed: 20/11/2020].

Box, T.M., White, M.A. & Barr, S.H. 1994. A contingency model of new manufacturing firm performance. *Entrepreneurship Theory and Practice,* 18(2):31-45.

Boyatzis, R.E. 1982. *The competent manager: A model for effective performance.* New Jersey: Wiley.

Boyatzis, R.E. 2006. Using tipping points of emotional intelligence and cognitive competencies to predict financial performance of leaders. *Psicothema,* 18:124-131.

Boyd, S. 2017. *Ten work skills for the postnormal era*. [Online] Available from: https://www.linkedin.com/pulse/10-work-skills-postnormal-era-stowe-boyd [Accessed: 04/06/2017].

Boyles, T. 2012. 21st century knowledge, skills, and abilities and entrepreneurial competencies: A model for undergraduate entrepreneurship education. *Journal of Entrepreneurship Education,* 15:41.

Bratianu, C., Hadad, S. & Bejinaru, R. 2020. Paradigm shift in business education: a competence-based approach. *Sustainability,* 12(4):1348.

Bray, D.W., Campbell, R.J. & Grant, D.L. 1974. *Formative years in business: A long-term AT&T study of managerial lives.* Wiley-Interscience.

Brix, J. 2019. Innovation capacity building: An approach to maintaining balance between exploration and exploitation in organizational learning. *The Learning Organization,* 26(1):12-26.

Brockhaus, R. & Horwitz, P. 1986. The psychology of the entrepreneur in Sexton, D. and RW Smilor (Eds), The art and science of entrepreneurship. *Cambridge, Mass: Ballinger*.

Broomhead, D.S. & Lowe, D. 1988. *Radial basis functions, multi-variable functional interpolation and adaptive networks.* Malvern, United Kingdom.

Brown, S., Hingel, G., Ratcheva, V. & Zahidi, S. 2020. *World Economic Forum: The future of jobs report 2020.* Switzerland: [Online] Available from:

http://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf [Accessed: 03/11/2020].

Brown, T. 2008. Design thinking. *Harvard Business Review,* 86(6):84.

Bryant, J. & Poustie, K. 2001. *Competencies needed by public library staff.* Geutersloh: Bertelsmann Foundation.

Brynjolfsson, E. & McAfee, A. 2012. *Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy.* Lexington, MA: Digital Frontier Press.

Bui, A.T., Liao, Y., Nguyen, P.T. & Chang, C.F. 2019. Acquiring Top Management Team, Core Competence through Absorptive Capacity and Entrepreneurial Orientation. *Academy of Entrepreneurship Journal,* 25(1):1-20.

Bukach, B., Abdrakhmanova, A. & Litvinova, R. 2020. Peculiarities of forming entrepreneurial competencies of an entrepreneurial manager.159-167.

Burcharth, A.A.L.L., Lettl, C. & Ulhøi, J.P. 2015. Extending organizational antecedents of absorptive capacity: Organizational characteristics that encourage experimentation. *Technological Forecasting and Social Change,* 90:269-284.

Burggräf, P., Wagner, J. & Weißer, T. 2020. Knowledge-based problem solving in physical product development—A methodological review. *Expert Systems with Applications: X,* 5:1-14.

Byrne, B.M. 2016. *Structural equation modeling with AMOS: basic concepts, applications, and programming (multivariate applications series).* 3rd ed. New York: Routledge.

Cable, D.M. & Judge, T.A. 1996. Person–organization fit, job choice decisions, and organizational entry. *Organizational Behavior and Human Decision Processes,* 67(3):294-311.

Caiazza, R., Belitski, M. & Audretsch, D.B. 2020. From latent to emergent entrepreneurship: the knowledge spillover construction circle. *The Journal of Technology Transfer,* 45(3):694-704.

Calantone, R.J., Cavusgil, S.T. & Zhao, Y. 2002. Learning orientation, firm innovation capability, and firm performance. *Industrial marketing management,* 31(6):515-524.

Caloghirou, Y., Kastelli, I. & Tsakanikas, A. 2004. Internal capabilities and external knowledge sources: Complements or substitutes for innovative performance? *Technovation,* 24(1):29-39.

Camisón, C. & Forés, B. 2011. Knowledge creation and absorptive capacity: The effect of intra-district shared competences. *Scandinavian Journal of Management,* 27(1):66-86.

Campbell, T.T. & Armstrong, S.J. 2013. A longitudinal study of individual and organisational learning. *The Learning Organization,* 20(3):240-258.

Candidate, S. 2013. *OPQ Universal Competency Report.*10. [Online] Available from: https://www.cebglobal.com/shl/us/solutions/products/docs/OPQ32%20Universal%20Competency%20Report%20English%20US.pdf. [Accessed: 14/06/2018].

Caragliu, A. & Nijkamp, P. 2012. The impact of regional absorptive capacity on spatial knowledge spillovers: the Cohen and Levinthal model revisited. *Applied Economics,* 44(11):1363-1374.

Carayannis, E.G., Grigoroudis, E., Sindakis, S. & Walter, C. 2014. Business model innovation as antecedent of sustainable enterprise excellence and resilience. *Journal of the Knowledge Economy,* 5(3):440-463.

Carayannis, E.G. & Provance, M. 2008. Measuring firm innovativeness: Towards a composite innovation index built on firm innovative posture, propensity and performance attributes. *International Journal of Innovation and Regional Development,* 1(1):90-107.

Carpenter, G.S., Glazer, R. & Nakamoto, K. 1994. Meaningful brands from meaningless differentiation: The dependence on irrelevant attributes. *Journal of Marketing Research,* 31(3):339-350.

Casper, S. & Whitley, R. 2004. Managing competences in entrepreneurial technology firms: A comparative institutional analysis of Germany, Sweden and the UK. *Research Policy,* 33(1):89-106.

Caves, R.E. 1998. Industrial organization and new findings on the turnover and mobility of firms. *Journal of Economic Literature,* 36(4):1947-1982.

CEB 2013. OPQ Universal Competency Report.

Chan, D. 1996. Cognitive misfit of problem-solving style at work: A facet of person-organization fit. *Organizational Behavior and Human Decision Processes,* 68(3):194-207.

Chandler, G.N. & Hanks, S.H. 1994. Founder competence, the environment, and venture performance. *Entrepreneurship: Theory and Practice,* 18(3):77-90.

Chandler, G.N. & Jansen, E. 1992. The founder's self-assessed competence and venture performance. *Journal of Business Venturing,* 7(3):223-236.

Chang, J., Bai, X. & Li, J.J. 2015. The influence of leadership on product and process innovations in China: The contingent role of knowledge acquisition capability. *Industrial Marketing Management,* 50:18-29.

Chang, Y.-Y., Gong, Y. & Peng, M.W. 2012. Expatriate knowledge transfer, subsidiary absorptive capacity, and subsidiary performance. *Academy of Management Journal,* 55(4):927-948.

Chaston, I. & Scott, G.J. 2012. Entrepreneurship and open innovation in an emerging economy. *Management Decision,* 50(7):1161-1177.

Chawla, S.K., Pullig, C. & Alexander, F.D. 1997. Critical success factors from an organizational life cycle perspective: Perceptions of small business owners from different business environments. *Journal of Business and Entrepreneurship,* 9(1):47.

Cheetham, G. & Chivers, G. 1996. Towards a holistic model of professional competence. *Journal of European Industrial Training,* 20(5):20-30.

Chen, Y.-S., Lin, M.-J.J. & Chang, C.-H. 2009. The positive effects of relationship learning and absorptive capacity on innovation performance and competitive advantage in industrial markets. *Industrial Marketing Management,* 38(2):152-158.

Chesbrough, H. 2012. *Open innovation: Where we've been and where we're going.* Cambridge.

Chesbrough, H.W. 2006. *Open innovation: The new imperative for creating and profiting from technology.* Harvard Business Press.

Chou, C.P., Bentler, P.M. & Satorra, A. 1991. Scaled test statistics and robust standard errors for non-normal data in covariance structure analysis: A Monte Carlo study. *British Journal of Mathematical and Statistical Psychology,* 44(2):347-357.

Christensen, C. 2003. *The innovator's solution: Creating and sustaining successful growth.* Cambridge: Harvard Business Review Press.

Christensen, C.M. 1997. *The innovator’s dilemma.* Boston: Harvard Business School Press.

Chung, D., Kim, M.J. & Kang, J. 2018. Influence of alliance portfolio diversity on innovation performance: The role of internal capabilities of value creation. *Review of Managerial Science*:1-28.

CIPC. 2016-2017. *Companies and Intellectual Property Commission (CIPC) Annual Report.* [Online] Available from: http://www.cipc.co.za/files/7415/0521/5538/CIPC_2016 2017_ANNUAL_REPORT_-_EMAIL.pdf [Accessed: 17/10/2017].

Clark, K.B. & Fujimoto, T. 1991. *Product development performance (Harvard Business School Press, Boston, MA).* Cambridge: Harvard Business review Press.

Clark, L.A. & Watson, D. 1995. Constructing validity: Basic issues in objective scale development. *Psychological Assessment,* 7(3):309.

Cohen, M.D., Burkhart, R., Dosi, G., Egidi, M., Marengo, L., Warglien, M. & Winter, S. 1996. Routines and other recurring action patterns of organizations: contemporary research issues. *Industrial and Corporate Change,* 5(3):653-698.

Cohen, W.M. & Levinthal, D.A. 1989. Innovation and learning: the two faces of R & D. *The Economic Journal,* 99(397):569-596.

Cohen, W.M. & Levinthal, D.A. 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative science quarterly,* 35(1):128-152.

Collis, J. & Hussey, R. 2013. *Business research: A practical guide for undergraduate and postgraduate students.* Macmillan International Higher Education.

Colombo, M.G. & Grilli, L. 2005. Founders' human capital and the growth of new technology-based firms: A competence-based view. *Research Policy,* 34(6):795-816.

Commission, N.P. 2013. *National Development Plan Vision 2030.*1-444. [Online] Available from.

Contu, A. & Willmott, H. 2003. Re-embedding situatedness: The importance of power relations in learning theory. *Organization Science,* 14(3):283-296.

Cooper-Thomas, H.D. & Anderson, N. 2006. Organizational socialization: A new theoretical model and recommendations for future research and HRM practices in organizations. *Journal of Managerial Psychology,* 21(5):492-516.

Cooper, A.C. 1971. Spin-offs and technical entrepreneurship. *IEEE Transactions on Engineering Management,* (1):2-6.

Cooper, A.C., Dunkelberg, W.C. & Woo, C.Y. 1988. Survival and failure: A longitudinal study. *Frontiers of Entrepreneurship Research,* 1:225-237.

Cooper, D. & Schindler, P. 2011. *Business research methods* 11th ed. Shanghai: Singapore, McGraw Hill.

Cooper, D. & Schindler, P. 2014. *Business research methods.* 12th ed.: The McGraw Hill Companies.

Cooper, R.G. 1979. The dimensions of industrial new product success and failure. *The Journal of Marketing*:93-103.

Cooper, R.G. & De Brentani, U. 1991. New industrial financial services: what distinguishes the winners. *Journal of Product Innovation Management,* 8(2):75-90.

Cope, J. 2005. Toward a dynamic learning perspective of entrepreneurship. *Entrepreneurship Theory and Practice,* 29(4):373-397.

Corbett, A.C. 2005. Experiential learning within the process of opportunity identification and exploitation. *Entrepreneurship Theory and Practice,* 29(4):473-491.

Costa, V. & Monteiro, S. 2016. Knowledge processes, absorptive capacity and innovation: A mediation analysis. *Knowledge and Process Management,* 23(3):207-218.

Couger, J.D. 1995. *Creative problem solving and opportunity finding.* Boyd and Fraser Publishing.

Covin, J.G. & Miles, M.P. 1999. Corporate entrepreneurship and the pursuit of competitive advantage. *Entrepreneurship: Theory and Practice,* 23(3):47-47.

Cragg, P.B. & King, M. 1988. Organizational characteristics and small firms' performance revisited. *Entrepreneurship Theory and Practice,* 13(2):49-64.

Creswell, J.W. & Creswell, J.D. 2018. *Research design: Qualitative, quantitative, and mixed methods approaches.* 5th ed. California: SAGE.

Crisp, J., Pelletier, D., Duffield, C., Adams, A. & Nagy, S. 1997. The Delphi method? *Nursing Research,* 46(2):116-118.

Cross, R. & Cummings, J.N. 2004. Tie and network correlates of individual performance in knowledge-intensive work. *Academy of Management Journal,* 47(6):928-937.

Curran, P.J., West, S.G. & Finch, J.F. 1996. The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods,* 1(1):16.

DA. 2013. *DA Policy on Innovation*. [Online] Available from: https://cdn.da.org.za/wp-content/uploads/2018/02/14234250/Innovation1.pdf [Accessed: 22/09/2019].

Daghfous, A. 2004. Absorptive capacity and the implementation of knowledge-intensive best practices. *SAM Advanced Management Journal,* 69(2):21.

Dahlstrand, A.L. & Stevenson, L. 2010. Innovative entrepreneurship policy: linking innovation and entrepreneurship in a European context. *Annals of Innovation and Entrepreneurship,* 1(1):5602.

Dai, M. & Yu, M. 2013. Firm R&D, absorptive capacity and learning by exporting: Firm-level evidence from China. *The World Economy,* 36(9):1131-1145.

Dale, A., Ling, C. & Newman, L. 2010. Community vitality: The role of community-level resilience adaptation and innovation in sustainable development. *Sustainability,* 2(1):215-231.

Dalkey, N. & Helmer, O. 1963. An experimental application of the Delphi method to the use of experts. *Management Science,* 9(3):458-467.

Danneels, E. 2002. The dynamics of product innovation and firm competences. *Strategic Management Journal,* 23(12):1095-1121.

Danneels, E. 2003. Tight–loose coupling with customers: The enactment of customer orientation. *Strategic Management Journal,* 24(6):559-576.

Danneels, E. 2004. Disruptive technology reconsidered: A critique and research agenda. *Journal of Product Innovation Management,* 21(4):246-258.

Darr, E.D., Argote, L. & Epple, D. 1995. The acquisition, transfer, and depreciation of knowledge in service organizations: Productivity in franchises. *Management Science,* 41(11):1750-1762.

Darroch, M.A. & Clover, T. 2005a. The effects of entrepreneurial quality on the success of small, medium and micro agri-businesses in KwaZula-Natal, South Africa. *Agrekon,* 44(3):321-343.

Darroch, M.A. & Clover, T. 2005b. The effects of entrepreneurial quality on the success of small, medium and micro agri-businesses in KwaZulu-Natal, South Africa. *Agrekon,* 44(3):321-343.

Datta, A. 2012. Combining networks, ambidexterity and absorptive capacity to explain commercialization of innovations: a theoretical model from review and extension.

David, H. & Dorn, D. 2013. The growth of low-skill service jobs and the polarization of the US labor market. *American Economic Review,* 103(5):1553-1597.

Davila, T. & Epstein, M. 2006. *Making innovation work: how to manage it, measure it, and profit from it.* New Jersey: Wharton School Publishing.

De Fuentes, C., Dutrenit, G., Santiago, F. & Gras, N. 2015. Determinants of innovation and productivity in the service sector in Mexico. *Emerging Markets Finance and Trade,* 51(3):578-592.

De Vos, A.S., Delport, C., Fouché, C.B. & Strydom, H. 2012. *Research at grass roots: A primer for the social science and human professions.* 4th ed. Pretoria: Van Schaik

Deeds, D.L. 2001. The role of R&D intensity, technical development and absorptive capacity in creating entrepreneurial wealth in high technology start-ups. *Journal of Engineering and Technology Management,* 18(1):29-47.

Delamare Le Deist, F. & Winterton, J. 2005. What is competence? *Human Resourse Development International,* 8(1):27-46.

Delshab, V., Winand, M., Sadeghi Boroujerdi, S., Hoeber, L. & Mahmoudian, A. 2020. The impact of knowledge management on performance in nonprofit sports clubs: the mediating role of attitude toward innovation, open innovation, and innovativeness. *European Sport Management Quarterly*:1-22.

Denscombe, M. 2007. The good research guide for small-scale social projects. *Maidenhead, England: McGraw Hill*.

DeTienne, D.R. & Chandler, G.N. 2004. Opportunity identification and its role in the entrepreneurial classroom: A pedagogical approach and empirical test. *Academy of Management Learning and Education,* 3(3):242-257.

Devezas, T. & Sarygulov, A. 2017. *Industry 4.0.* Springer.

Diamantopoulos, A. & Winklhofer, H.M. 2001. Index construction with formative indicators: An alternative to scale development. *Journal of Marketing Research,* 38(2):269-277.

Divisekera, S. & Nguyen, V.K. 2018. Determinants of innovation in tourism evidence from Australia. *Tourism Management,* 67:157-167.

Dixon, R., Meier, R.L., Brown, D.C. & Custer, R.L. 2005. The critical entrepreneurial competencies required by instructors from institution-based enterprises: A Jamaican study. *Journal of STEM Teacher Education,* 42(4):24-51.

do Valle, P.O. & Assaker, G. 2016. Using partial least squares structural equation modeling in tourism research: A review of past research and recommendations for future applications. *Journal of Travel Research,* 55(6):695-708.

Dodgson, M. & Gann, D. 2010. *Innovation: A very short introduction.* United Kingdom: Oxford University Press.

Dodoo, R.N.A., Appiah, M. & Donkor, D.T. 2020. Examining the factors that influence firm performance in Ghana: a GMM and OLS approach *National Accounting Review,* 2(3):309-323.

Dosi, G., Levinthal, D.A. & Marengo, L. 2003. Bridging contested terrain: Linking incentive-based and learning perspectives on organizational evolution. *Industrial and Corporate Change,* 12(2):413-436.

Dougherty, D. & Hardy, C. 1996. Sustained product innovation in large, mature organizations: Overcoming innovation-to-organization problems. *Academy of Management Journal,* 39(5):1120-1153.

Draskovic, V., Jovovic, R., Draskovic, M. & Jereb, B. 2013. *Knowledge–keystone of the modern economy.* Ljubljana: Hub, S.P.

Drath, R. & Horch, A. 2014. Industrie 4.0: Hit or hype? *IEEE industrial electronics magazine,* 8(2):56-58.

Drisko, J.W. 2015. Holistic competence and its assessment. *Smith College Studies in Social Work,* 85:110-127.

Drucker, P. 2014. *Innovation and entrepreneurship.* United Kingdom: Routledge.

Drucker, P.F. 1985. The discipline of innovation. *Harvard Business Review,* 63(3):67-72.

Dulewicz, V. & Herbert, P. 1996. General management competences and personality: A 7 year follow-up study. *Working Paper series - Henley Management College*.

Dyer, J.H., Gregersen, H.B. & Christensen, C. 2008. Entrepreneur behaviors, opportunity recognition, and the origins of innovative ventures. *Strategic Entrepreneurship Journal,* 2(4):317-338.

Dyke, L.S., Fischer, E.M. & Reuber, A.R. 1992. An inter-industry examination of the impact of owner experience on firm performance. *Journal of Small Business Management,* 30(4):72.

Dzhengiz, T. & Niesten, E. 2020. Competences for environmental sustainability: A systematic review on the impact of absorptive capacity and capabilities. *Journal of Business Ethics,* 162(4):881-906.

Eberhard, B., Podio, M., Alonso, A.P., Radovica, E., Avotina, L., Peiseniece, L., Caamaño Sendon, M., Gonzales Lozano, A. & Solé-Pla, J. 2017. Smart work: The transformation of the labour market due to the fourth industrial revolution

(I4.0). *International Journal of Business and Economic Sciences Applied Research,* 10(3).

Edgeman, R.L. & Eskildsen, J.K. 2012. Viral innovation: Integration via sustainability & enterprise excellence. *Journal of Innovation and Business Best Practices,* 2012:1.

Edwards-Schachter, M., García-Granero, A., Sánchez-Barrioluengo, M., Quesada-Pineda, H. & Amara, N. 2015. Disentangling competences: Interrelationships on creativity, innovation and entrepreneurship. *Thinking skills and creativity,* 16:27-39.

Eisenhardt, K.M. & Martin, J.A. 2000. Dynamic capabilities: what are they? *Strategic Management Journal,* 21(10-11):1105-1121.

Erikson, T. 2002. Entrepreneurial capital: the emerging venture's most important asset and competitive advantage. *Journal of Business Venturing,* 17(3):275-290.

Erol, S., Jäger, A., Hold, P., Ott, K. & Sihn, W. 2016. Tangible Industry 4.0: A scenario-based approach to learning for the future of production. *Procedia CIRP,* 54:13-18.

Escribano, A., Fosfuri, A. & Tribó, J.A. 2009. Managing external knowledge flows: The moderating role of absorptive capacity. *Research Policy,* 38(1):96-105.

Fachrunnisa, O., Adhiatma, A. & Tjahjono, H.K. 2020. Cognitive collective engagement: relating knowledge-based practices and innovation performance. *Journal of the Knowledge Economy,* 11(2):743-765.

Fagerberg, J., Mowery, D.C. & Nelson, R.R. 2005. *The Oxford handbook of innovation.* England: Oxford University Press.

Fayolle, A., Gailly, B. & Lassas-Clerc, N. 2006. Assessing the impact of entrepreneurship education programmes: a new methodology. *Journal of European Industrial Training,* 30(9):701-720.

Feki, C. & Mnif, S. 2016. Entrepreneurship, technological innovation, and economic growth: empirical analysis of panel data. *Journal of the Knowledge Economy,* 7(4):984-999.

Fernando, A. 2020. Assessing the development of entrepreneurial competencies. *Technology Transfer: Innovative Solutions in Social Sciences and Humanities*:65-67.

Ferreira, J.J., Fernandes, C.I., Raposo, M.L., Thurik, R. & Faria, J.R. 2016. Entrepreneur location decisions across industries. *International Entrepreneurship and Management Journal,* 12(4):985-1006.

Field, A. 2009. *Discovering statistics using SPSS.* United Kingdom: Sage.

Field, A. 2013. *Discovering statistics using IBM SPSS statistics.* Sage.

Fındıklı, M.A., Yozgat, U. & Rofcanin, Y. 2015. Examining organizational innovation and knowledge management capacity the central role of strategic human resources practices (SHRPs). *Procedia-Social and Behavioral Sciences,* 181:377-387.

Fiol, C.M. 1996. Squeezing harder doesn't always work: Continuing the search for consistency in innovation research. *Academy of Management Review,* 21(4):1012-1021.

Fiol, C.M. & Lyles, M.A. 1985. Organizational learning. *Academy of Management Review,* 10(4):803-813.

Fiske, S.T. & Taylor, S.E. 2013. *Social cognition: From brains to culture.* Sage.

Flatten, T., Adams, D. & Brettel, M. 2015. Fostering absorptive capacity through leadership: A cross-cultural analysis. *Journal of World Business,* 50(3):519-534.

Floyd, S.W. & Lane, P.J. 2000. Strategizing throughout the organization: Managing role conflict in strategic renewal. *Academy of Management Review,* 25(1):154-177.

Forbes, N. & Wield, D. 2002. *From followers to leaders: Managing technology and innovation in newly industrializing countries.* Psychology Press.

Ford, C.M. 1996. A theory of individual creative action in multiple social domains. *Academy of Management Review,* 21(4):1112-1142.

Fornell, C. & Larcker, D.F. 1981. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research,* 18(1):39-50.

Fothergill, S. & Gudgin, G. 1982. *Unequal growth: urban and regional employment change in the UK.* Heinemann Educational Publishers.

Francalanci, C. & Morabito, V. 2008. IS integration and business performance: The mediation effect of organizational absorptive capacity in SMEs. *Journal of Information Technology,* 23(4):297-312.

Frank, E. 1991. The UK′ s management charter initiative: The first three years. *Journal of European Industrial Training,* 15(6).

Frankfort-Nachmias, C. & Nachmias, D. 1996. *Index construction and scaling methods.* London: St Martin’s Press.

Frazier, P.A., Tix, A.P. & Barron, K.E. 2004. " Testing moderator and mediator effects in counseling psychology research": Correction to Frazier et al.(2004).

Freeman, C. 2013. *Economics of industrial innovation.* Routledge.

Frey, C.B., Osborne, M., Holmes, C., Rahbari, E., Garlick, R., Friedlander, G., McDonald, G., Curmi, E., Chua, J. & Chalif, P. 2016. *Technology at work v2.0: The future is not what it used to be.* England: CityGroup and University of Oxford.

Frey, C.B. & Osborne, M.A. 2013. The future of employment: how susceptible are jobs to computerisation?

García-Piqueres, G., Serrano-Bedia, A.-M. & Pérez-Pérez, M. 2019. Knowledge management practices and innovation outcomes: The moderating role of risk-taking and proactiveness. *Administrative Sciences,* 9(4):75.

García-Sánchez, E., García-Morales, V.J. & Martín-Rojas, R. 2018. Analysis of the influence of the environment, stakeholder integration capability, absorptive capacity, and technological skills on organizational performance through corporate entrepreneurship. *International Entrepreneurship and Management Journal,* 14(2):345-377.

Garcia, R. & Calantone, R. 2002. A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management,* 19(2):110-132.

Gardner, M.W. & Dorling, S. 1998. Artificial neural networks (the multilayer perceptron)—a review of applications in the atmospheric sciences. *Atmospheric environment,* 32(14-15):2627-2636.

Garson, G.D. 2016. *Partial least squares: Regression & structural equation models* Asheboro, NC: Statistical Associates.

Garver, M.S. & Mentzer, J.T. 1999. Logistics research methods: Employing structural equation modeling to test for construct validity. *Journal of Business Logistics,* 20(1):33.

Garvin, D.A. 1993. *Building a learning organization.* Harvard Business Review July-August.

George, D. & Mallery, P. 2010. SPSS for Windows step by step. A simple study guide and reference (10. Baskı). *GEN, Boston, MA: Pearson Education*.

Ghio, N., Guerini, M., Lehmann, E.E. & Rossi-Lamastra, C. 2015. The emergence of the knowledge spillover theory of entrepreneurship. *Small Business Economics,* 44(1):1-18.

Ghorbel, F., Hachicha, W. & Boujelbène, Y. 2017. A mixed approach for studying effectual entrepreneurial opportunities: Development and application to Tunisian context. *Management Science Letters,* 7(9):439-456.

Ghoshal, S. & Bartlett, C.A. 1991. *Innovation processes in multinational corporations.* Massachusetts, United States: Allyn & Bacon.

Glancey, K. 1998. Determinants of growth and profitability in small entrepreneurial firms. *International Journal of Entrepreneurial Behavior Research,* 4(1):18-27.

Godbole, P., Burke, D. & Aylott, J. 2017. *Why hospitals fail: Between theory and practice.* Springer.

Goldman, K.D. & Schmalz, K.J. 2004. The matrix method of literature reviews. *Health Promotion Practice,* 5(1):5-7.

Goldsby, M.G., Kuratko, D.F., Bishop, J.W., Kreiser, P.M. & Hornsby, J.S. 2018. Social proactiveness and innovation: The impact of stakeholder salience on corporate entrepreneurship. *Journal of Small Business Strategy,* 28(2):1-15.

Govindarajan, V. & Kopalle, P.K. 2006. The usefulness of measuring disruptiveness of innovations ex post in making ex ante predictions. *Journal of Product Innovation Management,* 23(1):12-18.

Grafström, J. & Lindman, Å. 2017. Invention, innovation and diffusion in the European wind power sector. *Technological Forecasting and Social Change,* 114:179-191.

Graham, I.D., Logan, J., Harrison, M.B., Straus, S.E., Tetroe, J., Caswell, W. & Robinson, N. 2006. Lost in knowledge translation: time for a map? *Journal of Continuing Education in the Health Professions,* 26(1):13-24.

Grant, R. 1996a. Prospering in dynamic-competitive environments: Organizational capability as knowledge integrations. *Strategic Management Journal,* 13(4):335-387.

Grant, R.M. 1996b. Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science,* 7(4):375-387.

Grant, R.M. 1996c. Toward a knowledge-based theory of the firm. *Strategic Management Journal,* 17(S2):109-122.

Gray, A. 2016. *The 10 skills you need to thrive in the Fourth Industrial Revolution*. [Online] Available from: https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/ [Accessed: 12/09/2017].

Grégoire, D.A., Barr, P.S. & Shepherd, D.A. 2010. Cognitive processes of opportunity recognition: The role of structural alignment. *Organization Science,* 21(2):413-431.

Grzybowska, K. & Łupicka, A. 2017. Key competencies for Industry 4.0. *Economics & Management,* 1(1):250-253.

Gwadabe, U.M. & Amirah, N.A. 2017. Entrepreneurial Competencies: SMEs Performance Factor in the Challenging Nigerian Economy. *Academic Journal of Economic Studies,* 3(4):55-61.

Hadhri, W., Arvanitis, R. & M'Henni, H. 2016. Determinants of innovation activities in small and open economies: the Lebanese business sector. *Journal of Innovation Economics Management,* (3):77-107.

Hafer, R. & Jones, G. 2015. Are entrepreneurship and cognitive skills related? Some international evidence. *Small Business Economics,* 44(2):283-298.

Hair, J., Anderson, R., Tatham, R. & Black, W. 1998. *Factorial analysis.* 5 ed. New Jersey: Prentice Hall.

Hair, J.F., Anderson, R.E., Babin, B.J. & Black, W.C. 2010a. *Multivariate data analysis: A global perspective* Upper Saddle River, NJ: Pearson.

Hair, J.F., Black, W.C., Babin, B.J. & Anderson, R.E. 2014. *Multivariate data analysis: Pearson new international edition.* Essex: Pearson Education Limited.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. & Tatham, R.L. 2010b. *Multivariate data analysis: A global perspective.* Upper Saddle River, NJ: Pearson.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. & Tatham, R.L. 2019. *Multivariate data analysis.* 8th ed. United Kingdom: Annabel Ainscow.

Hajizadeh, A. & Zali, M. 2016. Prior knowledge, cognitive characteristics and opportunity recognition. *International Journal of Entrepreneurial Behavior & Research,* 22(1).

Hall, R. & Andriani, P. 2003. Managing knowledge associated with innovation. *Journal of Business Research,* 56(2):145-152.

Hamel, G. & Prahalad, C. 1994. *Competing for the future* Cambridge, MA: Harvard Business School Press.

Han, J. 2017. Exploitation of architectural knowledge and innovation. *Journal of Open Innovation: Technology, Market, and Complexity,* 3(3):1-15.

Harahap, L. 2017. *To be an entrepreneur or non-enterpreneur: Enterpreneur orientation dimensional*. Paper presented at International conference on management and entrepreneurship, Indonesia:9.

Harrison, R.T. & Leitch, C.M. 2005. Entrepreneurial learning: Researching the interface between learning and the entrepreneurial context. *Entrepreneurship Theory and Practice,* 29(4):351-371.

Hart, T.A., Gilstrap, J.B. & Bolino, M.C. 2016. Organizational citizenship behavior and the enhancement of absorptive capacity. *Journal of Business Research,* 69(10):3981-3988.

Hashim, N.A.B., Raza, S. & Minai, M.S. 2018. Relationship between entrepreneurial competencies and small firm performance: are dynamic capabilities the missing link? *Academy of Strategic Management Journal,* 17(2):1-10.

Hasson, F., Keeney, S. & McKenna, H. 2000. Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing,* 32(4):1008-1015.

Havlicek, L.L. & Peterson, N.L. 1976. Robustness of the Pearson correlation against violations of assumptions. *Perceptual and Motor Skills,* 43(3_suppl):1319-1334.

Hayes, J. & Allinson, C.W. 1994. Cognitive style and its relevance for management practice. *British Journal of Management,* 5(1):53-71.

Haykin, S. 1994. *Neural networks: a comprehensive foundation.* Prentice Hall PTR.

Haynie, M. & Shepherd, D.A. 2009. A measure of adaptive cognition for entrepreneurship research. *Entrepreneurship Theory and Practice,* 33(3):695-714.

Hayton, J.C. & Zahra, S.A. 2005. Venture team human capital and absorptive capacity in high technology new ventures. *International Journal of Technology Management,* 31(3-4):256-274.

Hazlina Ahmad, N., Ramayah, T., Wilson, C. & Kummerow, L. 2010. Is entrepreneurial competency and business success relationship contingent upon business environment? A study of Malaysian SMEs. *International Journal of Entrepreneurial Behavior & Research,* 16(3):182-203.

Healy, P. 2019. Garvin's learning organisation: A process perspective on learning for implementation, improvement, and innovation. In: Örtenblad, A. (ed.). *The Oxford handbook of the learning organization*. Oxford, United Kingdom: Oxford University Press.

Heinrichs, J.H. & Lim, J.S. 2005. Model for organizational knowledge creation and strategic use of information. *Journal of the American Society for Information Science and Technology,* 56(6):620-629.

Henderson, R. & Cockburn, I. 1994. Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal,* 15(S1):63-84.

Henderson, R.M. & Clark, K.B. 1990. Architectural innovation: The reconfiguration of existing. *Administrative Science Quarterly,* 35(1):9-30.

Henseler, J., Ringle, C.M. & Sarstedt, M. 2015. A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science,* 43(1):115-135.

Hermann, M., Pentek, T., Otto, B., Pentek, T. & Otto, B. 2015. Design principles for industry 4.0 scenarios: A literature review. *Dortmund, Germany: Technische Universität Dortmund*.

Hernández-Orallo, J., Dowe, D.L. & Hernández-Lloreda, M.V. 2014. Universal psychometrics: Measuring cognitive abilities in the machine kingdom. *Cognitive Systems Research,* 27:50-74.

Hernandez-Perlines, F. 2018. Moderating effect of absorptive capacity on the entrepreneurial orientation of international performance of family businesses. *Journal of Family Business Management*, 8(1)58-74.

Herrington, M., Kew, J. & Kew, P. 2010. *Global Entrepreneurship Monitor 2010 Global Report.* [Online] Available from: https://entreprenorskapsforum.se/wp-content/uploads/2011/02/GEM-2010-Global-Report.pdf [Accessed: 1/03/2019].

Herrington, M., Kew, J. & Kew, P. 2016. *Global Entrepreneurship Monitor, Global Report 2015/16.* [Online] Available from: https://www.gemconsortium.org/report/gem-2015-2016-global-report [Accessed: 16/08/2016].

Herrington, M., Kew, J. & Kew, P. 2018. Global Report 2017/18. *Global Entrepreneurship Monitor (GEM). The Global Entrepreneurship Research Association (GERA). Wellesley, Massachusetts: USA*.

Herrington, M., Kew, J. & Kew, P. 2019. *Global Report 2018/19.* Massachusetts, USA: Wellesley.

Herron, L. & Robinson, R.B. 1993. A structural model of the effects of entrepreneurial characteristics on venture performance. *Journal of Business Venturing,* 8(3):281-294.

Hill, C.W. & Rothaermel, F.T. 2003. The performance of incumbent firms in the face of radical technological innovation. *Academy of Management Review,* 28(2):257-274.

Hill, T., Marquez, L., O'Connor, M. & Remus, W. 1994. Artificial neural network models for forecasting and decision making. *International Journal of Forecasting,* 10(1):5-15.

Hills, G. & Shrader, R. 1998. Successful entrepreneur's insights into opportunity recognition. . *Frontiers of Entrepreneurial Research* 18(2):30-41.

Hisrich, R., Peters, M. & Shepherd, D. 2005. *Entrepreneurship.* 6th ed. New York: McGraw-Hill/Irwin.

Hjarnø, L., Syed, A.M. & Aro, A.R. 2007. *Report of interview summaries and Delphi rounds.*

Hoelter, J.W. 1983. The analysis of covariance structures: Goodness-of-fit indices. *Sociological Methods & Research,* 11(3):325-344.

Holcomb, T.R., Ireland, R.D., Holmes Jr, R.M. & Hitt, M.A. 2009. Architecture of entrepreneurial learning: Exploring the link among heuristics, knowledge, and action. *Entrepreneurship Theory and Practice,* 33(1):167-192.

Hollenbeck, G. & McCall, M. 1999. *Leadership development: Contemporary practices.* San Francisco: Jossey-Bass.

Holmes, W.M. & Scaffa, M.E. 2009. An exploratory study of competencies for emerging practice in occupational therapy. *Journal of Allied Health,* 38(2):81-90.

Hong, W. & Thong, J.Y. 2013. Internet privacy concerns: An integrated conceptualization and four empirical studies. *Mis Quarterly*:275-298.

Hooper, D., Coughlan, J. & Mullen, M.R. 2008. Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods,* 6(1):53-60.

Hsu, D.K., Burmeister-Lamp, K., Simmons, S.A., Foo, M.-D., Hong, M.C. & Pipes, J.D. 2019. “I know I can, but I don't fit”: Perceived fit, self-efficacy, and entrepreneurial intention. *Journal of Business Venturing,* 34(2):311-326.

Huber, G.P. 1991. Organizational learning: The contributing processes and the literatures. *Organization Science,* 2(1):88-115.

Huff, A.S. 1990. *Mapping strategic thought.* Wiley.

Hull, D.L. 2010. *Science as a process: an evolutionary account of the social and conceptual development of science.* University of Chicago Press.

Hurley, R.F. & Hult, G.T.M. 1998. Innovation, market orientation, and organizational learning: An integration and empirical examination. *The Journal of Marketing,* 62(3):42-54.

Hussler, C. & Ronde, P. 2009. Investing in networking competences or establishing in hot spots?: The innovation dilemna. *Journal of Technology Management and Innovation,* 4(4):1-13.

Ibidunni, A.S., Atolagbe, T.M., OBI, J.N., Olokundun, A.M., Oke, A.O., Amaihian, A., Borishade, T. & Obaoye, D. 2018. Moderating effect of entrepreneurial orientation on entrepreneurial competencies and performance of agro-based SMEs. *International Journal of Entrepreneurship,* 22(1).

Ibrahim, A.B. 1993. Strategy types and small firms' performance an empirical investigation. *Journal of Small Business Strategy,* 4(1):13-22.

Isaacson, W. 2011. *Steve Jobs (Italian Edition).* Edizioni Mondadori.

Isaksen, S.G., Dorval, K.B. & Treffinger, D.J. 2011. *Creative approaches to problem solving: A framework for innovation and change.* Sage.

Jaeger, S.R., Cardello, A.V., Jin, D., Hunter, D.C., Roigard, C.M. & Hedderley, D.I. 2017. Product uniqueness: Further exploration and application of a consumer-based methodology. *Food Quality and Preference,* 60:59-71.

Jane Zhao, Z. & Anand, J. 2009. A multilevel perspective on knowledge transfer: Evidence from the Chinese automotive industry. *Strategic Management Journal,* 30(9):959-983.

Jansen, J.J., Van den Bosch, F.A. & Volberda, H.W. 2003. Managing potential and realized absorptive capacity: Antecedents and consequences. Rotterdam, Netherlands.

Jasińska-Biliczak, A., Kowal, J. & Hafner, J. 2016. Innovative capacity in small regional enterprises in transition economies: An exploratory study in Poland. San Diego, California:1-10.

Jassawalla, A.R. & Sashittal, H.C. 2002. Cultures that support product-innovation processes. *Academy of Management Perspectives,* 16(3):42-54.

Jayathilake, P.B. 2018. Network ties, absorptive capacity and innovativeness of the SMEs in Sri Lanka.229-234.

Jewkes, J. 1969. *The sources of invention.* Springer.

Jiménez-Barrionuevo, M., Molina, L.M. & García-Morales, V.J. 2019. Combined influence of absorptive capacity and corporate entrepreneurship on performance. *Sustainability,* 11(11):3034.

Jiménez-Castillo, D. & Sánchez-Pérez, M. 2013. Nurturing employee market knowledge absorptive capacity through unified internal communication and integrated information technology. *Information and Management,* 50(2-3):76-86.

Jimenez-Jimenez, D. & Sanz-Valle, R. 2005. Innovation and human resource management fit: an empirical study. *International Journal of Manpower,* 26(4):364-381.

John, C.H.S., Balakrishnan, N. & Fiet, J.O. 2000. Modeling the relationship between corporate strategy and wealth creation using neural networks. *Computers & Operations Research,* 27(11-12):1077-1092.

Johnson-Lenz, P. & Johnson-Lenz, T. 2009. Six habits of highly resilient organizations. *People Place,* 1(3).

Jose, P.E. 2013. *Doing statistical mediation and moderation.* Guilford Press.

Kagermann, H., Helbig, J., Hellinger, A. & Wahlster, W. 2013. *Umsetzungsempfehlungen für das Zukunftsprojekt Industrie 4.0: Deutschlands Zukunft als Produktionsstandort sichern; Abschlussbericht des Arbeitskreises Industrie 4.0.* Forschungsunion.

Kahn, K.B. 2018. Understanding innovation. *Business Horizons,* 61(3):453-460.

Kaiser, H.F. 1970. A second generation little jiffy. *Psychometrika,* 35(4):401-415.

Kaiser, H.F. 1974. An index of factorial simplicity. *Psychometrika,* 39(1):31-36.

Kakapour, S., Hemmati, M. & Khanifar, H. 2014. Prioritization of constructive factors of the person-entrepreneurship fit in knowledge based entrepreneurial firms in

Tehran, applying PCA Technique. *Asian Journal of Research in Business Economics and Management,* 4(10):243-261.

Kanter, R.M. 1983. *The change masters: Binnovation and entrepreneturship in the American corporation.* Touchstone Book.

Kanter, R.M. 1988. When a thousand flowers bloom: Structural, collective, and social conditions for innovation in organizations. *Knowledge Management and Organisational Design,* 10:93-131.

Karre, H., Hammer, M., Kleindienst, M. & Ramsauer, C. 2017. Transition towards an Industry 4.0 state of the LeanLab at Graz University of Technology. *Procedia Manufacturing,* 9:206-213.

Kaufmann, G. 2003. *The effect of mood on creativity in the innovative process.* Kidlington, Oxford: Elsevier Science.

Kaur, H. & Bains, A. 2013. Understanding the concept of entrepreneur competency. *Journal of Business Management and Social Sciences Research,* 2(11):2013.

Kayes, D.C., Kayes, A.B. & Yamazaki, Y. 2005. Essential competencies for cross-cultural knowledge absorption. *Journal of Managerial Psychology,* 20(7):578-589.

Keh, H.T., Der Foo, M. & Lim, B.C. 2002. Opportunity evaluation under risky conditions: The cognitive processes of entrepreneurs. *Entrepreneurship Theory and Practice,* 27(2):125-148.

Kennedy, H.P. 2004. Enhancing Delphi research: Methods and results. *Journal of Advanced Nursing,* 45(5):504-511.

Kenny, D. 2014. SEM: Fit. *Measuring model fit* [Online] Available from: http://davidakenny.net/cm/fit.htm [Accessed: 08/08/2020].

Kenny, D.A. 2018. *Mediation*. [Online] Available from: http://davidakenny.net/cm/mediate.htm [Accessed: 09/06/2020].

Kenny, D.A. & Judd, C.M. 2014. Power anomalies in testing mediation. *Psychological Science,* 25(2):334-339.

Keskin, H. 2006. Market orientation, learning orientation, and innovation capabilities in SMEs: An extended model. *European Journal of Innovation Management,* 9(4):396-417.

Khan, S., Bhatti, S.H., Zaman, U. & Hussain, M. 2020. Breaking down the success barrier: The mediating role of absorptive capacity in linking entrepreneurial orientation to IT project success. *Pakistan Journal of Commerce and Social Sciences (PJCSS),* 14(2):529-550.

Kholodnaya, M. 1990. Is there intelligence as a psychical reality. *Voprosu Psichologii,* 5:121-128.

Kholodnaya, M. 2002. The psychology of intelligence. *St. Petersburg: Peter. 272p*.

Kier, A.S. & McMullen, J.S. 2018. Entrepreneurial imaginativeness in new venture ideation. *Academy of Management Journal,* 61(6):2265-2295.

Kim, D. 1993a. *The link between individual and organisational learning*. Elsevier

Kim, D.H. 1993b. *A framework and methodology for linking individual and organizational learning: Applications in TQM and product development.* Massachusetts Institute of Technology.

Kim, D.H. 1997. The link between individual and organizational learning. *The strategic management of intellectual capital*: Elsevier.

Kim, J. & McLean, G.N. 2015. An integrative framework for global leadership competency: Levels and dimensions. *Human Resource Development International,* 18(3):235-258.

Kim, L. 1998. Crisis construction and organizational learning: Capability building in catching-up at Hyundai Motor. *Organization Science,* 9(4):506-521.

King, N. 1990. *Innovation at work: The research literature.* Washington, DC: Wiley.

Kirton, M. 1976. Adaptors and innovators: A description and measure. *Journal of Applied Psychology,* 61(5):622.

Kleinschmidt, E.J. & Cooper, R.G. 1991. The impact of product innovativeness on performance. *Journal of Product Innovation Management,* 8(4):240-251.

Klendauer, R., Berkovich, M., Gelvin, R., Leimeister, J.M. & Krcmar, H. 2012. Towards a competency model for requirements analysts. *Information Systems Journal,* 22(6):475-503.

Kline, P. 2014. *An easy guide to factor analysis.* Routledge.

Kline, R.B. 1998a. Software review: Software programs for structural equation modeling: Amos, EQS, and LISREL. *Journal of Psychoeducational Assessment,* 16(4):343-364.

Kline, R.B. 1998b. Structural equation modeling. *New York: Guilford*.

Kline, R.B. 2011. Principles and practice of structural equation. *Modeling,* 3(19):509-512.

Kline, R.B. 2015. *Principles and practice of structural equation modeling.* Guilford publications.

Kline, S.J. & Rosenberg, N. 1986. *An overview of innovation. The positive sum strategy: Harnessing technology for economic growth.* Washington DC: National Academic Press.

Klopper, R., Lubbe, S. & Rugbeer, H. 2007. The matrix method of literature review. *Alternation,* 14(1):262-276.

Ko, H.-T. & Lu, H.-P. 2010. Measuring innovation competencies for integrated services in the communications industry. *Journal of Service Management,* 21(2):162-190.

Kobarg, S., Stumpf-Wollersheim, J. & Welpe, I.M. 2018. University-industry collaborations and product innovation performance: The moderating effects of absorptive capacity and innovation competencies. *The Journal of Technology Transfer,* 43(6):1696-1724.

Kogut, B. & Zander, U. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science,* 3(3):383-397.

Kolb, D.A. 1984. *Experience as the source of learning and development.* Upper Sadle River: Prentice Hall.

Kolb, D.A. 2014. *Experiential learning: Experience as the source of learning and development.* FT press.

Kor, Y.Y. 2003. Experience-based top management team competence and sustained growth. *Organization Science,* 14(6):707-719.

Kostopoulos, K., Papalexandris, A., Papachroni, M. & Ioannou, G. 2011. Absorptive capacity, innovation, and financial performance. *Journal of Business Research,* 64(12):1335-1343.

Kreiser, P.M., Marino, L.D. & Weaver, K.M. 2002. Assessing the psychometric properties of the entrepreneurial orientation scale: A multi-country analysis. *Entrepreneurship: Theory and Practice,* 26(4):71-95.

Kristof, A.L. 1996. Person-organization fit: An integrative review of its conceptualizations, measurement, and implications. *Personnel Psychology,* 49(1):1-49.

Krueger, N.F., Reilly, M.D. & Carsrud, A.L. 2000. Competing models of entrepreneurial intentions. *Journal of Business Venturing,* 15(5):411-432.

Kruger, M.E., Millard, S.M. & Pretorius, M. 2005. Creativity, innovation and implementation: Management experience, venture size, life cycle stage, race and gender as moderators. *South African Journal of Business Management,* 36(4):55-68.

Kruger, S. & Steyn, A.A. 2020. A conceptual model of entrepreneurial competencies needed to utilise technologies of Industry 4.0. *The International Journal of Entrepreneurship and Innovation*, 22(1):56-67.

Kuhn, T.S. 1970. The structure of scientific revolutions. *International Encyclopedia of Unified Science,* 2(2):1-210.

Kumar, R. 2019. *Research methodology: A step-by-step guide for beginners.* Sage

Kuratko, D.F. 2005. The emergence of entrepreneurship education: Development, trends, and challenges. *Entrepreneurship theory and practice,* 29(5):577-598.

Kurz, R. & Bartram, D. 2002. Competency and individual performance: Modelling the world of work. *Organizational effectiveness: The role of psychology*: Wiley.

Kyndt, E. & Baert, H. 2015. Entrepreneurial competencies: Assessment and predictive value for entrepreneurship. *Journal of Vocational Behavior,* 90:13-25.

Lane, P.J., Koka, B.R. & Pathak, S. 2006. The reification of absorptive capacity: A critical review and rejuvenation of the construct. *Academy of Management Review,* 31(4):833-863.

Lant, T.K., Milliken, F.J. & Batra, B. 1992. The role of managerial learning and interpretation in strategic persistence and reorientation: An empirical exploration. *Strategic Management Journal,* 13(8):585-608.

Lau, A.K. & Lo, W. 2015. Regional innovation system, absorptive capacity and innovation performance: An empirical study. *Technological Forecasting and Social Change,* 92:99-114.

Lau, T., Chan, K. & Man, T. 1999. Entrepreneurial and managerial competencies: Small business owner-managers in Hong Kong. Hong Kong Management and Labour: Change and Continuity. *Advances in Asia Pacific Business,* 9.

Lawal, F.A., Iyiola, O.O., Adegbuyi, O.A., Ogunnaike, O.O. & Taiwo, A.A. 2018. Modelling the relationship between entrepreneurial climate and venture performance: The moderating role of entrepreneurial competencies. *Academy of Entrepreneurship Journal,* 24(1):1-16.

Lawrence, P.R. & Dyer, D. 1983. *Renewing American Industry.* New York: Free Press; London: Collier Macmillan.

Le Deist, F.D. & Winterton, J. 2005. What is competence? *Human Resource Development International,* 8(1):27-46.

Le, P.B. & Lei, H. 2019. Determinants of innovation capability: the roles of transformational leadership, knowledge sharing and perceived organizational support. *Journal of Knowledge Management,* 23(3):527-547.

Leal-Rodríguez, A.L., Ariza-Montes, J.A., Roldán, J.L. & Leal-Millán, A.G. 2014a. Absorptive capacity, innovation and cultural barriers: A conditional mediation model. *Journal of Business Research,* 67(5):763-768.

Leal-Rodríguez, A.L., Roldán, J.L., Ariza-Montes, J.A. & Leal-Millán, A. 2014b. From potential absorptive capacity to innovation outcomes in project teams: The conditional mediating role of the realized absorptive capacity in a relational learning context. *International Journal of Project Management,* 32(6):894-907.

Lee, M. & Na, D. 1994. Determinants of technical success in product development when innovative radicalness is considered. *Journal of Product Innovation Management,* 11(1):62-68.

Leedy, P. & Ormrod, J. 2013. The nature and tools of research. *Practical research: Planning and Design,* 1:1-26.

Leedy, P.D. & Ormrod, J.E. 2010. Practical research. *Journal of Applied Psychology,* 74:424-432.

Lemke, C., Coughlin, E., Thadani, V. & Martin, C. 2003. enGauge 21st century skills: Literacy in the digital age. [Online] Available from: https://www.cwasd.k12.wi.us/highschl/newsfile1062_1.pdf [Accessed: 30/05/2017].

Leong, L.-Y., Hew, T.-S., Lee, V.-H. & Ooi, K.-B. 2015. An SEM–artificial-neural-network analysis of the relationships between SERVPERF, customer satisfaction and loyalty among low-cost and full-service airline. *Expert Systems with Applications,* 42(19):6620-6634.

Leopold, T.A., Ratcheva, V.R. & Zahidi, S. 2016. *The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution.* [Online] Available from: http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf [Accessed: 24/05/2020].

Lerner, M., Brush, C. & Hisrich, R. 1997. Israeli women entrepreneurs: An examination of factors affecting performance. *Journal of Business Venturing,* 12(4):315-339.

Leth-Steensen, C. & Gallitto, E. 2016. Testing mediation in structural equation modeling: The effectiveness of the test of joint significance. *Educational and Psychological Measurement,* 76(2):339-351.

Levenson, A. 2005. Do competencies drive organizational performance? Can they? Evidence and implications for professional and HR competencies. *Effective Organizations,* 6:1-28.

Levenson, A.R., Van der Stede, W.A. & Cohen, S.G. 2006. Measuring the relationship between managerial competencies and performance. *Journal of Management,* 32(3):360-380.

Levinthal, D. & Rerup, C. 2006. Crossing an apparent chasm: Bridging mindful and less-mindful perspectives on organizational learning. *Organization Science,* 17(4):502-513.

Levitt, B. & March, J.G. 1988. Organizational learning. *Annual Review of Sociology,* 14(1):319-338.

Levy, Y. & Ellis, T.J. 2006. A systems approach to conduct an effective literature review in support of information systems research. *Informing Science,* 9:181-212.

Li, D., Paulin, D., Fast-Berglund, Å., Gullander, P. & Bligård, L.-O. 2018. Supporting individual needs for intra-organisational knowledge sharing activities in pre-industry 4.0 SMEs.160-170.

Li, X. 2009. *Entrepreneurial competencies as an entrepreneurial distinctive: An examination of the competency approach in defining entrepreneurs.* Singapore Management University.

Liang, J., Wang, H. & Lazear, E.P. 2018. Demographics and entrepreneurship. *Journal of Political Economy,* 126(1):140-196.

Liao, J., Welsch, H. & Stoica, M. 2003. Organizational absorptive capacity and responsiveness: An empirical investigation of growth–oriented SMEs. *Entrepreneurship Theory and Practice,* 28(1):63-86.

Liao, S.-H., Wu, C.-C., Hu, D.-C. & Tsuei, G.A. 2009. Knowledge acquisition, absorptive capacity, and innovation capability: An empirical study of Taiwan's knowledge-intensive industries. *Technology,* 11:13.

Lichtenthaler, U. 2009. Absorptive capacity, environmental turbulence, and the complementarity of organizational learning processes. *The Academy of Management Journal,* 52(4):822-846.

Lilleväli, U. & Täks, M. 2017. Competence models as a tool for conceptualizing the systematic process of entrepreneurship competence development. *Education Research International,* 2017.

Lim, W.L. & Xavier, S.R. 2015. Opportunity recognition framework: Exploring the technology entrepreneurs. *American Journal of economics,* 5(2):105-111.

Lin, A.C. 1998. Bridging positivist and interpretivist approaches to qualitative methods. *Policy Studies Journal,* 26(1):162-180.

Lin, H.-F. 2007. Knowledge sharing and firm innovation capability: an empirical study. *International Journal of Manpower,* 28(3/4):315-332.

Liñán, F. & Chen, Y.W. 2009. Development and cross-cultural application of a specific instrument to measure entrepreneurial intentions. *Entrepreneurship Theory and Practice,* 33(3):593-617.

Liñán, F., Rodríguez-Cohard, J.C. & Rueda-Cantuche, J.M. 2011. Factors affecting entrepreneurial intention levels: a role for education. *International Entrepreneurship and Management Journal,* 7(2):195-218.

Linstone, H.A. & Turoff, M. 1975. *The Delphi method: Techniques and applications.* Addison-Wesley Reading, MA.

Liu, H., Ke, W., Wei, K.K. & Hua, Z. 2013. The impact of IT capabilities on firm performance: The mediating roles of absorptive capacity and supply chain agility. *Decision Support Systems,* 54(3):1452-1462.

López-Bonilla, J.M. & López-Bonilla, L.M. 2014. Holistic competence approach in tourism higher education: An exploratory study in Spain. *Current Issues in Tourism,* 17(4):312-326.

Löwik, S., Kraaijenbrink, J. & Groen, A.J. 2012. The effects of prior knowledge, networks, and cognitive style on individuals' absorptive capacity. Briarcliff Manor, NY:10776.

Löwik, S., Kraaijenbrink, J. & Groen, A.J. 2017. Antecedents and effects of individual absorptive capacity: a micro-foundational perspective on open innovation. *Journal of Knowledge Management,* 21(6).

Löwik, S.J.A. 2013. *Micro-foundations of absorptive capacity: A study on knowledge processes for innovation in SMEs.* University of Twente.

Lukjanska, R. 2010. *Innovation capacity–problems and solutions for successful development*. Paper presented at Annual 16th international Scientific Conference Proceedings Research for Rural Development:42-48.

Lumpkin, G.T. & Dess, G.G. 2001. Linking two dimensions of entrepreneurial orientation to firm performance: The moderating role of environment and industry life cycle. *Journal of Business Venturing,* 16(5):429-451.

Lund Vinding, A. 2006. Absorptive capacity and innovative performance: A human capital approach. *Economics of Innovation and New Technology,* 15(4-5):507-517.

Łupicka, A. & Grzybowska, K. 2018. Key managerial competencies for industry 4.0-practitioners’, researchers' and students' opinions. *Logistics and Transport,* 39.

Lyle, M. & Spencer, M.S. 1993. *Competence at work: Models for superior performance.* United States: Wiley.

MacDaniel, C.D. & Gates, R.H. 2013. *Marketing Research.* Wiley.

Machlup, F. 2014. *Knowledge: Its creation, distribution and economic significance, volume III: The economics of information and human capital.* Princeton University Press.

MacPherson, A.D. 1997. A Comparison of within-firm and external sources of product innovation. *Growth and Change,* 28(3):289-308.

Malhotra, N.K. 2015. *Essentials of marketing research: A hands-on orientation.* Essex Pearson.

Mamabolo, M.A., Kerrin, M. & Kele, T. 2017. Entrepreneurship management skills requirements in an emerging economy: A South African outlook. *The Southern African Journal of Entrepreneurship and Small Business Management,* 9(1):1-10.

Man, T.W. & Lau, T. 2005. The context of entrepreneurship in Hong Kong: An investigation through the patterns of entrepreneurial competencies in contrasting industrial environments. *Journal of Small Business and Enterprise Development,* 12(4):464-481.

Man, T.W., Lau, T. & Chan, K. 2002a. The competitiveness of small and medium enterprises: A conceptualization with focus on entrepreneurial competencies. *Journal of Business Venturing,* 17(2):123-142.

Man, T.W., Lau, T. & Chan, K. 2002b. The competitiveness of small and medium enterprises: A conceptualization with focus on entrepreneurial competencies. *Journal of Business Venturing,* 17(2):123-142.

Man, T.W., Lau, T. & Snape, E. 2008. Entrepreneurial competencies and the performance of small and medium enterprises: An investigation through a framework of competitiveness. *Journal of Small Business and Entrepreneurship,* 21(3):257-276.

Mangham, I.L. 1986. In search of competence. *Journal of General Management,* 12(2):5-12.

Manuel Martínez-López, A. & Vargas-Sánchez, A.A. 2013. The strategic management process and the innovative capacity of the Spanish hotel industry. *Journal of Hospitality Marketing and Management,* 22(6):596-618.

Marchesnay, M. 2014. Strategic scanning of small entrepreneurs: a pragmatic view. *Journal of Innovation Economics Management,* (2):105-120.

Markides, C. 2006. Disruptive innovation: In need of better theory. *Journal of Product Innovation Management,* 23(1):19-25.

Markman, G.D. & Baron, R.A. 2003. Person–entrepreneurship fit: Why some people are more successful as entrepreneurs than others. *Human Resource Management Review,* 13(2):281-301.

Marks, J., Dawa, S. & Kanyemba, S. 2020. Transnational entrepreneurship in Sub-Saharan Africa: An absorptive capacity theory of knowledge spillover entrepreneurship perspective. *Journal of Entrepreneurship and Innovation in Emerging Economies,* 6(1):114-139.

Markus, L., Thomas, H. & Allpress, K. 2005. Confounded by competencies? An evaluation of the evolution and use of competency models. *New Zealand Journal of Psychology,* 34(2):117.

Marsh, H.W. & Hocevar, D. 1985. Application of confirmatory factor analysis to the study of self-concept: First-and higher order factor models and their invariance across groups. *Psychological Bulletin,* 97(3):562.

Marshall, A. 1920. *Principles of Economics.*

Marshall, S.P. 1995. *Schemas in problem solving.* Cambridge University Press.

Martensen, A. 1998. Leadership for product development: A business excellence approach. *Total Quality Management,* 9(4-5):172-176.

Martin, B.C., McNally, J.J. & Kay, M.J. 2013. Examining the formation of human capital in entrepreneurship: A meta-analysis of entrepreneurship education outcomes. *Journal of Business Venturing,* 28(2):211-224.

Martin, J. 1980. *Stories and scripts in organizational settings.* Graduate School of Business, Stanford University.

Marvel, M.R., Davis, J.L. & Sproul, C.R. 2016. Human capital and entrepreneurship research: A critical review and future directions. *Entrepreneurship Theory and Practice,* 40(3):599-626.

Marvel, M.R. & Lumpkin, G.T. 2007. Technology entrepreneurs' human capital and its effects on innovation radicalness. *Entrepreneurship Theory and Practice,* 31(6):807-828.

Mason, G., Rincon-Aznar, A. & Venturini, F. 2020. Which skills contribute most to absorptive capacity, innovation and productivity performance? Evidence from the US and Western Europe. *Economics of Innovation and New Technology,* 29(3):223-241.

Matthews, C.H. & Brueggemann, R. 2015. *Innovation and entrepreneurship: A competency framework.* Routledge.

Matusik, S.F. & Heeley, M.B. 2005. Absorptive capacity in the software industry: Identifying dimensions that affect knowledge and knowledge creation activities. *Journal of Management,* 31(4):549-572.

Maynard, A.D. 2015. Navigating the fourth industrial revolution. *Nature Nanotechnology,* 10(12):1005-1006.

Mazzei, M.J. 2018. Strategic entrepreneurship: Content, process, context, and outcomes. *International Entrepreneurship and Management Journal,* 14(3):657-670.

McCall, M.W. 1998. *High flyers: Developing the next generation of leaders.* United States: Harvard Business Press.

McClelland, D.C. 1973. Testing for competence rather than for "intelligence". *American Psychologist,* 28(1):1.

McClelland, D.C. 1987. Characteristics of successful entrepreneurs. *The Journal of Creative Behavior,* 21(3):219-233.

McGrath, R.G., Mac Grath, R.G. & MacMillan, I.C. 2000. *The entrepreneurial mindset: Strategies for continuously creating opportunity in an age of uncertainty.* Harvard Business Press.

McKenna, H.P. 1994. The Delphi technique: a worthwhile research approach for nursing? *Journal of Advanced Nursing,* 19(6):1221-1225.

McKim, C.A. 2017. The value of mixed methods research: A mixed methods study. *Journal of Mixed Methods Research,* 11(2):202-222.

McMullen, J.S. & Kier, A.S. 2017. You don't have to be an entrepreneur to be entrepreneurial: The unique role of imaginativeness in new venture ideation. *Business Horizons,* 60(4):455-462.

McQuitty, S. 2004. Statistical power and structural equation models in business research. *Journal of Business Research,* 57(2):175-183.

Mensch, G. 1979. *Stalemate in technology: Innovations overcome the depression.* Ballinger

Merx-Chermin, M. & Nijhof, W.J. 2005. Factors influencing knowledge creation and innovation in an organisation. *Journal of European Industrial Training,* 29(2):135-147.

Meyers, P.W. 1990. Non-linear learning in large technological firms: Period four implies chaos. *Research Policy,* 19(2):97-115.

Miles, M.B., Huberman, A.M., Huberman, M.A. & Huberman, M. 1994. *Qualitative data analysis: An expanded sourcebook.* Sage.

Miles, R.E., Snow, C.C., Meyer, A.D. & Coleman Jr, H.J. 1978. Organizational strategy, structure, and process. *Academy of Management Review,* 3(3):546-562.

Miller, D. 2011. Miller (1983) revisited: A reflection on EO research and some suggestions for the future. *Entrepreneurship Theory and Practice,* 35(5):873-894.

Miller, L. 1991. Managerial competences. *Industrial and Commercial Training,* 23(6).

Miller, W.L. & Morris, L. 2008. *Fourth generation R&D: Managing knowledge, technology, and innovation.* Wiley.

Mills, R. 2004. The Competencies Pocketbook.

Minbaeva, D., Petersen, T., Bjorkman, I., Fey, C. & Park, H. 2003. MNC knowledge transfer, subsidiary absorptive capacity and HRM. *Journal of International Business Studies,* 5:586-599.

Minniti, M. & Bygrave, W. 2001. A dynamic model of entrepreneurial learning. *Entrepreneurship Theory and Practice,* 25(3):5-16.

Mirabile, R.J. 1997. Everything you wanted to know about competency modeling. *Training & Development,* 51(8):73-78.

Mirghafoori, S., Taheri, M. & Zareh Ahmadabadi, H. 2010. Accessing service quality measurement techniques using artificial neural networks. *Iranian Journal of Business Management Perspective,* 8(31):63-79.

Mitchell, R.K. 2005. Tuning up the global value creation engine: The road to excellence in international entrepreneurship education. *International entrepreneurship*: Emerald Group.

Mitchell, R.K., Busenitz, L., Lant, T., McDougall, P.P., Morse, E.A. & Smith, J.B. 2002a. Toward a theory of entrepreneurial cognition: Rethinking the people side of entrepreneurship research. *Entrepreneurship Theory and Practice,* 27(2):93-104.

Mitchell, R.K., Smith, J.B., Morse, E.A., Seawright, K.W., Peredo, A.M. & McKenzie, B. 2002b. Are entrepreneurial cognitions universal? Assessing entrepreneurial cognitions across cultures. *Entrepreneurship Theory and Practice,* 26(4):9-32.

Mitchelmore, S. & Rowley, J. 2010. Entrepreneurial competencies: A literature review and development agenda. *International Journal of Entrepreneurial Behavior and Research,* 16(2):92-111.

Mitchelmore, S. & Rowley, J. 2013. Entrepreneurial competencies of women entrepreneurs pursuing business growth. *Journal of Small Business and Enterprise Development,* 20(1):125-142.

Mitroff, I.I. & Kilmann, R.H. 1976. On organization stories: An approach to the design and analysis of organizations through myths and stories. *The Management of Organization Design,* 1(189-207).

Mohsin, A.M.B.A., Halim, H.A. & Farhana, N. 2017. Assessing the role of entrepreneurial competencies on innovation performance: A partial least squares (PLS) approach. *The Journal of Business Inquiry,* 16(1):88-101.

Moilanen, M., Østbye, S. & Woll, K. 2014. Non-R&D SMEs: External knowledge, absorptive capacity and product innovation. *Small Business Economics,* 43(2):447-462.

Mokhber, M., Khairuzzaman, W. & Vakilbashi, A. 2018. Leadership and innovation: The moderator role of organization support for innovative behaviors. *Journal of Management & Organization,* 24(1):108-128.

Molina Morales, F.X., De Marchi, V. & Martínez-Cháfer, L. 2021. Absorptive capacity and radical innovation in industrial districts. *Technology Analysis & Strategic Management,* 33(1):1-13.

Moolman, H. 2017. A conceptual competence-based framework for enhancing the employability of graduates. *The Independent Journal of Teaching and Learning,* 12(2):26-43.

Morais-Storz, M., Platou, R.S. & Norheim, K.B. 2018. Innovation and metamorphosis towards strategic resilience. *International Journal of Entrepreneurial Behavior & Research,* 24(7):1181-1199.

More, R.A. 1982. Risk factors in accepted and rejected new industrial products. *Industrial Marketing Management,* 11(1):9-15.

Moremong-Nganunu, T., Rametse, N., Al-Muharrami, S. & Sharma, S.K. 2018. Perceptions towards entrepreneurship and intention to become entrepreneurs: The case of Sultan Qaboos University female undergraduate students. *Entrepreneurship Education and Research in the Middle East and North Africa (MENA)*: Springer.

Morris, M.H., Pitt, L.F. & Berthon, P. 1996. Entrepreneurial activity in the Third World informal sector: The view from Khayelitsha. *International Journal of Entrepreneurial Behavior and Research,* 2(1):59-76.

Morris, M.H., Webb, J.W., Fu, J. & Singhal, S. 2013. A competency-based perspective on entrepreneurship education: Conceptual and empirical insights. *Journal of Small Business Management,* 51(3):352-369.

Morse, J.M. & Richards, L. 2002. *Readme first for a user's guide to qualitative methods.* Sage.

Mostafiz, I. & Goh, S.-K. 2018. International women entrepreneurs and international opportunity recognition skills for start-up ventures. *Journal for International Business and Entrepreneurship Development,* 11(3):201-220.

Moura, D.C., Madeira, M.J., Duarte, F.A., Carvalho, J. & Kahilana, O. 2018. Absorptive capacity and cooperation evidence in innovation from public policies for innovation. *International Journal of Innovation Science,* 11(1):2-19.

Mouton, J. & Marais, H. 1996. *Basic concepts in the methodology of the social sciences.* 5th ed. Pretoria: HSRC Printers.

Muchinsky, P.M. & Monahan, C.J. 1987. What is person-environment congruence? Supplementary versus complementary models of fit. *Journal of Vocational Behavior,* 31(3):268-277.

Nada, N. & Ali, Z. 2015. Service value creation capability model to assess the service innovation capability in SMEs. *Procedia CIRP,* 30:390-395.

Nahavandi, S. 2019. Industry 5.0 - A Human-centric solution. *Sustainability,* 11(16):4371.

Najafi-Tavani, S., Najafi-Tavani, Z., Naudé, P., Oghazi, P. & Zeynaloo, E. 2018. How collaborative innovation networks affect new product performance: Product innovation capability, process innovation capability, and absorptive capacity. *Industrial Marketing Management,* 73:193-205.

Nakale, M. 2015. *To what extent do informal learning and technology transfer impact absorptive capacity?* Centre for Labour Market Studies.

Namatovu, R. & Dawa, S. 2017. Motivation, competences and the moderating role of business discontinuance on the entrepreneurial effect of self-employment. *International Journal of Entrepreneurship and Small Business,* 30(3):410-426.

Nambisan, S. & Baron, R.A. 2013. Entrepreneurship in innovation ecosystems: Entrepreneurs' self–regulatory processes and their implications for new venture success. *Entrepreneurship Theory and Practice,* 37(5):1071-1097.

Nassif, V.M.J., Ghobril, A.N. & Silva, N.S.d. 2010. Understanding the entrepreneurial process: a dynamic approach. *BAR-Brazilian Administration Review,* 7(2):213-226.

Naudé, W. 2017. Entrepreneurship, education and the fourth industrial revolution in Africa. *Institute of Labour Economics*:1-22.

Nel, C.J. 2016. *Development and validation of the career orientations, meta-competencies and career outcomes model.* University of Johannesburg.

Nieman, G. 2006. *Small business management: A South African approach.* Pretoria: Van Schaik.

Nieman, G. 2013. *Study Guide for Post Graduate Diploma in Entrepreneurship and Small Business Management.* Pretoria: Department of Business Management, University of Pretoria.

Nieman, G. & Nieuwenhuizen, C. 2009. *Entrepreneurship: A South African perspective.* Pretoria: Van Schaik.

Nieuwenhuizen, C. 2008. *Entrepreneurial skills.* 2nd ed.: Juta.

Nieuwoudt, S., Henning, J.I. & Jordaan, H. 2017. Entrepreneurial competencies and financial performance of farmers in South Africa. *South African Journal of Economic and Management Sciences,* 20(1):13.

Noblet, J.-P., Simon, E. & Parent, R. 2015. Absorptive capacity: a proposed operationalization. *The Essentials of Knowledge Management*: Springer.

Nonaka, I. 1990. Redundant, overlapping organization: A Japanese approach to managing the innovation process. *California Management Review,* 32(3):27-38.

Nonaka, I. 1994. A dynamic theory of organizational knowledge creation. *Organization Science,* 5(1):14-37.

Nonaka, I. & Takeuchi, H. 1995. *The knowledge-creating company: How Japanese companies create the dynamics of innovation.* Oxford university press.

Nordin, R. & Purwaningrum, F. 2018. Tacit knowledge acquisition in organisations: The case of ICT companies in Brunei Darussalam and Malaysia. *Southeast Asian Social Science Review,* 3(1):30-52.

Nunnally, J. 1978. *Psychometric theory.* 2nd ed. Neew York: McGraw Hill.

Nunnally, J. & Bernstein, I. 1994. Psychometric Theory. 3rd ed. New York: MacGraw-Hill.

O'Reilly III, C.A. & Tushman, M.L. 2008. Ambidexterity as a dynamic capability: Resolving the innovator's dilemma. *Research in organizational behavior,* 28:185-206.

Ochoa Jiménez, S., Cervantes Hurtado, G.V., Jacobo Hernández, C.A. & Flores López, J.G. 2020. Knowledge and innovation in Mexican Agricultural Organizations. *Economies,* 8(4):103.

Ojo, A.O., Raman, M. & Chong, C.W. 2017. Microlevel antecedents of absorptive capacity in joint project engineering teams. *Management Research Review,* 40(9):990-1006.

Okoli, C. & Pawlowski, S.D. 2004. The Delphi method as a research tool: an example, design considerations and applications. *Information and Management,* 42(1):15-29.

Ommi, A. & Zeng, Y. 2018. Defining the appropriate course project for fostering the expected cognitive competencies: EBD approach to an engineering design course. *Proceedings of the Canadian Engineering Education Association (CEEA)*.

Oosterbeek, H., Van Praag, M. & IJsselstein, A. 2008. The impact of entrepreneurship education on entrepreneurship competencies and intentions: An evaluation of the Junior Achievement Student Mini-Company Program. *Available at SSRN 1118251*.

Orhei, L. 2011. The competence of social entrepreneurship: A multidimensional competence approach. Berlin: Kluwer/Springer.

Orhei, L.E., Nandram, S.S. & Vinke, J. 2015. Social entrepreneurship competence: evidence from founders of social enterprises in Romania. *International Journal of Entrepreneurship and Small Business,* 25(1):80-105.

Orr, M.J. 1996. *Introduction to radial basis function networks.* University of Edinburgh.

Ortony, A. & Rumelhart, D.E. 2017. The representation of knowledge in memory 1. *Schooling and the acquisition of knowledge*: Routledge.

Östlund, U., Kidd, L., Wengström, Y. & Rowa-Dewar, N. 2011. Combining qualitative and quantitative research within mixed method research designs: a methodological review. *International Journal of Nursing Studies,* 48(3):369-383.

Ozkaya, H.E., Droge, C., Hult, G.T.M., Calantone, R. & Ozkaya, E. 2015. Market orientation, knowledge competence, and innovation. *International Journal of Research in Marketing,* 32(3):309-318.

Pacheco, L.M., Alves, M.F.R. & Liboni, L.B. 2018. Green absorptive capacity: A mediation-moderation model of knowledge for innovation. *Business Strategy and the Environment,* 27(8):1502-1513.

Pallant, J. 2011. *SPSS Survival Manual 4th edition: A step by step guide to data analysis using SPSS* Maidenhead, Berkshire Open University Press.

Pawitan, G., Widyarini, M. & Nawangpalupi, C.B. 2018. Moderating effect of demographic factors and entrepreneurial phase on the relationship between entrepreneurial competencies and innovation of ASEAN entrepreneurs. *Pertanika Journal of Social Science and Humanities,* 26:151-166.

Payne, R.L., Lane, D. & Jabri, M. 1990. A two-dimensional person-environment fit analysis of the performance, effort and satisfaction of research scientists. *British Journal of Management,* 1(1):45-57.

Pellissier, R. 2011. The implementation of resilience engineering to enhance organizational innovation in a complex environment. *International Journal of Business and Management,* 6(1):145.

Pérez-Luño, A., Alegre, J. & Valle-Cabrera, R. 2019. The role of tacit knowledge in connecting knowledge exchange and combination with innovation. *Technology Analysis & Strategic Management,* 31(2):186-198.

Pérez-Luño, A., Wiklund, J. & Cabrera, R.V. 2011. The dual nature of innovative activity: How entrepreneurial orientation influences innovation generation and adoption. *Journal of Business Venturing,* 26(5):555-571.

Perks, S. & Strüwig, M. 2005. Skills necessary to grow micro entrepreneurs into small business entrepreneurs: Management. *South African Journal of Economic and Management Sciences,* 8(2):171-186.

Perry, R.H., Charlotte, B., Isabella, M. & Bob, C. 2004. *SPSS explained.* London, UK: Routledge.

Persaud, A., Kumar, U. & Kumar, V. 2001. Harnessing scientific and technological knowledge for the rapid deployment of global innovations. *Engineering Management Journal,* 13(1):12-18.

Peteraf, M.A. & Barney, J.B. 2003. Unraveling the resource-based tangle. *Managerial and Decision Economics,* 24(4):309-323.

Peters, L.H., O'Connor, E.J. & Rudolf, C.J. 1980. The behavioral and affective consequences of performance-relevant situational variables. *Organizational Behavior and Human Performance,* 25(1):79-96.

Pfeffer, J. 1981. *Power in organizations.* Cambridge: MA: Ballinger.

Pfeffer, J. 1998. *The human equation: Building profits by putting people first.* Cambridge: Harvard Business Press.

Pfeiffer, S. 2016. Robots, Industry 4.0 and humans, or why assembly work is more than routine work. *Societies,* 6(2):16.

Piaget, J. 1947. *La psychologie de l'intelligence* Paris: Colin.

Piaget, J. & Cook, M. 1952. *The origins of intelligence in children.* International Universities Press New York.

Pierre, A. & Fernandez, A.-S. 2018. Going deeper into SMEs' innovation capacity: An empirical exploration of innovation capacity factors. *Journal of Innovation Economics Management,* (1):139-181.

Pihie, Z.A.L., Bagheri, A. & Sani, Z.H.A. 2013. Knowledge of cognition and entrepreneurial intentions: Implications for learning entrepreneurship in public and private universities. *Procedia-Social and Behavioral Sciences,* 97:174-181.

Pittaway, L. & Cope, J. 2007. Management Sciences: Entrepreneurship education a systematic review of the evidence. *International Small Business Journal,* 8(2):171-186.

Plattner, H. 2010. An introduction to design thinking process guide. *The Institute of Design at Stanford: Stanford*.

Politis, D. 2005. The process of entrepreneurial learning: A conceptual framework. *Entrepreneurship Theory and Practice,* 29(4):399-424.

Ponta, L., Puliga, G., Oneto, L. & Manzini, R. 2020. Identifying the determinants of Innovation Capability With Machine Learning and Patents. *IEEE Transactions on Engineering Management*:1-11.

Popadiuk, S. & Choo, C.W. 2006. Innovation and knowledge creation: How are these concepts related? *International Journal of Information Management,* 26(4):302-312.

Porter, M. 1998. *Competitive advantage: Creating and sustaining superior performance* New York: Free Press-152.

Porter, M.E. 1985. Technology and competitive advantage. *The Journal of Business Strategy,* 5(3):60.

Prajogo, D.I. & Ahmed, P.K. 2006. Relationships between innovation stimulus, innovation capacity, and innovation performance. *R&D Management,* 36(5):499-515.

Priem, R.L. 1994. Executive judgment, organizational congruence, and firm performance. *Organization Science,* 5(3):421-437.

Priem, R.L. 2007. A consumer perspective on value creation. *Academy of Management Review,* 32(1):219-235.

Prifti, L., Knigge, M., Kienegger, H. & Krcmar, H. 2017. *A Competency Model for" Industrie 4.0" Employees*. Paper presented at 13th International Conference on Wirtschaftsinformatik, St. Gallen, Switzerland: 46-60.

Proeger, T. 2020. Knowledge spillovers and absorptive capacity—Institutional evidence from the “German Mittelstand”. *Journal of the Knowledge Economy,* 11(1):211-238.

Punch, K. 2014. *Social Research: quantitative and qualitative approaches.* 3rd ed. London: SAGE.

Qian, G. & Li, L. 2003. Profitability of small-and medium-sized enterprises in high-tech industries: The case of the biotechnology industry. *Strategic Management Journal,* 24(9):881-887.

Qian, H. & Acs, Z.J. 2013. An absorptive capacity theory of knowledge spillover entrepreneurship. *Small Business Economics,* 40(2):185-197.

Quinlan, C., Babin, B., Carr, J. & Griffin, M. 2019. *Business research methods.* South Western Cengage.

Quintana-García, C. & Benavides-Velasco, C.A. 2008. Innovative competence, exploration and exploitation: The influence of technological diversification. *Research Policy,* 37(3):492-507.

Racela, O.C. 2014. Customer orientation, innovation competencies, and firm performance: A proposed conceptual model. *Procedia-Social and Behavioral Sciences,* 148:16-23.

Rae, D. & Carswell, M. 2001. Towards a conceptual understanding of entrepreneurial learning. *Journal of Small Business and Enterprise Development,* 8(2):150-158.

Rasmussen, E., Mosey, S. & Wright, M. 2011. The evolution of entrepreneurial competencies: A longitudinal study of university spin-off venture emergence. *Journal of Management Studies,* 48(6):1314-1345.

Rattray, J. & Jones, M.C. 2007. Essential elements of questionnaire design and development. *Journal of Clinical Nursing,* 16(2):234-243.

Rattray, J. & Raaper, R. 2019. *Development, Assessment and Validation of Social Competencies in Higher Education (DASCHE).* United Kingdom.

Raudeliūnienė, J., Davidavičienė, V. & Jakubavičius, A. 2018. Knowledge management process model. *Entrepreneurship and Sustainability Issues,* 5(3):542.

Ravichandran, T. 2018. Exploring the relationships between IT competence, innovation capacity and organizational agility. *The Journal of Strategic Information Systems,* 27(1):22-42.

Raykov, T. & Marcoulides, G.A. 2000. *A first course in structural equation modeling.* Routledge.

Řehoř, P., Pech, M., Slabová, M. & Rolínek, L. 2020. Contemporary opinions on the importance of entrepreneurial competencies. *European Journal of Business Science and Technology,* 6(2):127-137.

Reid, W., Pease, J. & Taylor, R. 1990. The Delphi technique as an aid to organization development activities. *Organization Development Journal,* 8(3):37-42.

Reinard, J.C. 2006. *Communication research statistics.* Sage.

Reis, D.A., Fleury, A.L. & Carvalho, M.M. 2020. Consolidating core entrepreneurial competences: toward a meta-competence framework. *International Journal of Entrepreneurial Behavior & Research,* 27(1):179-204.

Reuber, A.R., Dyke, L.S. & Fischer, E.M. 1990. Experientially acquired knowledge and entrepreneurial venture success. *Academy of Management Proceedings,* 1990(1):69-73.

Rezaei-Zadeh, M. & Darwish, T.K. 2016. Antecedents of absorptive capacity: A new model for developing learning processes. *The Learning Organization,* 23(1):1-19.

Ro, H. 2012. Moderator and mediator effects in hospitality research. *International Journal of Hospitality Management,* 31(3):952-961.

Robb, D. 2000. Building resilient organizations actively build and integrate performance and adaptive skills. *OD Practitioner,* 32(3):27-32.

Roberts, E.B. 1968. New enterprise on route 128. *Science Journal,* 412:78-83.

Robles, L. & Zárraga-Rodríguez, M. 2015. Key competencies for entrepreneurship. *Procedia economics and finance,* 23:828-832.

Rogers, E.M. 2003. Diffusion of innovations. Free Press. *New York*:551.

Romer, P.M. 1990. Endogenous technological change. *Journal of Political Economy,* 98(5, Part 2):71-102.

Rosman, M., Shukry, A., Baharuddin, N., Razlan, N., Rosli, N. & Razali, M. 2020. *Model referencing competency and individual performance*. Paper presented at Virtual Innovation Competition 2020, Malaysia.

Rossi, M. 2016. The impact of age on firm performance: a literature review. *Corporate Ownership and Control,* 13(2):217-223.

Rouse, W.B. 1992. Strategies for innovation. Creating successful products, systems, and organizations.

Rousseau, D.M. 1985. Issues of level in organizational research: Multi-level and cross-level perspectives. *Research in Organizational Behavior,* 7(1):1-37.

Russell, C.J. 2001. A longitudinal study of top-level executive performance. *Journal of Applied Psychology,* 86(4):560.

Rwigema, H. 2004. *Advanced entrepreneurship.* United Kingdom: Oxford University Press.

Ryan, G., Emmerling, R.J. & Spencer, L.M. 2009. Distinguishing high-performing European executives: The role of emotional, social and cognitive competencies. *The Journal of Management Development,* 28(9):859-875.

Saad, M., Kumar, V. & Bradford, J. 2017. An investigation into the development of the absorptive capacity of manufacturing SMEs. *International Journal of Production Research,* 55(23):6916-6931.

Sabherwal, R. & Becerra-Fernandez, I. 2005. Integrating specific knowledge: insights from the Kennedy Space Center. *IEEE Transactions on Engineering Management,* 52(3):301-315.

Samson, K. & Gurdon, M. 1990. Entrepreneurial scientist: Organizational performance in scientist-started high technology firms. *Frontiers of Entrepreneurship Research*:437-451.

Sánchez-Báez, E.A., Fernández-Serrano, J. & Romero, I. 2018. Personal values and entrepreneurial attitude as intellectual capital: impact on innovation in small enterprises. *Amfiteatru Economic,* 20(49):771-787.

Sánchez, J. 2012. The influence of entrepreneurial competencies on small firm performance. *Revista Latinoamericana de Psicología,* 44(2):165-177.

Sánchez, J.C. 2013. The impact of an entrepreneurship education program on entrepreneurial competencies and intention. *Journal of Small Business Management,* 51(3):447-465.

Sandberg, E. 2018. Challenges to African entrepreneurship in the twenty-first century. *Challenges to African Entrepreneurship in the 21st Century*: Springer.

Santandreu-Mascarell, C., Garzon, D. & Knorr, H. 2013. Entrepreneurial and innovative competences, are they the same? *Management Decision,* 51(5):1084-1095.

Sarfraz, M., He, B. & Shah, S.G.M. 2020. Elucidating the effectiveness of cognitive CEO on corporate environmental performance: The mediating role of corporate innovation. *Environmental Science and Pollution Research,* 27(36):45938-45948.

Sarooghi, H., Libaers, D. & Burkemper, A. 2015. Examining the relationship between creativity and innovation: A meta-analysis of organizational, cultural, and environmental factors. *Journal of Business Venturing,* 30(5):714-731.

Saunders, M., Lewis, P. & Thornhill, A. 2016. Research methods for business students 7th ed. Nueva York: Pearson Education.

Scharf, F. & Bell, J. 2002. Developing export management competencies and skills among undergraduate business students. *Journal of European Industrial Training,* 26(7):327-332.

Schilling, M.A., Vidal, P., Ployhart, R.E. & Marangoni, A. 2003. Learning by doing something else: Variation, relatedness, and the learning curve. *Management Science,* 49(1):39-56.

Schindler, P. 2018. *Business research methods.* 13th ed. Shanghai, Singapore: McGraw Hill.

Schley, D.G. 2003. The art and science of competency models: Pinpointing critical success factors in organizations. *Academy of Management Learning & Education,* 2(2):210-212.

Schneider, D. & Bjorklund, W. 1996. The interaction of knowledge, aptitude, and strategies in childrens memory. *Advances in Child Development and Behavior,* 26:59-89.

Schneider, K. 2017. Entrepreneurial competencies of women entrepreneurs of micro and small enterprises. *Science Journal of Education,* 5(6):252-261.

Schraw, G. & Dennison, R.S. 1994. Assessing metacognitive awareness. *Contemporary Educational Psychology,* 19(4):460-475.

Schreiber, J.B., Nora, A., Stage, F.K., Barlow, E.A. & King, J. 2006. Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research,* 99(6):323-338.

Schumacker, R.E. & Lomax, R.G. 2004. *A beginner's guide to structural equation modeling.* Psychology Press.

Schumpeter, J. 1934. *The theory of economic development.* Cambridge, MA: Harvard University Press.

Schumpeter, J.A. 1939. *Business cycles.* McGraw-Hill New York.

Schumpeter, J.A. 2017. *Theory of economic development.* Routledge.

Schwab, K. 2016. *The fourth industrial revolution: what it means, how to respond.* Geneva: [Online] Available from: https://professionallearning.education.gov.scot/media/1352/the-fourth-industrial-revolution-what-it-means-and-how-to-respond-world-economic-forum.pdf [Accessed: 25/05/2020].

Schweisfurth, T.G. & Raasch, C. 2018. Absorptive capacity for need knowledge: Antecedents and effects for employee innovativeness. *Research Policy,* 47(4):687-699.

Sciascia, S., Naldi, L. & Hunter, E. 2006. Market orientation as determinant of entrepreneurship: An empirical investigation on SMEs. *The International Entrepreneurship and Management Journal,* 2(1):21-38.

Scuotto, V., Del Giudice, M. & Carayannis, E.G. 2017a. The effect of social networking sites and absorptive capacity on SMES' innovation performance. *The Journal of Technology Transfer,* 42(2):409-424.

Scuotto, V., Del Giudice, M. & Obi Omeihe, K. 2017b. SMEs and mass collaborative knowledge management: toward understanding the role of social media networks. *Information Systems Management,* 34(3):280-290.

SEDA. 2008. *Annual Report 2008.* Pretoria: SEDA (A member of the **dti**): [Online] Available from: http:www.seda.org.za [Accessed: 2018-06-21].

Seelig, B.T. 2015. *Insight Out: Get ideas out of your head and into the world.* New York: HarperOne.

Seibert, S.E., Crant, J.M. & Kraimer, M.L. 1999. Proactive personality and career success. *Journal of Applied Psychology,* 84(3):416-427.

Semuel, H., Siagian, H. & Octavia, S. 2017. The effect of leadership and innovation on differentiation strategy and company performance. *Procedia-Social and Behavioral Sciences,* 237:1152-1159.

Senge, P. 1990. The fifth discipline: The art and practice of organizational learning. *New York*.

Shan, P., Song, M. & Ju, X. 2016. Entrepreneurial orientation and performance: Is innovation speed a missing link? *Journal of Business Research,* 69(2):683-690.

Shane, S. 2000. Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science,* 11(4):448-469.

Shane, S. & Venkataraman, S. 2000. The promise of entrepreneurship as a field of research. *Academy of Management Review,* 25(1):217-226.

Sharma, S.K., Sharma, H. & Dwivedi, Y.K. 2019. A hybrid SEM-neural network model for predicting determinants of mobile payment services. *Information Systems Management,* 36(3):243-261.

Shavinina, L.V. & Seeratan, K.L. 2003. *On the nature of individual innovation.* 1st ed. Kidlington: Elsevier.

Sheng, M.L., Hartmann, N.N., Chen, Q. & Chen, I. 2015. The synergetic effect of multinational corporation management's social cognitive capability on tacit-knowledge management: Product innovation ability insights from Asia. *Journal of International Marketing,* 23(2):94-110.

Shrout, P.E. & Bolger, N. 2002. Mediation in experimental and nonexperimental studies: New procedures and recommendations. *Psychological Methods,* 7(4):422.

Simon, H.A. 1969. The sciences of the artificial MIT Press. *Cambridge, MA*.

Sivo, S.A., Fan, X., Witta, E.L. & Willse, J.T. 2006. The search for" optimal" cutoff properties: Fit index criteria in structural equation modeling. *The Journal of Experimental Education,* 74(3):267-288.

Skilton, P.F., Bernardes, E., Li, M. & Creek, S.A. 2020. The structure of absorptive aapacity in three product development strategies. *Journal of Supply Chain Management,* 56(3):1-43.

Slater, S.F. & Narver, J.C. 1998. Customer-led and market-oriented: let's not confuse the two. *Strategic Management Journal,* 19(10):1001-1006.

Smit, M.J., Abreu, M.A. & de Groot, H.L. 2015. Micro-evidence on the determinants of innovation in the Netherlands: The relative importance of absorptive capacity and agglomeration externalities. *Papers in Regional Science,* 94(2):249-272.

Smith, A., Courvisanos, J., Tuck, J. & McEachern, S. 2011a. *Building innovation capacity: the role of human capital formation in enterprises.* Australia.

Smith, A., Courvisanos, J., Tuck, J. & McEachern, S. 2011b. *Building innovation capacity: The role of human capital formation in enterprises.* Adelaide: NCVER.

Smith, D. 2010. *Exploring innovation.* McGraw-Hill Higher Education.

Smith, D. 2015. *Exploring innovation.* McGraw-Hill Higher Education.

Smith, K.G. & Gregorio, D.D. 2017. *Bisociation, discovery, and the role of entrepreneurial action.* Blackwell

Smith, S. 1995. *Tourism Analysis—A Handbook.* 2nd ed. Harlaw: Longman.

Sopegina, V.T., Chapaev, N.K. & Simonova, M.V. 2016. Integration of pedagogical and technological knowledge in forming meta-competencies of a modern worker. *International Journal of Environmental and Science Education,* 11(15):7836-7846.

Souder, W.E. & Song, X.M. 1997. Contingent product design and marketing strategies influencing new product success and failure in US and Japanese electronics firms. *Journal of Product Innovation Management,* 14(1):21-34.

Specht, D.F. 1991. A general regression neural network. *IEEE Transactions on Neural Networks,* 2(6):568-576.

Spithoven, A., Clarysse, B. & Knockaert, M. 2011. Building absorptive capacity to organise inbound open innovation in traditional industries. *Technovation,* 31(1):10-21.

Spreitzer, G.M., McCall, M.W. & Mahoney, J.D. 1997. Early identification of international executive potential. *Journal of Applied Psychology,* 82(1):6.

Starbuck, W.H. 1992. Learning by knowledge-intensive firms. *Journal of Management Studies,* 29(6):713-740.

Steiner, G. 2009. The concept of open creativity: Collaborative creative problem solving for innovation generation-a systems approach. *Journal of Business & Management,* 15(1).

Stewart, J. 2001. Is the Delphi technique a qualitative method? *Medical Education,* 35(10):922.

Stoner, C.R. 1987. Distinctive competence and competitive advantage. *Journal of Small Business Management,* 25(2):33.

Storey, D.J., Keasey, K., Watson, R. & Wynarczyk, P. 2016. *The performance of small firms: profits, jobs and failures.* United Kingdom: Routledge.

Stošić-Mihajlović, L. & Trajković, S. 2016. Modern economy: Features and developments. *Journal of Process Management. New Technologies,* 4(2):17-25.

Straka, G.A. 2004. Measurement and evaluation of competence. *The foundations of evaluation and impact research. Third report on vocational training research in Europe: background report. Luxembourg: Office for Official Publications of the European Communities*.

Straus, S.E., Tetroe, J. & Graham, I. 2009. Defining knowledge translation. *Cmaj,* 181(3-4):165-168.

Stuetzer, M., Obschonka, M., Davidsson, P. & Schmitt-Rodermund, E. 2013. Where do entrepreneurial skills come from? *Applied Economics Letters,* 20(12):1183-1186.

Suarez-Villa, L. 1990. Invention, inventive learning, and innovative capacity. *Systems Research and Behavioral Science,* 35(4):290-310.

Suarez-Villa, L. 2017. *Innovative capacity* [Online] Available from: http://www.innovativecapacity.com/Introduction.htm [Accessed: 04/09/2017].

Suarez-Villa, L. & Hasnath, S.A. 1993. The effect of infrastructure on invention: Innovative capacity and the dynamics of public construction investment. *Technological Forecasting and Social Change,* 44(4):333-358.

Suarez-Villa, L. 1993. The dynamics of regional invention and innovation: Innovative capacity and regional change in the twentieth century. *Geographical Analysis,* 25(2):147-164.

Suddaby, R., Bruton, G.D. & Si, S.X. 2015. Entrepreneurship through a qualitative lens: Insights on the construction and/or discovery of entrepreneurial opportunity. *Journal of Business Venturing,* 30(1):1-10.

Sudman, S. & Blair, E. 1998. *Marketing research: A problem-solving approach.* Univerza v Mariboru, Ekonomsko-poslovna fakulteta.

Sydänmaanlakka, P. 2002. *An intelligent organization: Integrating performance, competence and knowledge management.* Oxford: Capstone.

Tabachnick, B.G., Fidell, L.S. & Ullman, J.B. 2007. *Using multivariate statistics.* Pearson Boston, MA.

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.

Teddlie, C. & Tashakkori, A. 2009. *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences.* Sage.

Teece, D.J., Pisano, G. & Shuen, A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal,* 18(7):509-533.

Ter Wal, A., Criscuolo, P. & Salter, A. 2011. Absorptive capacity at the individual level: An ambidexterity approach to external engagement. *DRUID 2011-Innovation, Strategy, and Stucture-Organizations, Institutions, Systems and Regions*.

Ter Wal, A.L., Criscuolo, P. & Salter, A. 2017. Making a marriage of materials: The role of gatekeepers and shepherds in the absorption of external knowledge and innovation performance. *Research Policy,* 46(5):1039-1054.

Terrell, S.R. 2012. Mixed-methods research methodologies. *Qualitative Report,* 17(1):254-280.

Tian, A.W. & Soo, C. 2018. Enriching individual absorptive capacity. *Personnel Review,* 47(5):1116-1132.

Tidd, J. & Bessant, J.R. 2018. *Managing innovation: Integrating technological, market and organizational change.* Wiley.

Tikrity, M. 2021. *Competency based management: A framework for generic competency model for educational institutes*. Paper presented at Education sustainability, Dubai.

Tisch, M., Abele, E. & Metternich, J. 2019. Competencies for Future Production. *Learning Factories*: Springer.

Tittel, A. & Terzidis, O. 2020. Entrepreneurial competences revised: developing a consolidated and categorized list of entrepreneurial competences. *Entrepreneurship Education,* 3(1):1-35.

Todorova, G. & Durisin, B. 2007. Absorptive capacity: Valuing a reconceptualization. *Academy of Management Review,* 32(3):774-786.

Tortoriello, M. 2015. The social underpinnings of absorptive capacity: The moderating effects of structural holes on innovation generation based on external knowledge. *Strategic Management Journal,* 36(4):586-597.

Turan, A., Tunç, A.Ö. & Zehir, C. 2015. A theoretical model proposal: Personal innovativeness and user involvement as antecedents of unified theory of acceptance and use of technology. *Procedia-Social and Behavioral Sciences,* 210(2015):43-51.

Turton, N. & Herrington, M. 2013. Global Entrepreneurship Monitor 2012 South Africa. *The UCT Centre for Innovation and Entrepreneurship*.

Tushman, M.L. 1977. Special boundary roles in the innovation process. *Administrative science quarterly*:587-605.

Tushman, M.L. & Anderson, P. 1986. Technological discontinuities and organizational environments. *Administrative Science Quarterly,* 31(3):439-465.

Tustin, D., Ligthelm, A., Martins, J. & Van Wuk, H.d.J. 2010. *Marketing Research in practice. 2nd Impression.* Pretoria: Unisa Press.

Tutida, A.Y., Possamai, C.T.N., Barcelos, R.L. & Rossetto, C.R. 2020. Microfoundations of absorptive capacity: A theoretical discussion about the theme. *Revista Eletrônica Científica do CRA-PR-RECC,* 6(2):1-15.

Ucbasaran, D., Westhead, P. & Wright, M. 2002. Human capital based determinants of opportunity identification.

Ullah, A.S. 2020. What is knowledge in Industry 4.0? *Engineering Reports,* 2(8):12217.

Urabe, K. 1988. Innovation and the Japanese management system. *Innovation and management international comparisons. Berlin: Walter de Gruyter*.

Usp, N. & Winter, S. 2012. Some clarifications and recommendations on fit indices. *Structural Equation Modeling,* 523(623):1-4.

Uygur, U. & Kim, S.M. 2017. Cognitive origins of new venture creation: How knowledge drives entrepreneurial action.14879.

Vala, L., Pereira, R. & Caetano, I. 2017. Innovation management processes and routines for business success and value creation. *Journal of Management,* 5(5):471-481.

Valentim, L., Lisboa, J.V. & Franco, M. 2016. Knowledge management practices and absorptive capacity in small and medium-sized enterprises: is there really a linkage? *R&D Management,* 46(4):711-725.

Van Den Bosch, F.A., Van Wijk, R. & Volberda, H.W. 2003. *Absorptive capacity: antecedents, models and outcomes.* Netherlands.

Van der Westhuizen, T. & Goyayi, M.J. 2020. The influence of technology on entrepreneurial self-efficacy development for online business start-up in developing nations. *The International Journal of Entrepreneurship and Innovation,* 21(3):168-177.

Van Dyne, L. & LePine, J.A. 1998. Helping and voice extra-role behaviors: Evidence of construct and predictive validity. *Academy of Management Journal,* 41(1):108-119.

Van Klink, M.R.d. & Boon, J. 2003. Competencies: The triumph of a fuzzy concept. *International Journal of Human Resources Development and Management,* 3(2):125-137.

Van Vuuren, J. & Nieman, G. 1999. Entrepreneurship education and training: A model for syllabi/curriculum development. In: Business, I.C.F.S. (ed.).

Vargas-Halabí, T., Mora-Esquivel, R. & Siles, B. 2017. Intrapreneurial competencies: development and validation of a measurement scale. *European Journal of Management and Business Economics,* 26(1):86-111.

Veliu, L. & Manxhari, M. 2017. The impact of managerial competencies on business performance: SME's in Kosovo. *Journal of Management,* 30(1):59-65.

Vendrell-Herrero, F., González-Pernía, J.L. & Peña-Legazkue, I. 2014. Do incentives matter to promote high technology-driven entrepreneurial activity? *International Entrepreneurship and Management Journal,* 10(1):43-66.

Venkataraman, S. 2019. The distinctive domain of entrepreneurship research. *Seminal ideas for the next twenty-five years of advances*: Emerald.

Venkatesh, V., Brown, S.A. & Bala, H. 2013. Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS Quarterly*:21-54.

Venkatesh, V., Brown, S.A. & Sullivan, Y.W. 2016. Guidelines for conducting mixed-methods research: An extension and illustration. *Journal of the Association for Information Systems,* 17(7):2.

Venkatraman, N. 1989. The concept of fit in strategy research: Toward verbal and statistical correspondence. *Academy of Management Review,* 14(3):423-444.

Volberda, H.W., Foss, N.J. & Lyles, M.A. 2010. Perspective—Absorbing the concept of absorptive capacity: How to realize its potential in the organization field. *Organization Science,* 21(4):931-951.

Vom Brocke, J., Simons, A., Niehaves, B., Riemer, K., Plattfaut, R. & Cleven, A. 2009. Reconstructing the giant: On the importance of rigour in documenting the literature search process. Verona, Italy:2206-2217.

Voorhees, C.M., Brady, M.K., Calantone, R. & Ramirez, E. 2016. Discriminant validity testing in marketing: an analysis, causes for concern, and proposed remedies. *Journal of the Academy of Marketing Science,* 44(1):119-134.

Waldman, D.A. & Spangler, W.D. 1989. Putting together the pieces: A closer look at the determinants of job performance. *Human Performance,* 2(1):29-59.

Wang, C.L. & Chung, H.F. 2020. Business networking and innovation of Asian enterprises in Western countries: The moderation of institutional distance. *Industrial Marketing Management,* 88:152-162.

Wang, Y.-L., Wang, Y.-D. & Horng, R.-Y. 2010. Learning and innovation in small and medium enterprises. *Industrial Management & Data Systems,* 110(2):175-192.

Warleta, G.M., Suplet, M.R., Slocum, A. & Schmitz, A. 2019. Educating future managers in social competencies in Spain: how far have we got, 20 years after the Bologna declaration? *Education and New Developments*:243.

Wasilczuk, J. 2000. Advantageous competence of owner/managers to grow the firm in Poland: Empirical evidence. *Journal of Small Business Management,* 38(2):88.

Watanabe, S. 1970. Entrepreneurship in small enterprises in Japanese manufacturing. *International Labour Review,* 102:531.

Weaver, T.E. 2006. Adherence to positive airway pressure therapy. *Current Opinion in Pulmonary Medicine,* 12(6):409-413.

Webster, J. & Watson, R.T. 2002. Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly*:xiii-xxiii.

Weinert, F.E. 2001a. Concept of competence: A conceptual clarification. In: Rychen, D.S. & Salganik, L.H. (eds.). *Defining and selecting key competencie*: Hogrefe & Huber Publishers.

Weinert, F.E. 2001b. Vergleichende Leistungsmessung in Schulen-eine umstrittene Selbstverständlichkeit. *Leistungsmessungen in schulen*: Beltz.

Welsch, H., Liao, J. & Stoica, M. 2001. Absorptive capacity and firm responsiveness: An empirical investigation of growth-oriented firms. Orlando USA:7-10.

Wenk, E. 1989. The politics of technology and the technology of politics: Issues for the US Congress's third century. *Technological Forecasting and Social Change,* 36(1-2):171-183.

Westhead, P., Ucbasaran, D. & Wright, M. 2005. Experience and cognition: do novice, serial and portfolio entrepreneurs differ? *International Small Business Journal,* 23(1):72-98.

Wheatley, M. 1992. *Leadership and the new sciences.* Berrett-Koehler.

Wheelwright, S.C. 1992. *Revolutionizing product development.* New York: The Free Press.

Wickham, P. 2001. *Strategic Entrepreneurship: A decision making approach to new venture creation and management.* Essex, UK: Pearson Education.

Williams, A. & Anyanwu, S.A. 2017. Innovation and organizational resilience: A study of selected food and beverage firms in Port Harcourt. *International Journal of Advanced Academic Research,* 3(6):1-15.

Williams, D.L., Boone, R. & Kingsley, K.V. 2004. Teacher beliefs about educational software: A Delphi study. *Journal of Research on Technology in Education,* 36(3):213-229.

Wingwon, B. 2012. Effects of entrepreneurship, organization capability, strategic decision making and innovation toward the competitive advantage of SMEs enterprises. *Journal of Management and Sustainability,* 2:137.

Winter, S.G. 2000. The satisficing principle in capability learning. *Strategic Management Journal,* 21(10-11):981-996.

Winterton, J., Delamare-Le Deist, F. & Stringfellow, E. 2006. *Typology of knowledge, skills and competences: clarification of the concept and prototype.* Office for Official Publications of the European Communities Luxembourg. [Online]

Available from: https://infoeuropa.eurocid.pt/files/database/000037001-000038000/000037620.pdf [Accessed: 13/08/2017].

Winzenried, A. 1997. *Delphi studies: The value of expert opinion bridging the gap - data to knowledge.*

Wong, K.K.-K. 2013. Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS. *Marketing Bulletin,* 24(1):1-32.

Wong, T.C., Wong, S. & Chin, K.S. 2011. A neural network-based approach of quantifying relative importance among various determinants toward organizational innovation. *Expert Systems with Applications,* 38(10):13064-13072.

Woodruff, A. & Alexander, T. 1958. *Success and Failure in the Small Business.* [Online] Available from.

Wu, A.D. & Zumbo, B.D. 2008. Understanding and using mediators and moderators. *Social Indicators Research,* 87(3):367.

Yang, Y.N. 2003. *Testing the stability of oxperts' opinions between successive rounds of delphi studies.* Chicago.

Yao, F.K. & Chang, S. 2017. Do individual employees' learning goal orientation and civic virtue matter? A micro-foundations perspective on firm absorptive capacity. *Strategic Management Journal,* 38(10):2041-2060.

Ye, A., Resnick, I., Hansen, N., Rodrigues, J., Rinne, L. & Jordan, N.C. 2016. Pathways to fraction learning: Numerical abilities mediate the relation between early cognitive competencies and later fraction knowledge. *Journal of Experimental Child Psychology,* 152:242-263.

Yildiz, H.E., Murtic, A., Klofsten, M., Zander, U. & Richtnér, A. 2020. Individual and contextual determinants of innovation performance: A micro-foundations perspective. *Technovation,* 99:1-9.

Young, J.E. & Sexton, D.L. 1997. Entrepreneurial learning: A conceptual framework. *Journal of Enterprising Culture,* 5(03):223-248.

Yusr, M.M., Mokhtar, S.S.M., Othman, A.R. & Sulaiman, Y. 2017. Does interaction between TQM practices and knowledge management processes enhance the innovation performance? *International Journal of Quality and Reliability Management,* 34(7):955-975.

Yusuf, S. 2007. *From creativity to innovation.* The World Bank.

Yuwono, W. 2020. Empirical analysis of intellectual capital, potential absorptive capacity, realized absorptive capacity and cultural intelligence on innovation. *Management Science Letters,* 11(4):1399-1406.

Zahra, S.A. & George, G. 2002. Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review,* 27(2):185-203.

Zekić-Sušac, M., Pfeifer, S. & Šarlija, N. 2014. A comparison of machine learning methods in a high-dimensional classification problem. *Business Systems Research Journal,* 5(3):82-96.

Zekić-Sušac, M., Šarlija, N. & Pfeifer, S. 2013. Combining PCA analysis and artificial neural networks in modelling entrepreneurial intentions of students. *Croatian Operational Research Review,* 4(1):306-317.

Zhai, Y.-M., Sun, W.-Q., Tsai, S.-B., Wang, Z., Zhao, Y. & Chen, Q. 2018. An empirical study on entrepreneurial orientation, absorptive capacity, and SMEs' innovation performance: A sustainable perspective. *Sustainability,* 10(2):1-14.

Zhang, M. & Hartley, J.L. 2018. Guanxi, IT systems, and innovation capability: The moderating role of proactiveness. *Journal of Business Research,* 90:75-86.

Zhao, S., Jiang, Y. & Wang, S. 2019. Innovation stages, knowledge spillover, and green economy development: moderating role of absorptive capacity and environmental regulation. *Environmental Science and Pollution Research,* 26(24):25312-25325.

Zhou, Y., Minshall, T. & Hampden-Turner, C. 2010. Entrepreneurial innovation problems associated with the dynamic growth of university spin-outs in China: A capabilities perspective. *International Journal of Entrepreneurship and Innovation Management,* 12(3-4):330-362.

Ziglio, E. 1996. *The Delphi method and its contribution to decision-making.* London, England: Jessica Kingsley.

Zikmund, W.G., Babin, B.J., Carr, J.C. & Griffin, M. 2013. *Business research methods.* 9th ed. Canada: Cengage Learning.

Zollo, M., Reuer, J.J. & Singh, H. 2002. Interorganizational routines and performance in strategic alliances. *Organization Science,* 13(6):701-713.

Zou, T., Ertug, G. & George, G. 2018. The capacity to innovate: A meta-analysis of absorptive capacity. *Journal of Innovation: Organization and Management,* 20(2):87-121.

APPENDICES

APPENDIX A:
RESEARCH ETHICS COMMITTEE APPROVAL

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Economic and Management Sciences

RESEARCH ETHICS COMMITTEE
Tel: +27 12 420 3434
E-mail: alewyn.nel@up.ac.za

12 March 2018

Prof M Botha
Department of Business Management

Dear Prof Botha

The application for ethical clearance for the research project described below served before this committee on 9 March 2017.

Protocol No:	EMS075/18
Research title:	The interrelationships between entrepreneurial competencies, absorptive capacity and innovation capacity
Principal researcher:	A Taljaard
Student/Staff No:	23020076
Degree:	PhD (Entrepreneurship)
Supervisor/Promoter:	Prof M Botha
Department:	Business Management

The decision by the committee is reflected below:

Decision:	Approved
Conditions (if applicable):	
Period of approval:	March 2018 – March 2019

The approval is subject to the researcher abiding by the principles and parameters set out in the application and research proposal in the actual execution of the research. The approval does not imply that the researcher, student or lecturer is relieved of any accountability in terms of the Codes of Research Ethics of the University of Pretoria if action is taken beyond the approved proposal. If during the course of the research it becomes apparent that the nature and/or extent of the research deviates significantly from the original proposal, a new application for ethics clearance must be submitted for review.

We wish you success with the project.

Sincerely

pp PROF JA NEL
CHAIR: COMMITTEE FOR RESEARCH ETHICS

cc: Prof AJ Antonites
Student Administration

Fakulteit Ekonomiese en Bestuurswetenskappe
Lefapha la Disaense tša Ekonomi le Taolo

APPENDIX B:
DELPHI: INTRODUCTION AND INFORMED CONSENT LETTER

Dear Entrepreneurship expert/lecturer/researcher

Please find below the link to the Delphi study. The link will be active for 2 weeks, or until all responses have been received.

My sincere appreciation for partaking in Round 1 of the study, your expert contribution is highly appreciated.

https?// XXXXXXXXXXlink

Participation in this research is voluntary. You retain the right to withdraw from the research at any time. You have the right to refuse answering questions which you are not comfortable with. Your personal information, identity, as well as any answers provided will remain confidential.

For any further questions the contact details of the researcher and supervisor are provided below.

Kind Regards
Amorie Taljaard

Researcher:
Ms. A. Taljaard (23020076)
Cell: 082339 3163
+27 12 429 2619
Email: amorie.taljaard@gmail.com
taljaa@unisa.ac.za
Supervisor:
Prof M. Botha
Email: melodi.botha@up.ac.za

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Economic and Management Sciences

Letter of Introduction and Informed Consent

**Dept. of
Business Management**

The interrelationships between entrepreneurial competencies, absorptive capacity and innovation capacity

Research conducted by:
Ms. A. Taljaard (23020076)
Cell: +27 82 339 3163

Dear Participant

Amorie Taljaard is a Doctoral student from the Department of Business Management at the University of Pretoria.

The purpose of the study is to determine whether there is a relationship between Entrepreneurial Absorptive Capacity (EACAP) and Innovation Capacity (IC) of established entrepreneurs in South Africa. Furthermore, the relationship includes individual Entrepreneurial Competencies (EC) to determine the moderating effect within this relationship. More specifically, the outcome of this study is to determine whether the relationship between EC, EACAP and IC indicates entrepreneurial competencies required for the fourth industrial revolution (Industry 4.0).

Please note the following:

- This is an anonymous study survey as your name will not appear on the questionnaire. The answers you give will be treated as strictly confidential as you cannot be identified in person based on the answers you give.
- Your participation in this study is very important to us. You may, however, choose not to participate and you may also stop participating at any time without any negative consequences.
- Please answer the questions in the survey as completely and honestly as possible. This should not take more than 20 minutes of your time.
- The results of the study will be used for academic purposes only and may be published in an academic journal.
- Please contact my study leader, Prof M Botha, +27 12 420 4774, melodi.botha@up.ac.za, if you have any questions or comments regarding the study.

In research of this nature the study leader may wish to contact respondents to verify the authenticity of data gathered by the researcher. It is understood that any personal contact details that you may provide will be used only for this purpose, and will not compromise your anonymity or the confidentiality of your participation.

Participation means that:

- You have read and understand the information provided above.
- You give your consent to participate in the study on a voluntary basis.

APPENDIX C:

DELPHI QUESTIONNAIRE: ROUND 1 AND ROUND 2

Delphi study Round I - Questionnaire 1

A Delphi study on the identification of entrepreneurial competencies for the Fourth Industrial Revolution and high levels of Innovation Capacity.

Stage 1 of the Delphi study. The form will remain open for 2 weeks.

Email address *

Section A: Entrepreneurial Competencies

Competency is a term defined as "an underlying characteristic of an individual that is causally related to criterion-referenced effective and/or superior performance in a job or situation". It is also "a characteristic and measurable pattern of knowledge, skills and behaviours that contribute to superior job performance" (Mills, 2004:10). Baum *et al.* (2001:293) define the concept as individual characteristics such as knowledge, skills and/or abilities required to perform a specific job.

A1. Please identify specific entrepreneurial competencies you think is required for the fourth industrial revolution (minimum of 10). Also, provide a short definition/description of each if you feel it is necessary. *

Before answering the question, please familiarise yourself with the concept.

Industry 4.0 or the fourth industrial revolution is known as the current trend of automation and data exchange in manufacturing technologies. It includes the internet of things, cyber physical systems and cloud computing. This industry has also been called a “smart factory”. It involves the transformation of entire systems across (and within) countries, companies and society as a whole. Therefore, by enabling smart factories, the fourth industrial revolution creates a world in which virtual and physical systems of manufacturing globally cooperate with each other in a flexible way. In reality, our devices will for example become an increasing part of our personal ecosystem, listening to us, anticipating our needs and helping us when required, even if not asked. In order for Entrepreneurial businesses to remain competitive, one must be at the frontier of innovation in all its forms, including speed, breath, depth and the complete transformation of entire systems.

*Please do not be limited to the space provided.

	Entrepreneurial Competencies for the Fourth Industrial Revolution	**Definition/Description**
1		
2		
3		
4		
5		
6		
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15		
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19		
20		

A2. Based on the competencies identified in question A1, distinguish these competencies by placing them in one of the 4 categories, where 1 = cognitive, 2 = functional, 3 = social, 4 = meta. *

Before answering the question, please familiarise yourself with the 4 categories of competencies.

Categories	**Description**
1. Cognitive competencies (Knowledge)	The possession of appropriate work-related knowledge and the ability to put it into effective use. Including underpinning theory and concepts, as well as informal tacit knowledge gained experientially. Knowledge (know-that), underpinned by understanding (know-why), is distinguished from competence.
2. Functional competencies (Skills)	The ability to perform a range of work-based tasks effectively to produce specific outcomes. Also known as skills or know-how. Things that a person who works in a given occupation area should be able to do and be able to demonstrate.
3. Social competencies (Attitudes and behaviours)	The ability to adopt appropriate, observable behaviours in work related situations. Known as behavioural competencies (know how to behave), defined as a relatively enduring characteristic of a person causally related to effective or superior performance in a job.
4. Meta competencies (Facilitating learning)	Described as meta-qualities, i.e. creativity, mental ability, and balanced learning skills, which is reinforced

	by other qualities. The ability to cope with uncertainty, as well as with learning and reflection. An individual's knowledge of their own intellectual strengths and weaknesses, how to apply skills and knowledge in various task situations and how to acquire missing competencies

Please list the competencies identified in question A1 in the column below and identify the relevant category of each competency. *

	Competency	Cognitive	Functional	Social	Meta
1		1	2	3	4
2		1	2	3	4
3		1	2	3	4
4		1	2	3	4
5		1	2	3	4
6		1	2	3	4
7		1	2	3	4
8		1	2	3	4
9		1	2	3	4
10		1	2	3	4
11		1	2	3	4
12		1	2	3	4
13		1	2	3	4
14		1	2	3	4
15		1	2	3	4
16		1	2	3	4
17		1	2	3	4
18		1	2	3	4
19		1	2	3	4
20		1	2	3	4

*This question requires a response per row

THANK YOU

Delphi study Round II - Questionnaire 2

A Delphi study on the identification of entrepreneurial competencies for the Fourth Industrial Revolution and high levels of Innovation Capacity.

Stage 2 of the Delphi study. The form will remain open for 2 weeks.

*Required

Email address *

Section A: Entrepreneurial Competencies

A1. Listed below are entrepreneurial competencies identified in round 1 to be essential for the fourth industrial revolution. Based on your knowledge and experience, please use the following Likert scale to rate your level of agreement that the competency is essential. *

*Please indicate your answers with a clear **X**

	Competencies	*Strongly Disagree*	*Disagree*	*Slightly disagree*	*Neutral*	*Slightly agree*	*Agree*	*Strongly Agree*
1	Action oriented	1	2	3	4	5	6	7
2	Decision-making capability	1	2	3	4	5	6	7
3	Guerilla Skills	1	2	3	4	5	6	7
4	Taking initiative	1	2	3	4	5	6	7
5	Proactiveness	1	2	3	4	5	6	7
6	Risk management/mitigation	1	2	3	4	5	6	7
7	Assertiveness	1	2	3	4	5	6	7
8	Culture Building	1	2	3	4	5	6	7
9	Leadership skills	1	2	3	4	5	6	7

10	People management	1	2	3	4	5	6	7
11	Collaboration skills	1	2	3	4	5	6	7
12	Concern for Employee Welfare	1	2	3	4	5	6	7
13	Humaneness	1	2	3	4	5	6	7
14	Interpersonal skills	1	2	3	4	5	6	7
15	Social skills	1	2	3	4	5	6	7
16	Discernment skills	1	2	3	4	5	6	7
17	Socially responsible	1	2	3	4	5	6	7
18	Building and Using Networks	1	2	3	4	5	6	7
19	Relationship building skills	1	2	3	4	5	6	7
20	Networking ability	1	2	3	4	5	6	7
21	Ability to change mindset	1	2	3	4	5	6	7
22	Emotional intelligence	1	2	3	4	5	6	7
23	Negotiation skills	1	2	3	4	5	6	7
24	Story Telling	1	2	3	4	5	6	7
25	Communication ability	1	2	3	4	5	6	7
26	Digital and technical proficiency	1	2	3	4	5	6	7
27	Advanced technical skills/ability	1	2	3	4	5	6	7
28	Computer skills	1	2	3	4	5	6	7
29	Multi-disciplinary and trans-disciplinary exposure and knowledge	1	2	3	4	5	6	7
30	Literacy: financial, economic and technical competence	1	2	3	4	5	6	7
31	STEM skills -Science, Technology, Engineering and Mathematics	1	2	3	4	5	6	7
32	Data Analysis	1	2	3	4	5	6	7
33	Analytical ability	1	2	3	4	5	6	7
34	Cognitive ability	1	2	3	4	5	6	7
35	Critical thinking	1	2	3	4	5	6	7
36	Detection of buying behaviour	1	2	3	4	5	6	7
37	Environmental scanning	1	2	3	4	5	6	7
38	Financial analysis	1	2	3	4	5	6	7
39	Judgement	1	2	3	4	5	6	7
40	Logical and mathematical reasoning	1	2	3	4	5	6	7

41	Problem solving	1	2	3	4	5	6	7
42	Situational analysis	1	2	3	4	5	6	7
43	Information seeking	1	2	3	4	5	6	7
44	Inquisitiveness	1	2	3	4	5	6	7
45	Lifelong learning	1	2	3	4	5	6	7
46	Extensive reading and comprehending	1	2	3	4	5	6	7
47	Creative Problem Solving & Imaginativeness	1	2	3	4	5	6	7
48	Creativity	1	2	3	4	5	6	7
49	Innovating	1	2	3	4	5	6	7
50	Design thinking	1	2	3	4	5	6	7
51	Experimentation	1	2	3	4	5	6	7
52	Innovation management	1	2	3	4	5	6	7
53	Innovativeness	1	2	3	4	5	6	7
54	Value creation	1	2	3	4	5	6	7
55	Conceptual ability	1	2	3	4	5	6	7
56	Conveying a compelling vision	1	2	3	4	5	6	7
57	Strategy development	1	2	3	4	5	6	7
58	Strategic Thinking	1	2	3	4	5	6	7
59	Business management ability	1	2	3	4	5	6	7
60	Coordination and integration skills	1	2	3	4	5	6	7
61	Efficiency Orientation	1	2	3	4	5	6	7
62	Ability to evaluation and control	1	2	3	4	5	6	7
63	Operations management	1	2	3	4	5	6	7
64	Organising ability	1	2	3	4	5	6	7
65	Systematic planning and organising of work	1	2	3	4	5	6	7
66	Resource Leveraging	1	2	3	4	5	6	7
67	Identify customer needs	1	2	3	4	5	6	7
68	Quality Consciousness	1	2	3	4	5	6	7
69	Individual Commitment	1	2	3	4	5	6	7
70	Ability to change	1	2	3	4	5	6	7
71	Adaptability	1	2	3	4	5	6	7
72	Coping with difficulties	1	2	3	4	5	6	7

73	Persistence/Tenacity/perseverance	1	2	3	4	5	6	7
74	Resilience	1	2	3	4	5	6	7
75	Maintain Focus yet Adapt	1	2	3	4	5	6	7
76	Ability to overcome stumbling blocks	1	2	3	4	5	6	7
77	Internal locus of control	1	2	3	4	5	6	7
78	Need for achievement	1	2	3	4	5	6	7
79	Performance motivation	1	2	3	4	5	6	7
80	Positive attitude	1	2	3	4	5	6	7
81	Self-efficacy	1	2	3	4	5	6	7
82	Willingness	1	2	3	4	5	6	7
83	Business Model Creation	1	2	3	4	5	6	7
84	Create new opportunities	1	2	3	4	5	6	7
85	Opportunity assessment	1	2	3	4	5	6	7
86	Opportunity recognition	1	2	3	4	5	6	7
87	Effectuation	1	2	3	4	5	6	7

A2. Please indicate the relevant category of each entrepreneurial competency. *

	Competencies	*Cognitive (Knowledge)*	*Functional (Skills)*	*Social (Attitudes and behaviours)*	*Meta (Facilitating learning)*
1		1	2	3	4
2		1	2	3	4
3		1	2	3	4
4		1	2	3	4
5		1	2	3	4
6		1	2	3	4
7		1	2	3	4
8		1	2	3	4
9		1	2	3	4
10		1	2	3	4
11		1	2	3	4
12		1	2	3	4
13		1	2	3	4
14		1	2	3	4
15		1	2	3	4
16		1	2	3	4
17		1	2	3	4

18		1	2	3	4
19		1	2	3	4
20		1	2	3	4

Section B: Innovation Capacity

The concept innovation capacity was originally introduced by Suarez-Villa (1990) as a concept, framework or method that measures the level of invention and the potential for innovation. The term innovative capacity also refers to an individual's aptitude, to an educational quality, or to an entity's condition, and therefore, merely denotes a characteristic. He defines innovation capacity as "the successful outcomes of all corporate and individual invention.

B1. In your opinion, to what extent do the following competencies influence an entrepreneur's ability to innovate/innovativeness? *

	Competencies	*To no extent*	*To little extent*	*To a moderate extent*	*To a large extent*	*To an extreme extent*
1		1	2	3	4	5
2		1	2	3	4	5
3		1	2	3	4	5
4		1	2	3	4	5
5		1	2	3	4	5
6		1	2	3	4	5
7		1	2	3	4	5
8		1	2	3	4	5
9		1	2	3	4	5
10		1	2	3	4	5
11		1	2	3	4	5
12		1	2	3	4	5
13		1	2	3	4	5
14		1	2	3	4	5
15		1	2	3	4	5
16		1	2	3	4	5
17		1	2	3	4	5
18		1	2	3	4	5
19		1	2	3	4	5
20		1	2	3	4	5

APPENDIX D:
INTRODUCTION, INFORMED CONSENT AND QUESTIONNAIRE

QUESTIONNAIRE

The interrelationships between entrepreneurial competencies, absorptive capacity and innovation capacity

Dear Participant

You are invited to participate in an academic research study conducted by Amorie Taljaard and Doctoral student from the Department of Business Management at the University of Pretoria. The study is only applicable if you are the owner of the business.

The purpose of the study is to determine whether there is a relationship between Entrepreneurial Absorptive Capacity (EACAP) and Innovation Capacity (IC) of entrepreneurs in South Africa. Furthermore, the relationship includes individual Entrepreneurial Competencies (EC) to determine the moderating effect within this relationship. More specifically, the outcome of this study is to determine whether the relationship between EC, EACAP and IC indicates entrepreneurial competencies required for the fourth industrial revolution (Industry 4.0).

Please note the following:

- This is an anonymous study survey as your name will not appear on the questionnaire.
- The answers you give will be treated as strictly confidential as you cannot be identified in person based on the answers you give.
- Your participation in this study is very important to us. You may, however, choose not to participate and you may also stop participating at any time without any negative consequences.
- Please answer the questions in the survey as completely and honestly as possible. This should not take more than 20 minutes of your time.
- The results of the study will be used for academic purposes only and may be published in an academic journal. We will provide you with a summary of our findings on request.
- Please contact my study leader, Prof M Botha, +27 12 420 4774, melodi.botha@up.ac.za, if you have any questions or comments regarding the study.

In research of this nature the study leader may wish to contact respondents to verify the authenticity of data gathered by the researcher. It is understood that any personal contact details that you may provide will be used only for this purpose, and will not compromise your anonymity or the confidentiality of your participation.

Please make sure that you have read and understood the information provided above and that you give your consent to participate in the study on a voluntary basis.

By clicking the consent button below, you acknowledge that your participation in the study is voluntary, you are above 18 years of age, and that you are aware that you may choose to terminate your participation at any point in time.

By clicking the consent button below, you acknowledge that your participation in the study is voluntary, you are above 18 years of age, and that you are aware that you may choose to terminate your participation at any point in time.

- I consent, begin the study
- I do not consent, I do not wish to participate

Section A: Demographic Information

Instructions: Carefully read all the instructions before beginning. Read each statement carefully and respond by choosing the most applicable option that best indicates your answer. Each question requires an answer.

Are you an owner of a business or an entrepreneur? If "Yes", continue to the next question.	1 Yes 2 No	Qa
Are you an innovative entrepreneur?	1 Yes 2 No	Qb

Only continue if your answers in the above questions were yes.

What is your gender?	1 Male 2 Female	Q1
Please indicate your age in years.	#	Q2
What is your race?	1 Black 2 Coloured 3 Indian 4 White 5 Other	Q3
What is your highest level of education attained?	1 None 2 Below grade 12 3 Grade 12 (Matric) 4 Certificate (e.g. short learning programme/s) 5 Diploma 6 Degree 7 Post-graduate degree (Honours) 8 Post-graduate degree (Masters) 9 Post-graduate degree (Doctoral) 10 Other (please specify)_______	Q4
In which I4.0 (Fourth Industrial Revolution) field does your business operate in specifically?	1 Robotics 2 Artificial intelligence 3 Nanotechnology 4 Quantum computing 5 Biotechnology 6 The Internet of Things 7 The Industrial Internet of Things (IIoT) 8 Fifth-generation wireless technologies (5G) 9 Additive manufacturing/3D printing 10 Fully autonomous vehicles 11 Biological technologies 12 Other (please specify)	Q5

	13 Manufacturing 14 Pharmaceuticals 15 Finance (e.g. blockchain)_____	
In which sector does the main focus of your business lie?	1 Agriculture, hunting forestry and fishing 2 Mining and quarrying 3 Manufacturing 4 Electricity, gas and water supply 5 Construction 6 Wholesale and retail trade; repair of motor vehicles, motor cycles and personal and household goods; hotels and restaurants 7 Transport, storage and communication 8 Financial intermediation insurance, real estate and business services 9 Community, social and personal services	Q6
How long have you been in business? Please indicate how many years and months. (e.g. yy/mm; 05/02).	# (yy/mm)	Q7
How many employees do you have in your business (except yourself)?	1 No employees 2 1-4 employees 3 5-9 employees 4 10-49 employees 5 50-99 employees 6 100-199 employees 7 200 or more employees	Q8
What has been your business' annual turnover over the last financial year?	1 Less than R150 000 2 Less than R400 000, but greater than R150 000 3 Less than R1 million, but greater than R400 000 4 Less than R2 million, but greater than R1 million 5 Less than R3 million, but greater than R2 million 6 Less than R4 million, but greater than R3 million 7 Less than R5 million, but greater than R4 million 8 Less than R7.5 million, but greater than R5 million 9 Less than 10 million, but greater than R7.5 million 10 Less than R15 million, but greater than R10 million More than R15 million	Q9

In what geographical area/s is your business operating (primary location)?	1 Eastern Cape 2 Free State 3 Gauteng 4 Kwa-Zulu Natal 5 Limpopo 6 Mpumalanga 7 North West 8 Northern Cape 9 Western Cape 10 Outside SA borders (Please specify the country and area)	Q10

Section B: Entrepreneurial Competencies

Please consider each of the following questions as if it applies to you at present as an entrepreneur.

Indicate your level of agreement with the following statements in Section B.

Statement In everyday business activities	***Strongly disagree***	***Disagree***	***Somewhat disagree***	***Neither agree nor disagree***	***Somewhat agree***	***Agree***	***Strongly agree***	***Office use only***
I take initiative and work under my own direction.	1	2	3	4	5	6	7	Q11
I like to take charge of situations.	1	2	3	4	5	6	7	Q12
I make quick, clear decisions, which may include tough choices or considered risks.	1	2	3	4	5	6	7	Q13
I initiate and generate activity and introduce changes into work processes.	1	2	3	4	5	6	7	Q14
When I have a problem, I tackle it head-on.	1	2	3	4	5	6	7	Q15
Nothing is more exciting than seeing my ideas turn into reality.	1	2	3	4	5	6	7	Q16
I am always looking for better ways to do things in my business.	1	2	3	4	5	6	7	Q17
If I believe in an idea, no obstacle will prevent me from making it happen.	1	2	3	4	5	6	7	Q18
It is extremely unlikely that I feel uncomfortable leading a group.	1	2	3	4	5	6	7	Q19

I often use persuasion to motivate others.	1	2	3	4	5	6	7	Q20
I often seek to understand what motivates others.	1	2	3	4	5	6	7	Q21
It is very likely that I trust, and thus empower, others.	1	2	3	4	5	6	7	Q22

Statement	***Strongly disagree***	***Disagree***	***Somewhat disagree***	***Neither agree nor disagree***	***Somewhat agree***	***Agree***	***Strongly agree***	***Office use only***
I often participate in social gatherings with people that I work with.	1	2	3	4	5	6	7	Q23
I often attend social functions for purposes of building professional relationships.	1	2	3	4	5	6	7	Q24
I often participate in community projects.	1	2	3	4	5	6	7	Q25
I serve on a community board, committee or task force.	1	2	3	4	5	6	7	Q26
I am good at organising information.	1	2	3	4	5	6	7	Q27
I am good at remembering information.	1	2	3	4	5	6	7	Q28
I try to use strategies for my business that have worked in the past.	1	2	3	4	5	6	7	Q29
I find myself using helpful learning strategies automatically.	1	2	3	4	5	6	7	Q30
I use different learning strategies (plans of action) depending on the situation.	1	2	3	4	5	6	7	Q31
I know when each strategy I use will be most effective.	1	2	3	4	5	6	7	Q32
I take into consideration what I really need to learn before I begin a task.	1	2	3	4	5	6	7	Q33
I think of several ways to solve a problem and choose the best one.	1	2	3	4	5	6	7	Q34
I consciously focus my attention on important information.	1	2	3	4	5	6	7	Q35
I draw pictures or diagrams to help me understand while learning.	1	2	3	4	5	6	7	Q36

I ask myself periodically if I am meeting my goals.	1	2	3	4	5	6	7	Q37
I ask myself if I considered all options when solving a problem.	1	2	3	4	5	6	7	Q38
I change strategies when I fail to understand a task or problem at hand.	1	2	3	4	5	6	7	Q39
I stop and go back over new information that is not clear.	1	2	3	4	5	6	7	Q40
Statement	***Strongly disagree***	***Disagree***	***Somewhat disagree***	***Neither agree nor disagree***	***Somewhat agree***	***Agree***	***Strongly agree***	***Office use only***
I ask myself if there was an easier way to do things after I finish a task.	1	2	3	4	5	6	7	Q41
I ask myself how well I accomplished my goals once I'm finished.	1	2	3	4	5	6	7	Q42
I have good analysis skills.	1	2	3	4	5	6	7	Q43
I have the ability to prioritise problems.	1	2	3	4	5	6	7	Q44
I have good critical thinking skills. (Critical thinking is the objective analysis and evaluation of an issue in order to form a judgement).	1	2	3	4	5	6	7	Q45
I use information to make decisions.	1	2	3	4	5	6	7	Q46
I am creative when asked to work with limited resources.	1	2	3	4	5	6	7	Q47
I think outside the box.	1	2	3	4	5	6	7	Q48
I identify opportunities for new services/products.	1	2	3	4	5	6	7	Q49
Freedom to be creative is extremely important to me.	1	2	3	4	5	6	7	Q50
Originality is very important to me.	1	2	3	4	5	6	7	Q51
I generate new innovations that differ from competitors' offering.	1	2	3	4	5	6	7	Q52
I improve existing products and services.	1	2	3	4	5	6	7	Q53

I exploit (use/utilize) innovations developed by others.	1	2	3	4	5	6	7	Q54
I successfully implement creative ideas within my business.	1	2	3	4	5	6	7	Q55

Statement	***Strongly disagree***	***Disagree***	***Somewhat disagree***	***Neither agree nor disagree***	***Somewhat agree***	***Agree***	***Strongly agree***	***Office use only***
I am constantly asking questions to understand why products and projects underperform.	1	2	3	4	5	6	7	Q56
New business ideas often come to me when directly observing how people interact with products and services.	1	2	3	4	5	6	7	Q57
I have a continuous flow of new business ideas that come through observing the world.	1	2	3	4	5	6	7	Q58
I love to experiment to understand how things work.	1	2	3	4	5	6	7	Q59
I love to create new ways of doing things.	1	2	3	4	5	6	7	Q60
I believe that I can grow in positive ways by dealing with difficult situations.	1	2	3	4	5	6	7	Q61
I only set goals which I know I can reach without the help of others.	1	2	3	4	5	6	7	Q62
I actively look for ways to replace the losses I encounter in life.	1	2	3	4	5	6	7	Q63
I look for creative ways to alter difficult situations.	1	2	3	4	5	6	7	Q64
Being an entrepreneur implies more advantages than disadvantages for me.	1	2	3	4	5	6	7	Q65
Being an entrepreneur provides great satisfaction for me.	1	2	3	4	5	6	7	Q66
Among various employment options, I would rather be an entrepreneur.	1	2	3	4	5	6	7	Q67
A career as an entrepreneur has been very attractive for me.	1	2	3	4	5	6	7	Q68

Statement	*Strongly disagree*	*Disagree*	*Somewhat disagree*	*Neither agree nor disagree*	*Somewhat agree*	*Agree*	*Strongly agree*	*Office use only*
I am an avid information seeker.	1	2	3	4	5	6	7	Q69
I often make novel connections and perceive new or emergent relationships between various pieces of information.	1	2	3	4	5	6	7	Q70
I often see connections between previously unconnected domains of information.	1	2	3	4	5	6	7	Q71
I am good at "connecting dots".	1	2	3	4	5	6	7	Q72

Section C: Entrepreneurial Absorptive Capacity

The following questions concerns your use of information and knowledge of your business.

Give an indication of your work experience before you started your own business by indicating the field you had the **most** experience in.	1 I have always had my own business 2 Sales 3 Manufacturing 4 Operations 5 Human Resources 6 Warehousing and/or logistics 7 Research and development 8 Procurement 9 Administration 10 Planning, quality assurance and/or production engineering 11 Support services like maintenance 12 Information Technology 13 General management 14 Other, please specify	Q73
Please indicate your total number of years of work experience. (Only the number value)	#	Q74

The following table concerns your use of information and knowledge of your business.

Please indicate the extent of your agreement with each statement.

Statement	*Strongly disagree*	*Disagree*	*Somewhat disagree*	*Neither agree nor disagree*	*Somewhat agree*	*Agree*	*Strongly agree*	*Office use only*
I am always actively looking for new knowledge for my business.	1	2	3	4	5	6	7	Q75
I intentionally search for knowledge in many different domains by looking 'outside the box'.	1	2	3	4	5	6	7	Q76
I am good at distinguishing between profitable opportunities and not-so-profitable opportunities.	1	2	3	4	5	6	7	Q77
I easily identify what new knowledge is most valuable for the business.	1	2	3	4	5	6	7	Q78
I frequently share my new knowledge with employees to establish a common understanding.	1	2	3	4	5	6	7	Q79
I translate new knowledge in such a way that my employees understand what I mean.	1	2	3	4	5	6	7	Q80
I communicate newly acquired knowledge that might be of interest for the business.	1	2	3	4	5	6	7	Q81
I often sit together with employees to come up with good ideas.	1	2	3	4	5	6	7	V82
I attend meetings with people from different departments to come up with new ideas.	1	2	3	4	5	6	7	Q83
I develop new insights from knowledge that is available within the business.	1	2	3	4	5	6	7	Q84
I can turn existing knowledge into new ideas.	1	2	3	4	5	6	7	Q85
I often apply newly acquired knowledge to my business/work.	1	2	3	4	5	6	7	Q86
I exploit new knowledge to create new products, services, or work methods.	1	2	3	4	5	6	7	Q87

I constantly consider how I can apply new knowledge to come up with new ideas.	1	2	3	4	5	6	7	Q88

Section D: Innovation Capacity

Innovation Capacity is known as a concept, framework or method that measures the level of invention and the potential for innovation. A society's innovation capacity is defined as "the successful outcomes of all corporate and individual invention." (Suarez-Villa, 1990).

Please read each statement carefully and rate the following statements based on the most current product/service you offer.

1. Please rate the following statements based on the **newness** of your most current product/service.

Statement	***Strongly disagree***	***Somewhat disagree***	***Disagree***	***Neither agree nor disagree***	***Somewhat agree***	***Agree***	***Strongly agree***	***Office use only***
The customers/potential customers are totally new to the business.	1	2	3	4	5	6	7	Q89
The class of the product/service is totally new to the business.	1	2	3	4	5	6	7	Q90
*It is an improvement/modification of an existing product/service.	1	2	3	4	5	6	7	Q91
The exploited technology is totally new to the business.	1	2	3	4	5	6	7	Q92
The production process is totally new to the business.	1	2	3	4	5	6	7	Q93
The competitive environment is totally new to the business.	1	2	3	4	5	6	7	Q94
The product use (need served) is totally new to the business.	1	2	3	4	5	6	7	Q95

2. The following statements are based on the **radicalness** of your most current product/service.

Statement	*Strongly disagree*	*Somewhat disagree*	*Disagree*	*Neither agree nor disagree*	*Somewhat agree*	*Agree*	*Strongly agree*	*Office use only*
The product/service is unlike any other.	1	2	3	4	5	6	7	Q96
The product/service requires users to change their ways.	1	2	3	4	5	6	7	Q97

3. The following statements are regarding the **uniqueness and superiority** of your most current product/service.

Statement	*Strongly disagree*	*Somewhat disagree*	*Disagree*	*Neither agree nor disagree*	*Somewhat agree*	*Agree*	*Strongly agree*	*Office use only*
It has a better "service outcome" than competitors' (end result).	1	2	3	4	5	6	7	Q98
It has unique benefits and features – perceived as superior to competitors'.	1	2	3	4	5	6	7	Q99
In terms of quality, the product/service provides a faster or more efficient service.	1	2	3	4	5	6	7	Q100
In terms of quality, the product/service provides a more reliable service (fewer fail points).	1	2	3	4	5	6	7	Q101
It has developed a "high quality" image.	1	2	3	4	5	6	7	Q102
In terms of quality, it has better value than previously available products/service.	1	2	3	4	5	6	7	Q103

4. Please rate the following statements based on the **innovativeness** of your most current product/service.

Statement	*Strongly disagree*	*Somewhat disagree*	*Disagree*	*Neither agree nor disagree*	*Somewhat agree*	*Agree*	*Strongly agree*	*Office use only*

It is a highly innovative product/service – there is nothing like it (it replaces the inferior alternative).	1	2	3	4	5	6	7	Q104
It follows an innovation strategy rather than a follower strategy.	1	2	3	4	5	6	7	Q105
It has radical changes rather than subtle differences.	1	2	3	4	5	6	7	Q106
The product technology is new to the customer.	1	2	3	4	5	6	7	Q107

5. The following statements relate to the **competitive advantage** of your most current product/service, where 1 = Low, 4 = Moderate and 7 = High.

Statement	***Low***			***Moderate***			***High***	
The extent of patent protection	1	2	3	4	5	6	7	Q108
The extent of licence protection	1	2	3	4	5	6	7	Q109
The ease of competitive duplication	1	2	3	4	5	6	7	Q110

6. The following statement relates to the **market pioneering** of the product.

Was your business the first into the market with this type of product?	1 Yes 2 No	Q111

Please answer the following questions regarding the innovations of your business during the past three years. Select all options that apply.

What type of radical innovation has been developed in your business during the past three years? Please answer yes or no for each statement. (Radical innovation: innovation that is new and different from what the competitors are doing)	1 None 2 Products (visible to external stakeholders) 3 Services (visible to external stakeholders) 4 Processes (includes all tasks, schedules, activities and routines) 5 Production methods (the way in which you make or build products and/or services) 6 Mode of action (single actions that have led to innovations of the entire managerial or organisational practices and procedures)	Q112
What type of incremental innovation has been developed in your business during the past three years?	1 None 2 Products (visible to external stakeholders) 3 Services (visible to external stakeholders) 4 Processes (includes all tasks, schedules, activities and routines) 5 Production methods (the way in which you make or build products and/or services)	Q113

Please answer yes or no for each statement. (Incremental innovation: innovation that is an improvement that is different from the existing offerings in the market in terms of some of its features)	6 Mode of action (single actions that have led to innovations of the entire managerial or organisational practices and procedures)	

THANK YOU FOR YOUR PARTICIPATION

APPENDIX E:
EXPLANATION OF THE RESEARCH DESIGN USING A DELPHI METHOD VERSUS A TRADITIONAL METHOD

Evaluation criteria	Delphi study	Traditional survey
Summary of procedure	All the questionnaire design issues of a survey also apply to a Delphi study. After the questionnaire is designed by the researcher, an appropriate group of experts are selected who are qualified to answer the questions. The responses of the surveys are then administered and analysed. Another survey is then designed based on the responses to the first one and re-administers it, asking respondents to revise their original responses and/or answer other questions based on group feedback from the first survey. The researchers reiterate this process until the respondents reach a satisfactory degree of consensus. The respondents are kept anonymous to each other throughout the process.	A questionnaire is designed with questions relevant to the issue of study. In order to develop a good survey, numerous issues concerning validity of the questions must be considered. The questionnaire can include questions that solicit qualitative or quantitative data, or both. The researcher decides on the population that the hypotheses apply to, and selects a random sample of this population on whom to administer the survey. The survey is filled in by the respondents and returned. The usable responses are then analysed to investigate the research questions.
Representativeness of sample	A Delphi study investigates questions that are of high uncertainty and speculation. It consists of a virtual panel of experts gathered to arrive at an answer to a difficult question. A Delphi study could thus be considered a type of virtual meeting or as a group decision technique, though it appears to be a complicated survey.	Using statistical sampling techniques, the researcher randomly selects a sample that is representative of the population.
Sample size for statistical power and significant findings	The Delphi group size depend on group dynamics and not on statistical power. The literature therefore recommends 10 to 18 experts on a Delphi panel.	The researcher needs to select a sample size that is large enough to detect statistically significant effects in the population, because the goal is to generalise results to a larger population.
Individual vs. group response	Studies have consistently shown that for questions requiring expert judgment, the average of individual responses is inferior.	The researcher usually average out individuals' responses to determine the average response for the sample, which is generalised to the relevant population.

Reliability and response revision	To assure reliability, pretesting is also important for the Delphi method, whereas test-retest reliability is not relevant, since researchers expect respondents to revise their responses.	The reliability of the measures are important criterion for evaluating surveys. This is assured through pretesting and by retesting to assure test-retest reliability.
Construct validity	The Delphi method additionally employs further construct validation by asking experts to validate the researcher's interpretation and categorization of the variables. The fact that Delphi is not anonymous (to the researcher) permits this validation step.	Construct validity is by careful survey design and pretesting.
Anonymity	The respondents are never anonymous to the researcher, but always to each other.	Respondents are almost always anonymous to the researcher and to each other.
Non-response issues	Non-response is usually very low in Delphi surveys, since most researchers have personally obtained assurance of participation.	There is a need to investigate the possibility of non-response bias to ensure that the sample remains representative of the population.
Attrition effects	Attrition tends to be low in Delphi studies, and the researchers have personally obtained assurances of participation.	Attrition is not an issue for single surveys, but for multi-step repeated survey studies, researchers should investigate attrition
Richness of data	In addition to the richness aspects of traditional surveys, Delphi studies inherently provide richer data because of their multiple interactions and their response revision due to feedback. Moreover, Delphi participants tend to be open to follow-up interviews.	It depends on the form and depth of the questions, and on the possibility of follow-up, such as interviews if respondents can be tracked.

APPENDIX F:
COMPETENCY FRAMEWORK AND DIMENSIONS FOR CLASSIFICATION AND CODING

"Great Eight" Competencies	20 Dimensions	Code	Delphi Results Round 1 From 108 – clustered to 87 for Round 2
LEADING AND DECIDING	**Deciding and initiating action**	C1	Action oriented
Takes control and exercises leadership. Initiates action, gives direction and takes responsibility.	Takes responsibility for actions, projects and people; takes initiative and works under own direction; initiates and generates activity and introduces changes into work processes; makes quick, clear decisions which may include tough choices or considered risks.	C2	Decision-making capability
		C3	Guerilla Skills
		C4	Taking initiative
		C5	Proactiveness
		C6	Risk management/mitigation
	Leading and supervising	C7	Assertiveness
	Provides others with a clear direction; motivates and empowers others; recruits staff of a high calibre; provides staff with development opportunities and coaching; sets appropriate	C8	Culture Building
		C9	Leadership skills
		C10	People management
SUPPORTING AND COOPERATING	**Working with people**	C11	Collaboration skills
Supports others and shows respect and positive regard for them in social situations. Puts people first, working effectively with individuals and teams, clients and staff. Behaves consistently with clear personal values that complement those of the organisation.	Shows respect for the views and contributions of other team members; shows empathy; listens, supports and cares for others; consults others and shares information and expertise with them; builds team spirit and reconciles conflict; adapts to the team and fits in well.	C12	Concern for Employee Welfare
		C13	Humaneness
		C14	Interpersonal skills
		C15	Social skills
	Adhering to principles and values	C16	Discernment skills
	Upholds ethics and values; demonstrates integrity; promotes and defends equal opportunities, builds diverse teams; encourages organizational and individual responsibility towards the community and the environment.	C17	Socially responsible
INTERACTING AND PRESENTING	**Relating and Networking**	C18	Building and Using Networks
Communicates and networks effectively. Successfully persuades and influences others. Relates to others in a confident and relaxed manner.	Easily establishes good relationships with customers and staff; relates well to people at all levels; builds wide and effective networks of contacts; uses humour appropriately to bring warmth to relationships with others.	C19	Relationship building skills
		C20	Networking ability
	Persuading and influencing	C21	Ability to change mind-sets
	Gains clear agreement and commitment from others by persuading, convincing and negotiating; makes effective use of political processes to influence and persuade others; promotes own ideas and those of others; makes a strong personal impact on others; takes care to manage one's impression on others.	C22	Emotional intelligence
		C23	Negotiation skills
		C24	Story Telling
	Presenting and communicating information		
	Speaks fluently; expresses opinions, information and key points of an argument clearly; makes presentations and undertakes public speaking with skill and confidence; responds quickly to the needs of an audience and to their reactions and feedback; projects credibility	C25	Communication ability
ANALYSING AND INTERPRETING	**Writing and Reporting**		
Shows evidence of clear analytical thinking. Gets to the heart of complex problems and issues. Applies own expertise effectively. Quickly learns new technology. Communicates well in writing.	Writes convincingly; writes clearly, succinctly and correctly; avoids the unnecessary use of jargon or complicated language; writes in a well-structured and logical way; structures information to meet the needs and understanding of the intended audience.		
	Applying Expertise and Technology	C26	Digital and technical proficiency

	Applies specialist and detailed technical expertise; uses technology to achieve work objectives; develops job knowledge and expertise (theoretical and practical) through continual professional development; demonstrates an understanding of different organizational departments and functions.	C27	Advanced technical skills/ability
		C28	Computer skills
		C29	Multi-disciplinary and trans-disciplinary exposure and knowledge
		C30	Literacy: financial, economic and technical competence
		C31	STEM skills -Science, Technology, Engineering and Mathematics
		C32	Data Analysis
	Analysing Analyses numerical data and all other sources of information, to break them into component parts, patterns and relationships; probes for further information or greater understanding of a problem; makes rational judgments from the available information and analysis; demonstrates an understanding of how one issue may be a part of a much larger system.	C33	Analytical ability
		C34	Cognitive ability
		C35	Critical thinking
		C36	Detection of buying behaviour
		C37	Environmental scanning
		C38	Financial analysis
		C39	Judgement
		C40	Logical and mathematical reasoning
		C41	Problem solving
		C42	Situational analysis
CREATING AND CONCEPTUALIZING Open to new ideas and experiences. Seeks out learning opportunities. Handles situations and problems with innovation and creativity. Thinks broadly and strategically. Supports and drives organisational change.	**Learning and Researching** Rapidly learns new tasks and commits information to memory quickly; demonstrates an immediate understanding of newly presented information; gathers comprehensive information to support decision making; encourages an organizational learning approach (i.e. learns from successes and failures and seeks staff and customer feedback).	C43	Information seeking
		C44	Inquisitiveness
		C45	Lifelong learning
		C46	Extensive reading and comprehending
	Creating and Innovating Produces new ideas, approaches, or insights; creates innovative products or designs; produces a range of solutions to problems.	C47	Creative Problem Solving & Imaginativeness
		C48	Creativity
		C49	Innovating
		C50	Design thinking
		C51	Experimentation
		C52	Innovation management
		C53	Innovativeness
		C54	Value creation
	Formulating Strategies and Concepts Works strategically to realize organizational goals; sets and develops strategies; identifies, develops positive and compelling visions of the organization's future potential; takes account of a wide range of issues across, and related to, the organization.	C55	Conceptual ability
		C56	Conveying a compelling vision
		C57	Strategy development
		C58	Strategic Thinking
ORGANISING AND EXECUTING Plans ahead and works in a systematic and organised way. Follows directions and procedures. Focuses on customer satisfaction and delivers a quality service or product to the agreed standards	**Planning and Organising** Sets clearly defined objectives; plans activities and projects well in advance and takes account of possible changing circumstances; identifies and organizes resources needed to accomplish tasks; manages time effectively; monitors performance against deadlines and milestones.	C59	Business management ability
		C60	Coordination and integration skills
		C61	Efficiency Orientation
		C62	Ability to evaluation and control
		C63	Operations management
		C64	Organising ability
		C65	Systematic planning and organising of work
		C66	Resource Leveraging
	Delivering Results and Meeting Customer Expectations Focuses on customer needs and satisfaction; sets high standards for quality and quantity; monitors and maintains quality and productivity; works in a systematic, methodical and orderly way; consistently achieves project goals	C67	Identify customer needs
		C68	Quality Consciousness

	Following Instructions and Procedures Not challenging authority; follows procedures and policies; keeps to schedules; arrives punctually for work and meetings; demonstrates commitment to the organization; complies with legal obligations and safety requirements of the role.	C69	Individual Commitment
ADAPTING AND COPING Adapts and responds well to change. Manages pressure effectively and copes with setbacks.	**Adapting and Responding to Change** Adapts to changing circumstances; tolerates ambiguity; accepts new ideas and change initiatives; adapts interpersonal style to suit different people or situations; shows an interest in new experiences.	C70	Ability to change
		C71	Adaptability
		C72	Coping with difficulties
		C73	Persistence/Tenacity/perseverance
		C74	Resilience
	Coping with Pressures and Setbacks Maintains a positive outlook at work; works productively in a high pressure environment; keeps emotions under control during difficult situations; handles criticism well and learns from it; balances the demands of a work life and a personal life.	C75	Maintain Focus yet Adapt
		C76	Ability to overcome stumbling blocks
ENTERPRISING AND PERFORMING Focuses on results and achieving personal work objectives. Works best when work is related closely to results and the impact of personal efforts is obvious. Shows an understanding of business, commerce and finance. Seeks opportunities for self-development and career advancement.	**Achieving Personal Work Goals and Objectives** Accepts and tackles demanding goals with enthusiasm; works hard and puts in longer hours when necessary; seeks progression to roles of increased responsibility and influence; identifies own development needs and makes use of developmental or training opportunities.	C77	Internal locus of control
		C78	Need for achievement
		C79	Performance motivation
		C80	Positive attitude
		C81	Self-efficacy
		C82	Willingness
	Entrepreneurial and Commercial Thinking Keeps up to date with competitor information and market trends; identifies business opportunities for the organization; maintains awareness of developments in the organizational structure and politics; demonstrates financial awareness; controls costs and thinks in terms of profit, loss and added value.	C83	Business Model Creation
		C84	Create new opportunities
		C85	Opportunity assessment
		C86	Opportunity recognition
		C87	Effectuation

APPENDIX G:

CONCEPTUAL AND OPERATIONAL DEFINITIONS AND CATEGORIES OF ENTREPRENEURIAL COMPETENCIES

ENTREPRENEURIAL COMPETENCIES

THEORY LEVEL						RESEARCH LEVEL
"Great Eight" Competencies	**20 Dimensions** **General Conceptual Definitions (SHL Competency Framework) (Bartram, 2011)**		**Conceptual Components (Constructs)**	**Conceptual Definitions**	**Operational Definitions (A set of questionnaire items**	**Observation Level**
LEADING AND DECIDING Takes control and exercises leadership. Initiates action, gives direction and takes responsibility.	**Deciding and initiating action** Takes responsibility for actions, projects and people; takes initiative and works under own direction; initiates and generates activity and introduces changes into work processes; makes quick, clear decisions which may include tough choices or considered risks.	**Q11 – 14**	**Decision-making capability**	Considering the relative costs and benefits of potential actions to choose the most appropriate one (Gray, 2016).	I take initiative and work under my own direction. I like to take charge of situations. I make quick, clear decisions, which may include tough choices or considered risks. I initiate and generate activity and introduce changes into work processes.	**COGNITIVE**
		Q15 - 18	**Proactiveness**	Proactive behaviour involves acting in advance of a future situation, rather than just reacting. It means taking control and making things happen rather than just adjusting to a situation or waiting for something to happen.	When I have a problem, I tackle it head-on. Nothing is more exciting than seeing my ideas turn into reality. I am always looking for better ways to do things in my business. If I believe in an idea, no obstacle will prevent me from making it happen.	Response to questionnaire **COGNITIVE**
	Leading and supervising Provides others with a clear direction; motivates and empowers others; recruits staff of a high calibre; provides staff with development opportunities and coaching; sets appropriate standards of behaviour.	**Q19 – 22**	**Leadership skills**	Minimises politics in the workplace; Expects excellence from all employees; Demonstrates good people skills; Shares information with employee; Is a good coach or mentor (Dixon et al., 2005).	It is extremely unlikely that I feel uncomfortable leading a group. I often use persuasion to motivate others. I often seek to understand what motivates others. It is very likely that I trust, and thus empower, others.	**SOCIAL**
INTERACTING AND PRESENTING Communicates and networks effectively. Successfully persuades and influences others. Relates to others in a confident and relaxed manner.	**Relating and Networking** Easily establishes good relationships with customers and staff; relates well to people at all levels; builds wide and effective networks of contacts; uses humour appropriately to bring warmth to relationships with others.	**Q23 - 26**	**Networking ability**	Using deliberate strategies to influence or persuade others; uses key people as agents to accomplish objectives; acts to develop and maintain business contracts (Santandreu-Mascarell et al., 2013).	I often participate in social gatherings with people that I work with. I often attend social functions for purposes of building professional relationships. I often participate in community projects. I serve on a community board, committee or task force.	

ANALYSING AND INTERPRETING	Analysing					
Shows evidence of clear analytical thinking. Gets to the heart of complex problems and issues. Applies own expertise effectively. Quickly learns new technology. Communicates well in writing.	Analyses numerical data and all other sources of information, to break them into component parts, patterns and relationships; probes for further information or greater understanding of a problem; makes rational judgments from the available information and analysis; demonstrates an understanding of how one issue may be a part of a much larger system.	**Q27 – 42**	**Cognitive ability**	The ability to generate or use different sets of rules for combining or grouping things in different ways (Gray, 2016).	I am good at organising information. I am good at remembering information. I try to use strategies for my business that have worked in the past. I find myself using helpful learning strategies automatically. I use different learning strategies (plans of action) depending on the situation. I know when each strategy I use will be most effective. I take into consideration what I really need to learn before I begin a task. I think of several ways to solve a problem and choose the best one. I consciously focus my attention on important information. I draw pictures or diagrams to help me understand while learning. I ask myself periodically if I am meeting my goals. I ask myself if I considered all options when solving a problem. I change strategies when I fail to understand a task or problem at hand. I stop and go back over new information that is not clear. I ask myself if there was an easier way to do things after I finish a task. I ask myself how well I accomplished my goals once I'm finished.	Response to questionnaire **META**
		Q43 - 46	**Problem solving**	Demonstrates good analysis skills; Has the ability to prioritise problems; Can prioritise problems; Has good critical thinking skills; A problem solver (Dixon et al., 2005).	I have good analysis skills. I have the ability to prioritise problems. I have good critical thinking skills. (Critical thinking is the objective analysis and evaluation of an issue in order to form a judgement). I use information to make decisions.	**META**

CREATING AND CONCEPTUALIZING						
Open to new ideas and experiences. Seeks out learning opportunities. Handles situations and problems with innovation and creativity. Thinks broadly and strategically. Supports and drives organisational change.	**Creating and Innovating** Produces new ideas, approaches, or insights; creates innovative products or designs; produces a range of solutions to problems.	**Q47 - 51**	**Creative Problem Solving & Imaginativeness**	The ability to relate previously unrelated variables or objects to produce novel and appropriate or useful outcomes (Morris et al., 2013).	I am creative when asked to work with limited resources. I think outside the box. I identify opportunities for new services/products. Freedom to be creative is extremely important to me. Originality is very important to me.	Response to questionnaire **COGNITIVE**
		Q52 – 55	**Innovating/ Innovation**	Innovating: make changes in something established, especially by introducing new methods, ideas, or products. Innovation: Introduction, establishment, institution, commencement, novelty, departure from the old, introduction of new and improved methods and things, modernisation, drastic change, breaking of a precedent (Antonites, 2017).	I generate new innovations that differ from competitors' offering. I improve existing products and services. I exploit (use/utilize) innovations developed by others. I successfully implement creative ideas within my business.	**COGNITIVE**
		Q56 – 60	**Value creation**	Capabilities of developing new products, services, and/or business models that generate revenues exceeding their costs and produce sufficient user benefits to have a fair return (Morris et al., 2013).	I am constantly asking questions to understand why products and projects underperform. New business ideas often come to me when directly observing how people interact with products and services. I have a continuous flow of new business ideas that come through observing the world. I love to experiment to understand how things work. I love to create new ways of doing things.	**FUNCTIONAL**

ADAPTING AND COPING Adapts and responds well to change. Manages pressure effectively and copes with setbacks.	**Adapting and Responding to Change** Adapts to changing circumstances; tolerates ambiguity; accepts new ideas and change initiatives; adapts interpersonal style to suit different people or situations; shows an interest in new experiences.	**Q61 - 64**	**Resilience**	The ability to cope with disturbances and stresses in such a way that one remains well, recovers, or even thrives in the face of adversity (Morris et al., 2013).	I believe that I can grow in positive ways by dealing with difficult situations. I only set goals which I know I can reach without the help of others. I actively look for ways to replace the losses I encounter in life. I look for creative ways to alter difficult situations.	**COGNITIVE**
ENTERPRISING AND PERFORMING Focuses on results and achieving personal work objectives. Works best when work is related closely to results and the impact of personal efforts is obvious. Shows an understanding of business, commerce and finance. Seeks opportunities for self-development and career advancement.	**Achieving Personal Work Goals and Objectives** Accepts and tackles demanding goals with enthusiasm; works hard and puts in longer hours when necessary; seeks progression to roles of increased responsibility and influence; identifies own development needs and makes use of development-tal or training opportunities.	**Q65 – 68**	**Positive attitude**	An attitude is defined as "a mental position with regard to a fact or state; a feeling or emotion toward a fact or state." The dictionary goes on to state that the word "positive" can be used as "having a good effect; favourable; marked by optimism."	Being an entrepreneur implies more advantages than disadvantages for me. Being an entrepreneur provides great satisfaction for me. Among various employment options, I would rather be an entrepreneur.	**SOCIAL** Response to questionnaire
	Entrepreneurial and Commercial Thinking Keeps up to date with competitor information and market trends; identifies business opportunities for the organization; maintains awareness of developments in the organizational structure and politics; demonstrates financial awareness; controls costs and thinks in terms of profit, loss and added value.	**Q69 - 72**	**Opportunity recognition**	The capacity to perceive changed conditions or overlooked possibilities in the environment that represent potential profit or return to a venture (Morris et al., 2013).	I am an avid information seeker. I often make novel connections and perceive new or emergent relationships between various pieces of information. I often see connections between previously unconnected domains of information. I am good at "connecting dots".	**COGNITIVE**

APPENDIX H:

CONCEPTUAL AND OPERATIONAL DEFINITIONS AND CATEGORIES OF ENTREPRENEURIAL ACAP AND INNOVATION CAPACITY

INDIVIDUAL ABSORPTIVE CAPACITY					
THEORY LEVEL				RESEARCH LEVEL	
Conceptual Level	**Q**	**Conceptual Components (Constructs)**	**Conceptual Definitions**	**Operational Definitions (A set of questionnaire items**	**Observation Level**
Individual Absorptive Capacity	Q75-78	**Recognition**	To recognise the value of new external knowledge, such as searching for new knowledge, identifying it, and evaluating it as opportunities for potential beneficial use.	I am always actively looking for new knowledge for my business. I intentionally search for knowledge in many different domains by looking 'outside the box'. I am good at distinguishing between profitable opportunities and not-so-profitable opportunities. I easily identify what new knowledge is most valuable for the business.	Response to questionnaire
	Q70-81	**Assimilation**	Assimilation activities includes interpretation, articulation, and codification, are concerned with the individual acquiring knowledge which is transformed into organisational knowledge by making it understandable and transferable to organisation members	I frequently share my new knowledge with employees to establish a common understanding. I translate new knowledge in such a way that my employees understand what I mean. I communicate newly acquired knowledge that might be of interest for the business.	
	Q82-85	**Transformation**	Transformation relates to an organisation's capability to develop and refine the routines that facilitate the combining of existing knowledge and newly acquired and assimilated knowledge. Transformation as an individual AAP activity concerns the generation of new ideas in collaboration with others.	I often sit together with employees to come up with good ideas. I attend meetings with people from different departments to come up with new ideas. I develop new insights from knowledge that is available within the business. I can turn existing knowledge into new ideas.	
	Q86-88	**Exploitation**	From an organisational capability perspective, exploitation is based on the routines that allow organisations to refine, extend, and leverage existing competencies to create new ones by incorporating acquired and transformed knowledge into its operations. On individual level, exploitation is defined as one's activities to apply new knowledge in own work routines.	I often apply newly acquired knowledge to my business/work. I exploit new knowledge to create new products, services, or work methods. I constantly consider how I can apply new knowledge to come up with new ideas.	

INNOVATION CAPACITY					
THEORY LEVEL				RESEARCH LEVEL	
Conceptual Level	**Q**	**Conceptual Components (Constructs)**	**Conceptual Definitions**	**Operational Definitions (A set of questionnaire items)**	**Observation Level**
Innovation Capacity	Q89-95	**Newness**		The customers/potential customers are totally new to the business. The class of the product/service is totally new to the business. It is an improvement /modification of an existing product/service. The exploited technology is totally new to the business. The production process is totally new to the business. The competitive environment is totally new to the business. The product use (need served) is totally new to the business.	Response to questionnaire
	Q96, 97, 112, 113	**Radicalness**	Radical innovation: innovation that is new and different from what the competitors are doing.	The product/service is unlike any other. The product/service requires users to change their ways.	
	Q98-103	**Uniqueness and superiority**		It has a better "service outcome" than competitors' (end result). It has unique benefits and features – perceived as superior to competitors'. In terms of quality, the product/service provides a faster or more efficient service. In terms of quality, the product /service provides a more reliable service (fewer fail points). It has developed a "high quality" image. In terms of quality, it has better value than previously available products/service.	
	Q104-107	**Innovativeness**		It is a highly innovative product/service – there is nothing like it (it replaces the inferior alternative). It follows an innovation strategy rather than a follower strategy. It has radical changes rather than subtle differences. The product technology is new to the customer.	
	Q108-110	**Competitive advantage**		The extent of patent protection The extent of licence protection The ease of competitive duplication	
	Q111	**Market pioneering**		Was your business the first into the market with this type of product?	

APPENDIX I:
STANDARDIZED REGRESSION WEIGHTS AND CORRELATION OUTPUTS – CFA MODELS

Output for the original model for Cognitive Competencies

Correlations for cognitive competencies Model 1

			Estimate
Decision-Making	<-->	Proactiveness	.817
Decision-Making	<-->	Resilience Coping	.420
Decision-Making	<-->	Creative Problem-solving	.395
Decision-Making	<-->	Innovation/Innovating	.448
Decision-Making	<-->	Opportunity Recognition	.310
Use of Social Supp	<-->	Decision-Making	.144
Proactiveness	<-->	Resilience Coping	.615
Proactiveness	<-->	Creative Problem-solving	.570
Proactiveness	<-->	Innovation/Innovating	.596
Proactiveness	<-->	Opportunity Recognition	.353
Use of Social Supp	<-->	Proactiveness	.237
Resilience Coping	<-->	Creative Problem-solving	.850
Resilience Coping	<-->	Innovation/Innovating	.892
Resilience Coping	<-->	Opportunity Recognition	.651
Use of Social Supp	<-->	Resilience Coping	.500
Creative Problem-solving	<-->	Innovation/Innovating	.896
Creative Problem-solving	<-->	Opportunity Recognition	.700
Use of Social Supp	<-->	Creative Problem-solving	.261
Innovation/Innovating	<-->	Opportunity Recognition	.684
Use of Social Supp	<-->	Innovation/Innovating	.306
Use of Social Supp	<-->	Opportunity Recognition	.202

Standardized Regression Weights Model 1

			Estimate
Q12	<---	Decision-Making	.820
Q11	<---	Decision-Making	.760
Q18	<---	Proactiveness	.619
Q16	<---	Proactiveness	.787
Q15	<---	Proactiveness	.764
Q64	<---	Resilience Coping	.754
Q61	<---	Resilience Coping	.627
Q13	<---	Decision-Making	.791
Q14	<---	Decision-Making	.843
Q51	<---	Creative Problem-sol	.613
Q50	<---	Creative Problem-sol	.768
Q49	<---	Creative Problem-sol	.749
Q48	<---	Creative problem-sol	.706
Q55	<---	Innovation/Innovating	.694
Q54	<---	Innovation/Innovating	.400
Q53	<---	Innovation/Innovating	.732
Q52	<---	Innovation/Innovating	,732
Q71	<---	Opportunity Recogni	.865
Q70	<---	Opportunity Recogni	.865
Q69	<---	Opportunity Recogni	.676
Q17	<---	Proactiveness	.748
Q63	<---	Use of Social Supp	1.048
Q62	<---	Use of Social Supp	.449
Q47	<---	Creative Problem-sol	.701
Q72	<---	Opportunity Recogni	.759

Output for final Cognitive Competencies measurement model

Correlations for cognitive competencies Model 2

			Estimate
Decision-Making	<-->	Proactiveness	.816
Decision-Making	<-->	Innovation	.430
Decision-Making	<-->	Opportunity Recognition	.309
Use of Social Supp	<-->	Decision-Making	1.63
Proactiveness	<-->	Innovation/Innovating	.605
Proactiveness	<-->	Opportunity Recognition	.354
Use of Social Supp	<-->	Proactiveness	.267
Innovation/Innovating	<-->	Opportunity Recognition	.702
Use of Social Supp	<-->	Innovation	.372
Use of Social Supp	<-->	Opportunity Recognition	.227

Standardized Regression Weights Model 2

			Estimate
Q12	<---	Decision-Making	.820
Q11	<---	Decision-Making	.761
Q18	<---	Proactiveness	.619
Q16	<---	Proactiveness	.785
Q15	<---	Proactiveness	.762
Q13	<---	Decision-Making	.791
Q14	<---	Decision-Making	.843
Q55	<---	Innovation/Innovating	.667
Q53	<---	Innovation/Innovating	.683
Q52	<---	Innovation/Innovating	.724
Q71	<---	Opportunity Recognition	.867
Q70	<---	Opportunity Recognition	.864
Q69	<---	Opportunity Recognition	.675
Q17	<---	Proactiveness	.752
Q63	<---	Use of Social Support	.754
Q62	<---	Use of Social Support	.584
Q72	<---	Opportunity Recognition	.759
Q51	<---	Innovation/Innovating	.634
Q50	<---	Innovation/Innovating	.744
Q49	<---	Innovation/Innovating	.735
Q48	<---	Innovation/Innovating	.669
Q47	<---	Innovation/Innovating	.683
Q64	<---	Innovation/Innovating	.666

Output of model 2 for Social Competencies

Correlations for cognitive competencies Model 2

			Estimate
Leadership	<-->	Networking	.642
Positive attitude	<-->	Networking	.270
Leadership	<-->	Positive attitude	.512

Standardized Regression Weights Model 2

			Estimate
Q66	<---	Positive attitude	.818
Q65	<---	Positive attitude	.732
Q25	<---	Networking	.578
Q24	<---	Networking	.788
Q23	<---	Networking	.759
Q22	<---	Leadership	.602
Q21	<---	Leadership	.720
Q20	<---	Leadership	.456
Q67	<---	Positive attitude	.815
Q68	<---	Positive attitude	.806

Output of model 2 for Functional Competencies

Covariances for functional competencies Model 2

			Estimate
e12	<-->	e11	.555

Standardized Regression Weights Model 2

			Estimate
Q66	<---	Positive attitude	.818
Q60	<---	Value Creation	.579
Q59	<---	Value Creation	.579
Q58	<---	Value Creation	.821
Q57	<---	Value Creation	.821
Q56	<---	Value Creation	.641

Output of model 2 for Meta Competencies

Correlations for meta competencies Model 2

			Estimate
Regulation of Cognition	<-->	Problem-Solving	.670
Knowledge of Cognition	<-->	Regulation of Cognition	.795
Knowledge of Cognition	<-->	Problem-Solving	.757
e7	<-->	e6	.433

Standardized Regression Weights Model 2

			Estimate
Q42	<---	Regulation of Cognition	.633
Q41	<---	Regulation of Cognition	.501
Q40	<---	Regulation of Cognition	.602
Q46	<---	Problem-Solving	.619
Q45	<---	Problem-Solving	.792
Q44	<---	Problem-Solving	.728
Q43	<---	Problem-Solving	.752
Q34	<---	Knowledge of Cognition	.738
Q35	<---	Knowledge of Cognition	.709
Q27	<---	Knowledge of Cognition	.679
Q28	<---	Knowledge of Cognition	.604
Q29	<---	Knowledge of Cognition	.580
Q30	<---	Knowledge of Cognition	.701
Q31	<---	Knowledge of Cognition	.757
Q32	<---	Knowledge of Cognition	.651
Q33	<---	Knowledge of Cognition	.622
Q37	<---	Regulation of Cognition	.706
Q38	<---	Regulation of Cognition	.759
Q39	<---	Regulation of Cognition	.543

Output of the model for EACAP

Correlations for ACAP Model 1

			Estimate
Recognition	<-->	Assimilation	.715
Recognition	<-->	Transformation	.926
Exploitation	<-->	Recognition	.917
Exploitation	<-->	Transformation	.926
Assimilation	<-->	Transformation	.822
Exploitation	<-->	Assimilation	.609
e22	<-->	e21	.589
e29	<-->	e28	.524
e30	<-->	e29	.221

Standardized Regression Weights first order Model

			Estimate
Q76	<---	Recognition	.630
Q75	<---	Recognition	.667
Q81	<---	Assimilation	.839
Q80	<---	Assimilation	.817
Q79	<---	Assimilation	.785
Q85	<---	Transformation	.777
Q84	<---	Transformation	.748
Q83	<---	Transformation	.566
Q82	<---	Transformation	.619
Q88	<---	Exploitation	.843
Q87	<---	Exploitation	.826
Q86	<---	Exploitation	.887
Q78	<---	Recognition	.719

Table: Output of the model for EACAP second-order model

Correlations for EACAP second order Model

			Estimate
e22	<-->	e21	.589
e29	<-->	e28	.543
e30	<-->	e29	.225

Standardized Regression Weights second order Model

			Estimate
Recognition	<---	AC	.954
Assimilation	<---	AC	.735
Transformation	<---	AC	1.022
Exploitation	<---	AC	.918
Q76	<---	Recognition	.628
Q75	<---	Recognition	.670
Q81	<---	Assimilation	.845
Q80	<---	Assimilation	.810
Q79	<---	Assimilation	.785
Q85	<---	Transformation	.809
Q84	<---	Transformation	.735
Q83	<---	Transformation	.536
Q82	<---	Transformation	.568
Q88	<---	Exploitation	.840
Q87	<---	Exploitation	.825
Q86	<---	Exploitation	.890
Q78	<---	Recognition	.718

Output of the model for IC

Correlations for the IC Model

			Estimate
Radicalness	<-->	Newness	.715
Uniqueness and Superiority	<-->	Newness	.386
Innovation	<-->	Newness	.564
Competitive Advantage	<-->	Newness	.314
Radicalness	<-->	Uniqueness and Superiority	.684
Radicalness	<-->	Innovation	.895
Radicalness	<-->	Competitive Advantage	.451
Uniqueness and Superiority	<-->	Innovation	.740
Uniqueness and Superiority	<-->	Competitive Advantage	.365
Innovation	<-->	Competitive Advantage	.500

Standardized Regression Weights

			Estimate
Q102	<---	Uniqueness and Superiority	.648
Q101	<---	Uniqueness and Superiority	.793
Q100	<---	Uniqueness and Superiority	.84
Q99	<---	Uniqueness and Superiority	.857
Q107	<---	Innovation	.801
Q106rev	<---	Innovation	-.881
Q105rev	<---	Innovation	-.869
Q104	<---	Innovation	.869
Q109	<---	Competitive Advantage	.755
Q108	<---	Competitive Advantage	.900
Q89	<---	Newness	.572
Q90	<---	Newness	.751
Q92	<---	Newness	.800
Q93	<---	Newness	.815
Q94	<---	Newness	.800
Q95	<---	Newness	.826
Q96	<---	Radicalness	.853
Q97	<---	Radicalness	.664
Q103	<---	Uniqueness and Superiority	.841
Q98	<---	Uniqueness and Superiority	.857

Output of the second-order model for IC

Standardized Regression Weights second order Model

			Estimate
Newness	<---	IC	.628
Radicalness	<---	IC	.953
Uniqueness and Superiority	<---	IC	.748
Innovation	<---	IC	.951
Competitive Advantage	<---	IC	.507
Q102	<---	Uniqueness and Superiority	.648
Q101	<---	Uniqueness and Superiority	.794
Q100	<---	Uniqueness and Superiority	.804
Q99	<---	Uniqueness and Superiority	.857
Q107	<---	Innovation	.804
Q106rev	<---	Innovation	-.881
Q105rev	<---	Innovation	-,866
Q104	<---	Innovation	.870
Q109	<---	Competitive Advantage	.758
Q108	<---	Competitive Advantage	.896
Q89	<---	Newness	.570
Q90	<---	Newness	.748
Q92	<---	Newness	.805
Q93	<---	Newness	.818
Q94	<---	Newness	.798
Q95	<---	Newness	.823
Q96	<---	Radicalness	.850
Q97	<---	Radicalness	.666
Q103	<---	Uniqueness and Superiority	.840
Q98	<---	Uniqueness and Superiority	.857

APPENDIX J:
FOURTH INDUSTRIAL REVOLUTION FIELD OF OPERATION

Field	Frequency	%	Field	Frequency	X
None	24	5.3%	Finance	3	0.7%
Manufacturing	35	**7.7%**	Change Management	1	0.2%
Pharmaceuticals	5	1.1%	Accounting	6	1.3%
Finance (block chain)	17	**3.8%**	Procurement	1	0.2%
Retail	11	2.4%	Information Technology	13	**2.9%**
Healthcare	10	2.2%	Import and Export	1	0.2%
Law	5	1.1%	Construction	10	2.2%
Human Resources	2	0.4%	Non Profit	1	0.2%
Real Estate	8	1.8%	Services	6	1.3%
Communication	13	**2.9%**	Insurance	1	0.2%
Supply Chain	4	0.9%	Mechanics	1	0.2%
Training and Development	7	1.5%	Logistics	1	0.2%
Incubation	1	0.2%	Franchising	2	0.4%
Education	11	2.4%	Transport	3	0.7%
Maintenance	1	0.2%	Telecommunications	1	0.2%
Agriculture	8	1.8%	Engineering	3	0.7%
Geography	1	0.2%	Music and Film	1	0.2%
Consulting	10	2.2%	Data Analytics	3	0.7%
Research	1	0.2%	Beauty	1	0.2%
Electronics	1	0.2%	Recycling	3	0.7%
Bioenergy	6	1.3%	Clothing/Fashion	2	0.4%
Tourism	1	0.2%	Jewellery	3	0.7%