SCHOOL OF BUSINESS SCIENCES

Research Report

THE EFFECTS OF INNOVATION CAPABILITIES ON THE BUSINESS VALUE OF SOFTWARE

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DECLARATION

I, Rael Mathew Williamson, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Commerce in the field of Information Systems at the University of the Witwatersrand, Johannesburg.

It has not been submitted before for any degree or examination in this or any other university.

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ABSTRACT

Purpose: The purpose of this research report is to investigate how innovation capabilities in software development affect the business value of software. This was achieved by drawing on the resource-based view of the firm to develop and test a research model to understand the relationships between innovation capabilities, the business value of the associated software, and its subsequent contributions to firm performance outcomes. The three selected innovation capabilities investigated in this study were agility, collaboration, and creativity.

Design / Methodology / Approach: The research study applied a relational cross-sectional survey research design and strategy. Through the lens of a positivist researcher, the study proceeded to deductively measure the effects of Innovation Capabilities on the Business Value of Software using new empirical data collected via a structured questionnaire instrument from a sample of 54 senior software professionals across several countries. The statistical relationship between the constructs was analyzed using correlation and multiple regression techniques. The findings show that Innovation Capabilities have a positive effect on Business Value of Software. Collaboration expressed the strongest relationship to the overall construct of Business Value of Software and strongly correlated with the individual dimensions of value and rarity. Agility is strongly related with both rarity and non-substitutability / immobility, with results also indicating a relationship with overall Business Value of Software. Creativity did not show a positive relationship to the overall Business Value of Software. Furthermore, the results show that Business Value of Software is important for Strategic and Customer Benefits.

Originality / Value: The study makes a novel contribution by applying the resource-based view of the firm to link innovation capabilities in software development with performance outcomes. The results provide researchers and organisations a better understanding of which innovation capabilities are most important and the mechanisms through which they improve software's business value.

Practical implications: There has been an increase in the popularity of 'hackathons', 'incubators', 'accelerators', and 'innovation labs' as a means for organisations to improve innovation. By identifying innovation capabilities and their relationship with the development of valuable software, this research helps practitioners better understand which innovation capabilities are most important and therefore better focus their energy on implementing interventions to develop these capabilities.

1. CHAPTER 1 – INTRODUCTION

1.1. Background

The digital era has seen an increase in disruptive technologies, changing customer behaviour and increasing uncertainty (Bughin and Van Zeebroeck, 2017). This has led to increased customer expectations for new products and services, which in turn has given rise to new industries and technology-driven business models (Quinney, 2015). The changing environment has caused concern for organisations as they struggle to keep up with the rapid pace of change (Clark, 2003). As a result, the chief information and technology officers of organisations are in the spotlight to deliver end-to-end digital transformation to drive competitive advantage and improve profitability (Kark, 2016; Quinney, 2015). Chief Information Officers (CIO) have ranked innovation as one of their top priorities as they are being forced to find new ways of doing business and providing new products (Kark, 2016). The inclusion of IT across the entire organisation and the importance of innovation have led many organisations to develop software as a method to foster innovation for internal and external stakeholders (Aaen, 2008). Software development within organisations is expected to contribute to technical innovation and product renewal (Koc, 2007). As a result, in-house software development has become one of the largest contributors of corporate expenditure (Pattit and Wilemon, 2005). This has led CIOs to actively invest in new methods to ensure the successful development of valuable technology-based products (Capgemini, 2017; Pattit and Wilemon, 2005).

1.1.1. Developing valuable software

As organisations shift their focus towards software driven innovation, they are faced with the decision of where to focus their efforts. As software has evolved, the application of technology as a driver of business has seen the rise of technology-focused areas such as mobile applications, big data and cloud-based software development (Capgemini, 2017). These changes mean that organisations are not only focused on creating software for internal use, but are also using software as a means to offer value to external customers (Quinney, 2015). In most cases, the decision to innovate is often taken to gain competitive advantage (Khurum et al., 2013). Although internally-focused software such as Enterprise and Business Intelligence applications are considered commodity software, they can yield business value through superior operational capabilities (Duan and Xu, 2012). On the other hand, externally-focused applications such as those found in mobile banking, communication and entertainment have been shown to strengthen customer engagement, increase brand loyalty and improve customer experience (Kim and Baek, 2018). Thus, innovation in both internally- and externally-focused software can deliver valuable outcomes.

Organisations focusing on developing these software innovations are, however, concerned with the ability to protect their newly developed knowledge as these innovations are required to produce future revenues and provide return on investments (Khurum et al., 2013; Liebeskind, 1996). Organisations that focus on in-house software development maintain complete control over their projects and the protection of confidential information which improves the ability to protect their knowledge (Aitzaz et al., 2016). However, the high cost associated with these activities and the inherent uncertainty of their success increase the associated risks while at the same time making the even distribution of these innovations across firms more unlikely (Liebeskind, 1996). Therefore, firms with better developed innovation capabilities are more likely to succeed and enjoy the advantages. The term Ricardian Rent is used to describe the surplus in earnings above the costs of a resource which is directly associated with the scarcity of the resource (Liebeskind, 1996). Through the concept of Ricardian rents an organisation that has developed superior innovation ability and knowledge can produce unique products and services, while reducing the observability of their underlying product knowledge and decreasing the risk of imitation by competitors (Liebeskind, 1996). Thus, organisations have been seeking new ways to develop superior innovation ability and knowledge.

1.1.2. Fostering innovation ability

Increasingly, organisations are faced with the challenge of fostering innovation ability. One possible solution that has emerged in recent years is the use of 'innovation labs' as a means to drive innovation (Capgemini, 2017). Innovation labs are identified as workspaces that are physically removed from normal working environments, providing low- and high-end technology infrastructure as well as facilitation in the hopes of increasing the ability of an organisation to innovate.

Innovation labs have been associated with three attributes in literature, these being: improved collaboration, creativity and agility (Cocu et al., 2015; Fecher et al., 2018; Lewis and Moultrie, 2005; Magadley and Birdi, 2009; Memon et al., 2018). Collectively, these attributes can be considered innovation capabilities which are intended to be fostered by innovation labs, among other examples of interventions such as 'incubators' and 'accelerators' (Capgemini, 2017).

Organisations foster these innovation capabilities to develop valuable software with the intention of driving increased revenues (Capgemini, 2017). However, these innovation capabilities are not solely the biproduct of innovation labs, nor are they proven to develop valuable software within the organisation. For this reason, it is important to understand how these capabilities may affect the development of innovative and valuable software. Without fully understanding the effects of innovation capabilities on the development of software, organisations run the risk of investing in software development practices that do not result in any business value, a problem facing many organisations (Clark, 2003).

1.2. Problem Statement

The aforementioned growth in the use of technology has caused IT departments to focus on developing revenue-generating technology to drive competitive advantage and improve profitability (Kark, 2016). Although technology has created new industries and helped companies differentiate from their competition, not all technology is guaranteed to lead to a competitive advantage (Quinney, 2015). It is for this reason that companies need to focus on creating valuable software that is differentiable from their competition. An organisation that can create innovative software is in a better position to produce future revenues and provide return on investments (Liebeskind, 1996). In order to achieve these goals, organisations have been seeking new ways to drive innovation in their software development teams. Extant literature in the innovation field suggests that collaboration, creativity, and agility could be important innovation capabilities. Yet, their significance for the development of advantage-creating software has not been empirically confirmed. Understanding how these innovation capabilities affect the development of valuable software may assist IT departments in deciding how to allocate resources to improve innovation in software development teams.

1.3. Purpose of the Study and Research Question

The purpose of this research is to investigate how three selected innovation capabilities, namely collaboration, creativity, and agility, affect the business value of developed software. To fill this gap, the research draws on the resource-based view of the firm to develop and test a research model to understand the relationship between innovation capabilities and the business value of the associated software in terms of value, rarity, inimitability, non-substitutability, and immobility.

The overall research question for this investigation is:

> **What are the effects of a firm's innovation capabilities in software development on the business value of their software?**

1.4. Intended Contributions of the Study

1.4.1. Contributions to Theory

This research identified that there is limited, and non-specific literature associated with the relevant dimensions of innovation capabilities and what their contributions are to software delivery. This research overcomes this issue by identifying innovation capabilities and their relationship with the development of valuable software. Specifically, the study draws on the innovation literature to introduce three dimensions of software innovation capability, namely collaboration, creativity, and agility. Collaboration, as defined in this study, is the increase in teaming over individual work (Brettel et al., 2011; Cockburn and Highsmith, 2001; Kahn, 2018; Schweitzer and Gabriel, 2012). Creativity is focused on the ability to develop new products and services as well as solving problems in a novel way (Basadur and Gelade, 2006; Magadley and Birdi, 2009; Schweitzer and Gabriel, 2012). Agility is the ability to display high levels of effectiveness through efficiency, adaptability, and flexibility (Cockburn and Highsmith, 2001; Misra et al., 2009; Sampietro, 2016; Vickery et al., 2010; Winter, 2014). Moreover, their effects on the business value of software are conceptualised in terms of the resource-based view of the firm (Nevo and Wade, 2011), and described through the value, rarity, inimitability, non-substitutability, and immobility of the developed software. By showing that innovation capabilities can promote software value, this study contributes a better understanding of why innovation capabilities are important and the mechanisms through which they affect the outcomes of software development within organisations. The research further demonstrates the utility of the resource-based view of the firm as a lens through which to study the business value of software. Ultimately, the results will provide a means to measure the effects of innovation capabilities on the business value of software developments.

1.4.2. Contributions to Practice

The implications for practitioners are equally as prosperous. Firms are seeking to improve and innovate at a rapid pace to keep up with the changing business landscape. There has been an increase in popularity of hackathons, incubators, accelerators, and innovation labs over the years as means for organisations to innovate. However, little is understood on how innovation capabilities derived from some of these initiatives benefit the firm, and thus the research model offers a means to understand innovation capabilities and how they affect the outcomes of software development. This is particularly important as organisations can focus their energy on developing innovation capabilities with an understanding of how these outcomes can affect the value of software developments.

1.5. Delimitations of the Study

Delimitations are used to define the boundaries of coverage for the intended research study. The following delimitations have been considered:

- The study will focus on firms sampled from various countries globally.
- The study will focus on medium to large organisations across sectors (cross-industry) that have established software development teams.
- The study will focus on key informants that are senior or manage software development teams within their respective firms as they will be most informed about innovation capabilities as well as the value of the software they produce.

1.6. Structure of the Report

Chapter one introduced the research report, detailing the issues associated with driving business value of software using innovation capabilities, why it is important to understand these innovation capabilities and how they affect the outcomes of software developments. The introduction defined the research problem, the purpose of the study along with the research question, contributions to theory and practice and finally the delimitations of the study.

Chapter two focuses on the literature review regarding the determinants of innovation in software development. The section includes an overview of innovation, innovative software, innovation capabilities and software development as well as software value. Finally, the theoretical background, past applications, and research model are presented along with the hypotheses.

Chapter three involves defining the research design of the study. This involves defining the elements that will be followed to ensure the research has been conducted appropriately. This includes defining an appropriate research method, data collection method as well as appropriate data analysis methods.

Chapter four presents the results of the data analysis. Data is screened and the research instrument is reviewed for validity and reliability. Finally, correlation and regression analyses are performed to test the hypothesis and the results are briefly discussed.

Chapter five focuses on discussing the findings of the study in detail. This involves interpreting and discussing the research question and hypothesis associated with the findings from the study.

Chapter six concludes the study by summarising the findings, acknowledging the research limitations, and outlining implications for future research and practice.

2. CHAPTER 2 – LITERATURE REVIEW

The purpose of this chapter is to review the literature associated with the determinants of innovation in software development. The chapter first reviews literature for the purpose of developing an understanding of innovation. Thereafter the chapter discusses how software is considered innovative, innovation capabilities in software development and how software is determined as valuable. The resource-based view (RBV) of the firm along with past applications of RBV are introduced. Finally, the conceptual model and hypotheses are presented.

2.1. Understanding Innovation

The definition of innovation is considered widely misunderstood (Kahn, 2018; Kogabayev and Maziliauskas, 2017). The term innovation has become pervasive and ubiquitous, being included in product marketing as well as organisational mission statements (Kahn, 2018), and this has resulted in the definition varying considerably depending on the context in which it is used. However, it is generally regarded that greater innovation is an essential means of overcoming difficulties or improving organisational outcomes (Grego-Planer and Kus, 2020). One definition, provided by The Organisation for Economic Co-operation and Development (OECD), defines innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (Organisation for Economic Co-operation and Development, 2009). Thus, innovation can be viewed as the introduction of something new, a new method or a new idea which requires innovation to be thought of as both an outcome and a process (Kahn, 2018; Kogabayev and Maziliauskas, 2017; Organisation for Economic Co-operation and Development, 2009).

Innovation as an outcome is mainly associated with the introduction of new or significantly improved products and services (Kahn, 2018; Kogabayev and Maziliauskas, 2017; Organisation for Economic Co-operation and Development, 2009). In this regard, the outcome of innovation is important for organisations who expect organisational growth following an investment in innovation projects (Kogabayev and Maziliauskas, 2017). Innovation outcomes can be further broken down into product, process, marketing, business model, supply chain and organisational innovation (Kahn, 2018). Since innovation may range in intensity, different types of products and services may arise. These products may lead to cost reductions, product improvement, line extensions, new markets, new uses, new categories and potentially "new to world" products. The product-market matrix is shown in figure 1. This figure describes how each of the different product types may arise as a result of markets and product technology (Kahn, 2018; Kogabayev and Maziliauskas, 2017).

Product Technology

Market		Current	New
	Current	**Market Penetration** (Product Improvement, Cost/Price Change)	**Product Development** (Line Extensions)
	New	**Market Development** (New Uses, New Market)	**Diversification** (New Categories, New to World)

Figure 1. The Product-Market Matrix (Kahn, 2018, p. 4)

Innovation as a process is different to the outcomes of innovation and cannot be overlooked. Innovation outcomes are directly related to and dependant on innovation processes. There are many models to describe the innovation process, however, most of these models are variations of the ‘discover, develop and deliver’ model outlined by the Product Development and Management Association (PDMA) (Grego-Planer and Kus, 2020; Kahn, 2018; Kogabayev and Maziliauskas, 2017). The discover phase involves idea generation and management where ideas are assessed as a potential opportunity (Dziallas and Blind, 2019; Kahn, 2018). Any promising ideas found through the discover phase then enter the develop phase where the idea is then transformed into an actual product or service. Lastly, the deliver phase involves the execution and production of the developed product for delivery into the hands of customers (Dziallas and Blind, 2019; Kahn, 2018). In addition to the discovery, development, and delivery of innovation, measuring the impact and success of the innovation are important when determining return on investment (ROI) (Dziallas and Blind, 2019). There are several measures which can be used to determine the value of innovation, these being the number of new products, improvement of processes and methods, ratio of innovative products sold versus total products in the respective product market as well as the number of new patents (Kogabayev and Maziliauskas, 2017).

In more recent research, innovation has become synonymous with the use of technology as a means to produce innovation (Grego-Planer and Kus, 2020). The application of technology has altered the way in which organisations and teams work to build and develop innovative products and services, many of which are technologies themselves. This has led to organisations focusing on outcomes and processes from a technology point of view.

2.2. Innovative Software

As the world has become more digital, so have the processes and outcomes associated with innovation (Hinings et al., 2018). The term digital innovation has been used to describe innovation that makes use of digital technology as a means of innovation (Hinings et al., 2018). Nowadays innovation has become synonymous with the use of technology, where technology has become embedded in almost all modern processes (Kogabayev and Maziliauskas, 2017), and it has become difficult to find an innovation that does not make use of technology at the core (Lundvall and Borrás, 2004).

Powering new innovative technologies requires modern software systems. These modern software systems cannot be understood solely from the perspective of the software itself. Software and hardware have become intertwined, with software defining the hardware, which ultimately leads to innovation (Alt et al., 2020). Software is becoming more embedded, complex and feature rich (Alt et al., 2020). Embedding complex connected systems into physical objects allows these objects to be transformed and experienced as software products (Alt et al., 2020). Tesla is an example of how a physical vehicle has been transformed into a software product. Tesla has simplified the production process of vehicles, by applying advanced fabrication processes to reduce costs and improve production capabilities. On the other hand, while Tesla has reduced the complexity of its production process it has produced a complex software product, allowing customers to receive software updates "over-the-air" that enhance their vehicles (Alt et al., 2020). The process of enhancing physical objects has in turn led to TV's, speakers and other devices being complemented with services such as Google Home, Alexa, or Netflix. These objects have been transformed into smart devices through the incorporation of software and services (Alt et al., 2020). In some cases, software has led to the replacement of physical objects. This was seen early on with answering machines, fax machines, CD's and many other physical devices being completely replaced with an equivalent software product (Alt et al., 2020).

It was common for many companies to rely on traditional product improvement methods such as the reduction of cost, improved speed of production as well as improved product quality as key differentiators from their competition (Edison et al., 2018). However, the world has evolved, and the internet age has made these previous methods insufficient. Instead, companies are now competing on a global scale with new technological innovations which have opened the doors for new markets and products (Edison et al., 2018). Through the use of technology innovation, new entrant companies have been able to challenge market leaders and leapfrog competition (Edison et al., 2018). This has been seen with companies such as Uber, Airbnb and Spotify which have grown rapidly on the back of technology innovation (Edison et al., 2018).

While Uber, Airbnb and Spotify represent new digital business models, their product is delivered using technology, specifically software. These businesses make use of mobile apps and websites to sell their products (Edison et al., 2018; Kahn, 2018). There are many more companies that sell software or products that are dependent on technology. These companies include most of the highest valued companies such Microsoft, Google, Apple, Netflix, Amazon, and Facebook. These companies may sell different products, but they rely on their technologies to differentiate themselves from their competition (Pisal, 2021). In some cases, their technology may make their competition obsolete, such as the emergence of e-commerce which has challenged many traditional brick and mortar stores. Many companies have been able to truly differentiate themselves further during the Covid-19 pandemic lockdowns throughout 2020 and 2021 through online business and virtual social engagement (Pisal, 2021). The changing landscape has clearly put organisations under increasing pressure to apply digital technologies to renew and transform their business models (Kohli and Melville, 2019). Most of the products consumers engage with are the outcomes of innovation, such as the software apps and websites deployed by companies. Consequently, there has been significant effort in understanding and developing processes and methods for developing innovative software (Kohli and Melville, 2019).

With the growing use of technology and software, organisations are left with no choice but to innovate and adapt to the changing market, a market which expects products and services to be offered through the use of software (Edison et al., 2018; Hinings et al., 2018). As competition increases, more companies will begin to implement software and technology innovations. In doing so, these companies will be required to develop and better understand the processes that are involved in developing digital innovations and better understand the capabilities required for the innovation of software.

2.3. Innovation Capabilities and Software Development

To better understand the current literature on innovation capabilities in software development, a systematic review of the literature was carried out. The specific focus of the review was to identify specific innovation capabilities that may be important for software development as well as the outcomes associated with innovation in software development, such as from the use of innovation labs. The initial database sources were chosen based on reputation, these being ScienceDirect and ProQuest. Google Scholar was used to identify other journal sources that may not have been included in the initial databases selected. The Google Scholar search found journals not contained within ScienceDirect and ProQuest. Because of the findings from Google Scholar, Wiley Online Library database was included as a database. Backward searching was also performed to increase the number of papers considered in the literature review. The backward search on identified papers became another source of data.

The initial search string used across the data sources is summarised in Table 1. Synonyms were also considered to provide a more robust search string and ensure that the initial search was broad enough to include a multitude of results. When performing the database search, the inclusion criteria was limited to peer reviewed journal papers, title search, abstract search and papers that were published in English. There was a considerable reduction in the number of papers when considering the abstract and title search. The same search methodology was applied to all data sources identified, resulting in the same search terms and inclusion criteria.

Table 1. Search Criteria

		Results
Step 1	Search terms used ("innovation lab" OR "innovation labs" OR "innovation laboratory" OR "innovation laboratories" OR “innovation capabilities”) AND ("organizations" OR "organisations") AND ("outcome" OR “outcomes” OR "success" OR “effect” OR “effects” OR "impacts")	4845
Step 2	"living labs" removed from above search	4740
Step 3	Abstract and title search	336
Step 4	Inclusion Criteria: peer reviewed journals, full text, English	8
Step 5	Backward Search	14

Once the initial batch of papers (n=4740) were identified, a review of the titles and abstracts was conducted. The exclusion criteria applied removed any papers associated with "living labs" and papers that were not related to organisations. This resulted in 336 papers being identified for detailed full text examination. The papers' full texts were reviewed for relevance and quality, reducing the number of papers to eight (8). Finally, an additional six (6) papers were identified through a backward search of the eight (8) papers. A total of fourteen (14) papers were retained and are summarised in detail. A summary of each paper's key contributions is presented in Table 2.

Table 2. Summary of identified articles

Reference	**Title**	**Key Contributions**
Magadley and Birdi (2009)	Innovation Labs: An Examination into the Use of Physical Spaces to Enhance Organizational Creativity	The study found that the use of high-tech tools, such as brainstorming software and tools that promote anonymity were able to encourage cognitive stimulation, which directly improves creativity and building on the ideas of others. The tools were able to decrease the fear of criticism and encourage the sharing of ideas regardless of position within the organizational hierarchy. The study also found that group problem solving is considered important as it may increase and improve group productivity and effectiveness.
Fecher et al. (2018)	Innovation labs from a participants' perspective	In their study, the researchers found that traditional innovation approaches are well suited to predictable environments, however they break down under dynamic market conditions. They found that Innovation Labs have come to the forefront of agile orientated innovation, however, these spaces must provide sufficient financial and technical resources to allow participants to acquire materials, obtain access to external know-how, and outsource certain activities in a quick and uncomplicated manner which is essential to providing the organization with the means to be agile and increase the speed of innovation.
Memon et al. (2018)	Inter-InnoLab collaboration: An investigation of the diversity and interconnection among Innovation Laboratories	In this study, the researchers observed that the removal of a formal working environment resulted in teaming over individual work to find solutions to challenges and problems. These results in turn improved the creation and sharing of new ideas.
Cocu et al. (2015)	Stimulating Creativity through Collaboration in	The study explored the role of collaborative software and how it assisted in breaking down traditional hierarchies, allowing participants to

	an Innovation Laboratory	share their ideas honestly, which was linked to improved creativity and idea generation. The use of collaborative software provides tools which were found to help guide and streamline creative processes in groups.
Lewis and Moultrie (2005)	The Organizational Innovation Laboratory	This study presented a general framework to describe the characteristics of innovation spaces as well as the perceived benefits in terms of dynamic capability and double loop learning. The framework is then used to analyse findings from several “real world” use cases. The findings highlighted the importance of context specific applications of innovation labs and the operating context, where the problem is well suited to the setting.
Osorio et al. (2019)	Design and management of innovation laboratories: Toward a performance assessment tool	Osorio et al. present an updated framework to study the processes of creation and use of innovation spaces to support innovation in driving strategic intention. The main takeaway from the study is the ability to address and understand the capabilities of innovation laboratories.
Saunila and Ukko (2012)	A conceptual framework for the measurement of innovation capability and its effects	In this paper, a conceptual model is presented to measure the cause-and-effect relationship between innovation capabilities and firm performance. The study identified innovation potential as being composed of organisational structure, culture, collaboration, and creativity.
Dervitsiotis (2010)	A framework for the assessment of an organisation's innovation excellence	Dervitsiotis presents a framework for a holistic view of innovation management. The framework looks at the entire innovation process in firms, using the firm’s innovation capability profile to inform how innovation occurs in the firm allowing management insight into areas of improvement. The framework developed describes organisational culture and employee participation as key enablers of a firm’s innovation capability. Organisational culture is associated with the providing creative interactions, knowledge sharing and collaboration with others.
Cockburn and Highsmith (2001)	Agile Software Development: The People Factor	This paper discusses the importance of people in the process of Agile software development. The focus is on individual and team competence within an agile ecosystem. The paper posits that agile development excels in

		exploratory problem solving and works best with a people centred approach.
Sampietro (2016)	The Adoption and Evolution of Agile Practices	In this paper, the researcher studied the dominant agile practices most adopted and how internal and external characteristics of the organisation affected these choices. The outcomes showed that agile practices were mostly aligned with managerial tasks.
Basadur and Gelade (2006)	The Role of Knowledge Management in the Innovation Process	In this study, the researchers discuss the role of organizational thinking and organisational effectiveness in the use of knowledge as a means to drive innovation. Innovative organisations do well to use knowledge creatively to drive innovation. The researchers present a model to develop towards mainstream innovation.
Schweitzer and Gabriel (2012)	Action at the front end of innovation	In their paper, Schweitzer and Gabriel look at the impact of creativity, knowledge gathering and collaboration on the success of new product development. Their findings show that the quality of collaboration is important for both efficiency and effectiveness of front-end innovation.
Inoue and Liu (2015)	Revealing the Intricate Effect of Collaboration on Innovation	The research conducted looked at patents' records from Japan and US over several decades to demonstrate the effects of collaboration on innovation. The researchers found that inventor teams performed better than solo inventors.
(Aaen, 2008)	Essence: facilitating software innovation	This paper introduces Essence as a new concept for software innovation, building from the perspectives of Product, Project, Process and People to suggest a new facility for facilitating creativity and innovation in software development.

2.3.1. Defining Innovation Capability

Based on the identified articles (Table 2), an innovation capability can be considered as an organisation's ability to generate innovation outputs by exploiting the intangible resources associated with innovation (Saunila and Ukko, 2012). The process of managing innovation capabilities is a vital element of any innovative organisation. Operating in challenging environments demands the development and management of innovation capabilities (Saunila and Ukko, 2012). Assessing innovation capabilities requires that organisations can measure them. However, this has proven to be challenging as innovation capabilities are most often intangible (Saunila and Ukko, 2012).

Innovation capability can be described as containing three elements; these being innovation potential, innovation process and innovation output (Saunila and Ukko, 2012). Similarly, Kemp et al. (2003) proposed the systems-theoretical approach to measuring innovation using innovation indicators to describe input, throughput, and output of innovations. Input, throughput, and output describe the stages of the innovation process within firms as seen in figure 2.

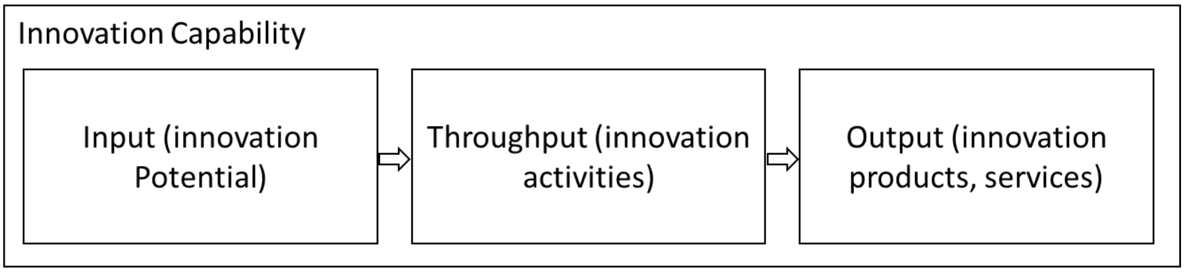

Figure 2. Innovation Capability Framework

Innovation potential includes the factors that create the potential to produce innovations. Previous studies have associated these innovation potential factors with collaboration, organizational culture, idea generation and creativity (Saunila and Ukko, 2012). The framework developed by Dervitsiotis (2010) describes organisational culture and employee participation as key enablers of a firm's innovation capability. Organisational culture is associated with providing creative interactions, knowledge sharing and collaboration with others. Employee participation promotes valuable input and support, which in turn improves product features and leads to process improvements (Dervitsiotis, 2010).

Innovation activities leverage innovation potential and enable innovation. Innovation results are the final outputs that can take the form of products, services, or processes. Saunila and Ukko (2012) use these three elements as the basis to measure the innovation capability of an organization, describing that the exploitation of innovation potential is needed for successful innovation activities which then lead to innovation outputs.

2.3.2. Three Innovation Capabilities for Software Development

Three capabilities emerged from the systematic review as most frequently cited (Table 3).

Table 3. Emergent Innovation Capabilities

Articles	Outcomes		
	Agility	Collaboration	Creativity
(Magadley and Birdi, 2009)		X	X
(Fecher et al., 2018)	X		
(Memon et al., 2018)		X	X
(Cocu et al., 2015)		X	X
(Lewis and Moultrie, 2005)	X	X	X
(Cockburn and Highsmith, 2001)	X	X	
Sampietro (2016)	X		
(Basadur and Gelade, 2006)	X		X
(Schweitzer and Gabriel, 2012)		X	X
(Inoue and Liu, 2015)		X	
(Aaen, 2008)		X	
(Saunila and Ukko, 2012)		X	X
(Dervitsiotis, 2010)	X		
Osorio et al. (2019)	X	X	X

The three most cited innovation potentials of creativity, agility and collaboration are therefore adopted as relevant innovation capabilities in this study. These three capabilities describe the way in which teams develop software. For example, agility describes the way in which teams are able to overcome changing requirements, develop software in short and frequent iterations and incorporate frequent customer and business feedback. Creativity is associated with creating novel solutions to problems and generating new knowledge that had not existed before. Collaboration involves how teams interact, work together, and the nature of their interactions.

Figure 3 illustrates the translation of the innovation capability framework to the context of software development. Software development refers to the activities involved in developing software; these include aspects such as defining requirements from stakeholders and customers, producing the underlying solution to the customers problems, developing the solution into software and the management of the entire process. Valuable business software is the outcome of the combination of these three innovation capabilities, applied to the software development process. The result is business software that solves customers problems and drives the strategic or operational goals of the firm.

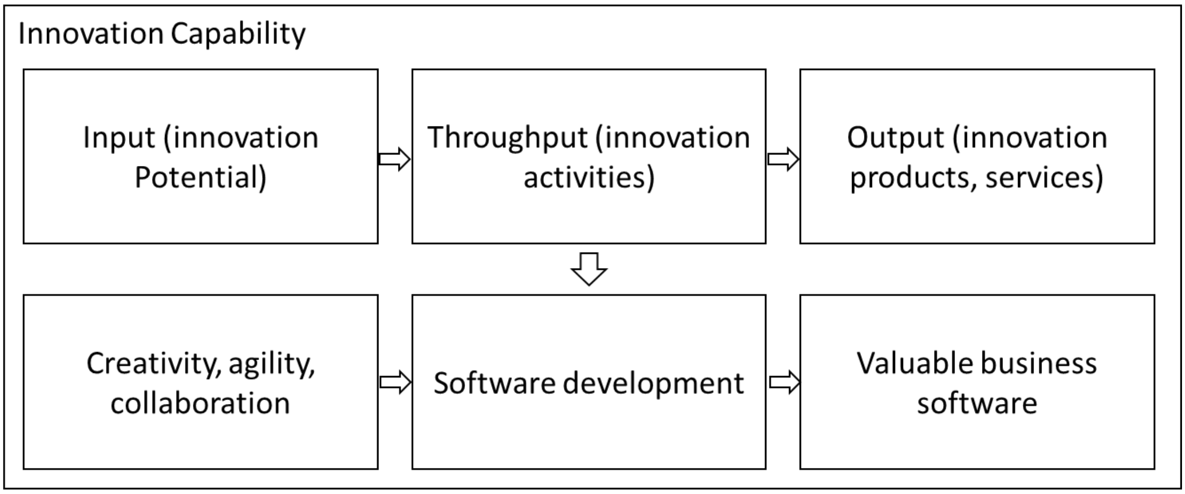

Figure 3. Innovation capability framework applied to software development

Each of the three innovation potentials, hereafter referred to as innovation capabilities, are discussed next.

2.3.2.1. Agility

The first innovation capability is agility. As organisations battle with the pace of the digital era, it is essential that they can adapt to a dynamic environment. The ability for organisations to adapt and change is referred to as agility. Agility is associated with speed of innovation, resource reconfiguration and adaption - traits that are often an intended feature within innovation labs (Fecher et al., 2018).

With the increased popularity of hackathons, incubators, accelerators and innovation labs, agile-orientated innovation has come to the forefront (Fecher et al., 2018). The ability to be agile can increase the speed of innovation, for example, through access to resources that can be dynamically adapted and reconfigured according to the challenge at hand (Lewis and Moultrie, 2005).

In recent years, an increase in the use of agile software methodologies has been seen to overcome challenges associated with high risk and rapidly changing environments (Sampietro, 2016)**.** The general idea around agile practice is concerned with improving the efficiency of teams by reducing the movement of information between people as well as reducing the time taken between making decisions (Cockburn and Highsmith, 2001). The application of the agile methodologies sees a shift in focus to outcomes and results with incremental, continuous progress (Cockburn and Highsmith, 2001; Winter, 2014). Table 4 details the elements of agility in software development in more detail.

Table 4. Elements of Agile

Elements of Agile	Explanation	Literature
Overcoming changing requirements	Changing requirements encountered in dynamic environments puts pressure on development teams to be able to overcome the issue related with changing requirements and their success can be dependent on this ability.	(Sampietro, 2016)
Iterative development	Breaking software development into shorter iterations allows for a quicker feedback cycle where developers can introduce a new feature, test it with the users and accept or reject the new feature, limiting the amount of potential time lost and moving onto the next feature.	(Vickery et al., 2010)
Frequent releases	By releasing software frequently, similarly to iterative development, the software product can be verified by customers and dynamically changed to suit changing needs. Frequent releases also benefit in reducing time to market and allow the value of the software to be realised sooner.	(Cockburn and Highsmith, 2001)
Focus on working software	Focusing on working software encourages a development style that allows software to be released frequently, iterated upon, and changed dynamically. This is in contrast to the design, build, and test methodology associated with waterfall development.	(Winter, 2014)
Frequent customer feedback	Incorporating frequent customer feedback ensures that the software is solving the users' problems and that the team is focusing on developing features that the user wants. This has the added benefit of encouraging buy-in from the users and improves acceptance of the software.	(Misra et al., 2009)

2.3.2.2. Collaboration

The second innovation capability is collaboration. Innovation requires groups of individuals who collectively set out to solve challenges and problems (Cockburn and Highsmith, 2001). Recognition of the importance of collaboration among individuals is evident, as an example, in how the architecture, décor and layout of innovation labs are designed to facilitate group participation, remove traditional and formal hierarchies, and leave groups feeling a dislocation from a formal and individualised working environment (Lewis and Moultrie, 2005; Magadley and Birdi, 2009; Memon et al., 2018).

Collaboration is often assisted by simple low-tech tools such as large writing surfaces and visual materials such as post-it notes, along with high-tech tools designed around brainstorming and distributed working systems (Lewis and Moultrie, 2005). The role of collaborative software assists in breaking down traditional hierarchies, allowing participants to share their ideas honestly. Through brainstorming and debate, participants can focus on developing and thinking about ideas. A similar approach is taken in agile software development practices where teams are brought closer together and promoted to share information through discussion and whiteboarding (Cockburn and Highsmith, 2001). Table 5 discusses elements of collaboration in software development in more detail.

Table 5. Elements of Collaboration

Elements of Collaboration	Explanation	Literature
Group participation	Group participation involves the prioritising of collaborative decision making and problem solving, where the responsibility of decisions and output are determined as a group rather than a by an individual.	(Cockburn and Highsmith, 2001)
Frequent and informal interaction	The presence of frequent and informal interaction removes the friction, rigidity and administration activities between teams which allows for higher levels of coordination and quicker turnaround time with regards to decision making.	(Brettel et al., 2011)
Shared vision and goals	Studies have found that when teams work together to solve a known goal or vision there is an improvement in effectiveness and efficiency in projects.	(Schweitzer and Gabriel, 2012)
Sharing of information	Sharing of information involves actively sharing any knowledge, prototypes, tools, or processes with team members which may result in the team performing better overall.	(Kahn, 1996)

2.3.2.3. Creativity

The third innovation capability is creativity. Increased creativity is important in innovation because people who are encouraged to think creatively tend to become more motivated, increase commitment and strive towards better quality and quantity of work while reducing costs (Schweitzer and Gabriel, 2012). Basadur and Gelade (2006) found that adaptability and flexibility are dependent on actively seeking out new problems, trends, technology, and information to create new processes, products, or services. This activity is described as innovation thinking and organisations focused on innovation have a habit of using knowledge creatively (Basadur and Gelade, 2006).

The removal of traditional and formal hierarchies influence participants' behaviour to promote "out-of-the-box" thinking and improved cognitive stimulation (Magadley and Birdi, 2009). Creativity can be influenced by physical design where, for example, the use of rich colours, art, pictures and objects foster cognitive stimulation (Magadley and Birdi, 2009), as well as through a feeling of psychological distance from the traditional working environment (Cocu et al., 2015; Magadley and Birdi, 2009; Memon et al., 2018). Magadley and Birdi (2009) found that participants felt that they generated more than the normal amount of ideas when participating in environments like innovation labs. Table 6 details elements of creativity.

Table 6. Elements of Creativity

Elements of Creativity	Explanation	Literature
Creative approach to problem solving	The ability to apply creative approaches, such as “out-of-the-box” thinking allows team members to solve problems using methods they may not have previously incorporated.	(Schweitzer and Gabriel, 2012)
Idea generation	Idea generation refers to the ability for team members to produce ideas, in volume, while also generating ideas that are believed to be more valuable. Overall, producing more ideas of higher quality.	(Magadley and Birdi, 2009)
New knowledge creation	Through creative problem solving and idea generation, teams can produce new knowledge around processes, designs and products that have not existed before in the organisation. The new knowledge improves the organisations effectiveness and efficiency.	(Basadur and Gelade, 2006)

Although agility, creativity and collaboration are perceived to be important to innovation, there is no explicit evidence linking them to outcomes - i.e., the benefits organisations achieve through fostering these innovation capabilities remains anecdotal. It is assumed that these capabilities promote the creation, development and implementation of new technologies, products and services within an organisation (Memon et al., 2018). This shortcoming has provided an opportunity to further understand how innovation capabilities can have a measurable effect on organisations. More specifically, the effect of these innovation capabilities on the ability to create innovative and valuable software within development teams. Software value is discussed next, while subsequent sections will link innovation capabilities to software value by drawing on the resource-based view of the firm.

2.4. Software Value

Software is becoming a larger part of an organisation’s competitive advantage, driving innovation and product differentiation (Khurum et al., 2013). These changes have resulted in an increased focus on the value of software within organisations (Khurum et al., 2013). The goal of capturing value from software products is challenging to most organisations, made worse by competition and markets that are subject to a winners-take-all dynamic (Teece and Linden, 2017). At the end of the day, any digital product or service must return value to the organisation either directly or indirectly (Teece and Linden, 2017). Previous studies emphasise IT factors over organizational factors, where researchers acknowledge the importance of the organisational context while only providing one or two factors that they perceive as relevant (Fink and Sukenik, 2011). As software becomes core to organisational success, organisations require several constructs that are able to measure not only technical value, but also business value (Khurum et al., 2013).

IT business value comprises of operational and strategic impact, where operational impact represents the value IT has on business efficiency through reduction in costs and improved collaboration including both internal and external collaboration (Fink and Sukenik, 2011). On the other hand, strategic impact represents the ability for IT to create business value through strategic objectives such as product differentiation (Fink and Sukenik, 2011). Past research into the business value of IT has addressed software value as a dimension of success (Gorla and Lin, 2010; Khurum et al., 2013). Value based software engineering (VBSE), a concept used to improve the value of software, states that not every feature of a software adds equal value to the entire software product (Khurum et al., 2013). Thus, decision-making should factor in overall value-creation. VBSE states that software should be designed and built around business problems, factoring in economic value rather than the traditional technical issues (Khurum et al., 2013). When considering the total value of software, the software product's value should be considered from different perspectives such as customers perceived value or the impact on internal business processes (Khurum et al., 2013). Traditional software development methodologies, such as cost benefit analysis, fall short in capturing the true value of software where the broader context is seldom incorporated into software planning (Khurum et al., 2013). As a result, the determinates of software value have seen a shift in focus from a purely technical aspect to one that incorporates a stronger business context (Fink and Sukenik, 2011; Gorla and Lin, 2010; Khurum et al., 2013; Lee and Chen, 2017). The shift in focus towards business value has seen an increase in alternative software development methodologies, which favour rapid development as well as customer-focused outcomes. In order to achieve greater business value using alternative software development methodologies, organisations are required to change the way in which they develop software. Organisations need to shift their focus towards developing innovative software products by leveraging the capabilities which foster innovation.

Different processes and frameworks that might support development of more valuable software have received some attention. The Agile Manifesto was developed as an innovative project management practice which changed the way in which software is developed (Ciric et al., 2018). The agile software development manifesto places emphasis on agile principles that every project should follow. These principles include frequent and continuous delivery of valuable software, collaboration with businesspeople, and welcoming of changing requirements (Ciric et al., 2018). Thus, agile software development practices emphasise agility and collaboration capabilities, and support innovation by embracing changing requirements and promoting rapid deployment of valuable software.

New methods for product developed have also arisen, that emphasise putting the user at the centre. These methods include User Driven Design, Activity Centred Design and Data Driven Design (Stoitsova, 2015). These methods are important to innovation because many companies' success depend on their ability to come up with new and innovative products that users want to engage with or purchase. By placing the user and data at the centre of design, companies ensure that they solve their customers' problems (Stoitsova, 2015). Involving the user, whether businesspeople or customers, is a principle of Agile and strongly linked to the three innovation capabilities identified. Including the user in the design of products increases agility, collaboration and creativity through increased interactions and idea generation.

In recent years, the "spaces" in which businesses developed their software has also evolved in an effort to promote the creation, development and implementation of new technologies, products and services (Memon et al., 2018). These new spaces, such as innovation labs, are increasingly being used as a means to drive innovation (Capgemini, 2017). The layout of these spaces varies widely, with a focus on the actual physical structure to the intangible services they provide for the organization (Memon et al., 2018). As such, innovation labs are defined as the synergy between facilitation, physical space and resources to capture and promote the development of innovative products and services within organizations (Memon et al., 2018). In most cases, innovation spaces are structured as workspaces that are physically removed from normal working environments, providing low- and high-end technology infrastructure as well as facilitation in the hopes of increasing the ability of an organisation to innovate. Innovation labs have been associated with improved collaboration, improved creativity, and improved agility. Thus, innovation labs can be used by organizations to harness these innovation capabilities. Fostering and harnessing these innovation capabilities can lead to improved innovation and the development of valuable software.

Organisations focusing on developing software innovations are required to ensure future revenues and provide return on investments (Khurum et al., 2013). However, high costs associated with software innovation are seen as a barrier and require firms to deliberately act to ensure their software innovations are successful (Liebeskind, 1996). Organisations focusing on software development to foster innovation have to actively direct their efforts towards creativity and innovation-promoting practices (Asil, 2013). The practices used to improve the business value of software, as well as modern approaches in software innovation - such as improving innovation capabilities - are centred around incorporating a stronger business context (Fink and Sukenik, 2011; Gorla and Lin, 2010; Khurum et al., 2013; Lee and Chen, 2017).

The use of innovations capabilities such as collaboration, agility and creativity are prevalent in research as capabilities associated with innovative software development. Organisations which are able to foster greater innovation capabilities are able to improve their innovation potential which in turn improves their propensity to innovate and thus create valuable business outcomes. Therefore, innovation capabilities may be important to the development of more valuable software. These relationships are explored next in the development of the study's research model.

2.5. Theoretical Background and Research Model

2.5.1. Resource Based View of the Firm

2.5.1.1. Overview

This study draws on the Resource Based View (RBV) of the firm to conceptualise the Business Value of Software, and support hypothesised relationships between Innovation Capabilities, software value and subsequent Firm Performance. The RBV of the firm is a common approach used in research to express the relationship between IT assets and Firm Performance (Bharadwaj, 2000). In this section, the RBV will be discussed in detail.

The RBV argues that firms possess a set of organisational resources which, in unique combinations, can result in sustained competitive advantage (Nevo and Wade, 2011; Schryen, 2013; Wade and Hulland, 2004). The different combinations of resources can provide economic and strategic potential through five properties: value, rarity, inimitability, non-substitutability and immobility (Nevo and Wade, 2011; Wade and Hulland, 2004). The RBV has gained popularity in the Business

Value of IT research field as it clearly defines a path between the strategic value of organisational resources and the measurable outcomes for the firm (Nevo and Wade, 2011).

A challenge in RBV is the definition of a resource. Wade and Hulland (2004) define resources as being made from assets and capabilities available to the firm. Assets are used in the process of creating and offering products to a market, whereas capabilities are the processes used to turn assets into the products that are offered to the market. A firm can gain temporary competitive advantage through the ownership and use of resources that are valuable and rare, however to sustain long term advantage, the firm needs to protect against resource imitation, substitution or transfer (Wade and Hulland, 2004). Researchers have made the distinction between resources that help to attain competitive advantage (ex ante) and those that help sustain competitive advantage (ex post) (Nevo and Wade, 2011). Ex ante advantage exists when a firm can take advantage of limited competition and access to resources to establish a superior position in the market. Ex ante advantage derives from the value and rarity properties of resources. Ex post advantage is associated with the firm's ability to maintain the superior position gained ex ante. This is achieved through the limitation of resources available to the competition (Wade and Hulland, 2004). Properties associated with ex post advantage are resource inimitability, non-substitutability and immobility (Wade and Hulland, 2004). The definition of the five properties of resources for deriving ex ante and ex post advantages are defined further in Table 7.

Table 7. The five properties of resources

Resource Attribute	**Definition**
Ex ante	
Value	A resource is said to have value if it can be used by the firm in implementing strategies to improve efficiency and effectiveness (Nevo and Wade, 2011; Wade and Hulland, 2004).
Rarity	Rarity is defined by the limitation of a resource, such that it is not simultaneously available to many firms (Nevo and Wade, 2011; Wade and Hulland, 2004).
Ex post	
Inimitability	The inability to easily replicate a resource based on factors such as the resource's history, ambiguity and complexity (Nevo and Wade, 2011; Wade and Hulland, 2004).
Non-Substitutability	Substitutability defines how easily other firms can find alternative resources to gain competitive advantage. This is strongly linked to inimitability and rarity (Nevo and Wade, 2011; Wade and Hulland, 2004).
Immobility	Mobility refers to how easily a firm can acquire resources that allow it to imitate a rival's competitive advantage (Wade and Hulland, 2004). Thus, immobility refers to the degree to which resources cannot be transferred between firms.

Therefore, considering the resource based view, software has greater business value when the software is used directly by the firm to implement a business or market strategy (value), is not easily procured in the software marketplace (rare), contains algorithms, features, or design elements that are not easily observable and not easily replicated by competitors (inimitable), provides unique functionality to achieve objectives that is not found in other available software or is not achievable by other means (non-substitutable), and contains proprietary code elements or other attributes that constitute a part of the intellectual property of the firm (immobile).

Nevo and Wade (2011) identify the outcome variable of an RBV framework as the firm's performance, which comprises of operational and strategic benefits. Operational benefits are associated with economic benefits such as improved efficiency, resulting in increased revenues and cost reduction. On the other hand, strategic benefits are associated with the firm's effectiveness, likely improving the firms competitive positioning and enhanced flexibility in responding to market changes. The research performed by Nevo and Wade (2011) found that a resource's value and rarity can have significant positive effects on organisational benefits such as cost reduction and increased revenue, while value and inimitability can have significant positive effect on strategic benefits such as competitive advantage.

2.5.1.2. Past Applications of RBV

The research by Ravinchandran and Lertwongsatien (2005) is a notable application of the RBV in IT value research. They posit that a firm's performance can be explained by how effectively a firm can utilise its own IT resources to enhance the capabilities of the firm. The degree to which resources are heterogeneously distributed across the firm accounts for the difference in Firm Performance. Thus, through resource complementarity, the well-focused use of IT assets will result in superior Firm Performance (Ravinchandran and Lertwongsatien, 2005).

The research model interrelates four constructs, namely – Firm Performance, IT support for core competencies, IS capabilities and IS resources. The relationship between constructs is shown in figure 4. The research model posits that a firm's performance is dependent on its ability to use IT to enhance its core competencies. Further, the model proposes that these core competencies are dependent on strong IS capabilities which in turn are dependent on the IS resources available to the IS department (Ravinchandran and Lertwongsatien, 2005). The strength of the IS resources available in the IS department is represented by Human Capital, Infrastructure and Flexibility, and Partnership Quality.

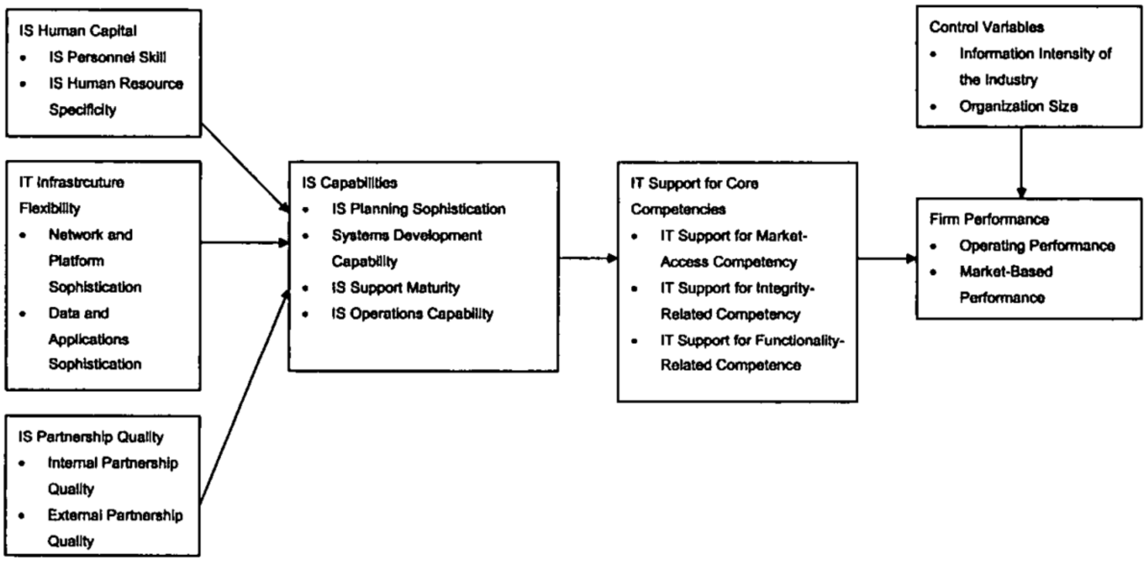

Figure 4. Ravinchandran and Lertwongsatien (2005, p. 7) Research Model

The results of their research support that the variations in Firm Performance are strongly related to the degree to which the organisation uses IT to support and enhance core competencies. Furthermore, the research supports that an organisation's ability to use IT to enhance the core competencies is dependent on IS capabilities, which in turn are dependent on IS resources (Ravinchandran and Lertwongsatien, 2005).

In their research, Nevo and Wade (2011) used the RBV with supplementary concepts derived from systems theory. The core of systems theory states that a system is comprised of interacting components that give rise to emergent capabilities (Nevo and Wade, 2011). Nevo and Wade (2011) describe the IT-enabled resource as the relationship between an IT asset and an organisational resource. The IT-enabled resources create a system with emergent capabilities that provide previously unattainable value. Positive emergent capabilities are described as a synergy between the IT asset and an organisational resource. However, to realise the benefits of synergy, the relationship depends on two enabling conditions – namely, compatibility and integration effort (Nevo and Wade, 2011).

Further to the addition of systems theory to RBV, Nevo and Wade (2011) investigated the external environment and events (turbulence) and how they may influence the strategic potential of organisational resources. The strategic potential of IT-enabled resources was defined in terms of rarity, value, inimitability, and non-substitutability. Figure 5 presents the extended RBV model investigated by Nevo and Wade (2011).

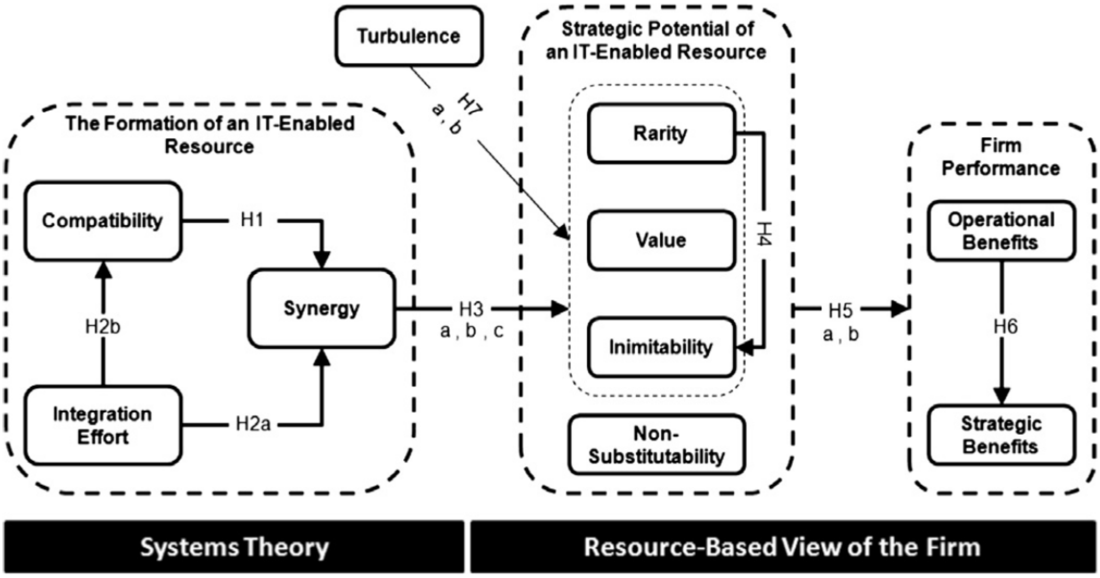

Figure 5. Nevo and Wade (2011, p. 3) Research Model

The empirical results from their research demonstrated that commodity-like IT assets, when combined with organisational resources can play a strategic role for an organisation through the creation of an IT-enabled resource (Nevo and Wade, 2011). Therefore, an asset on its own may not create any strategic value, but an ensuing IT-enabled resource may do so under a synergistic relationship. The resulting synergistic relationship has a positive impact on value, rarity, and inimitability, which in turn has a positive effect on Firm Performance as measured by strategic and operational benefits (Nevo and Wade, 2011).

The research performed by Sedera et al. (2016) applied an extension of the resource-based view of the firm by delving deeper into the context in which resources are perceived to be valuable, rare, inimitable, and non-substitutable. The resulting theory, contingent resource-based theory (CBRT), overcomes a shortfall of RBV by stipulating that the value of resources is contingent on the linkage between primary and secondary/complimentary resources (Sedera et al., 2016). Thus, CRBT helps identify contingencies that may make some resources more valuable than others in certain contexts. CRBT states that complimentary resources have a moderating effect on the primary resource.

Sedera et al. (2016) apply the notion of CRBT by considering digital platforms as primary resources and enterprise systems (ES) as complimentary resources in delivering innovation for an organisation. Although each of the two systems can provide value to the organisation through RBV theory, the synergistic relationship between these two resources produces superior benefits (Sedera et al., 2016). The additional benefits outside of what are described by RBV are archived by the moderating effect of ES (complimentary resource) on the digital platform (primary resource) (Sedera et al., 2016).

The study focused on three constructs and their sub-constructs to help recognise the individual ability of ES and digital platforms to facilitate innovation, while also being able to identify the contingent relationship between ES and digital platforms (Sedera et al., 2016). The research model shown in figure 6 describes the relationships between the constructs and subconstructs.

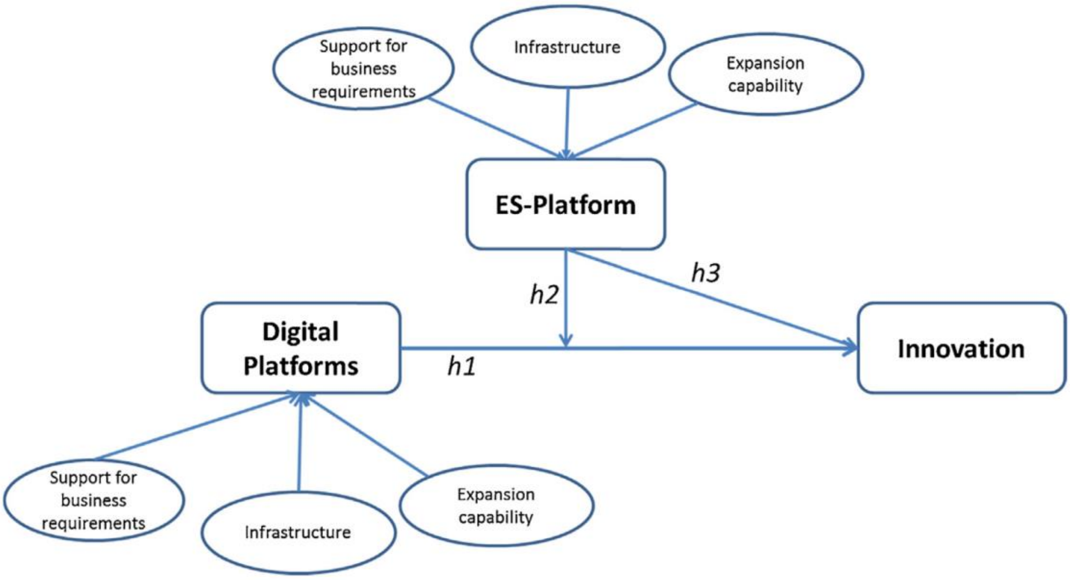

Figure 6. Sedera et al. (2016, p. 7) Research Model

The results of the study concluded that digital platforms could lead to innovation but only through the moderation of the ES platform. In addition, the moderating effects of ES platform varied based on the quality of the ES platform (Sedera et al., 2016).

The research performed by Schryen (2013) focused on the causal relationship between IS investment and business value to examine the concept of IS business value. In doing so, Schryen (2013) developed a conceptual model by synthesising four prominent business value models from IS literature. These four models included the resource based view of the firm, production-oriented model, process-oriented model and the model of Dehning and Richardson (Schryen, 2013). The resulting conceptual model helped understand the causal relationship between firm capabilities, IS assets and performance (Schryen, 2013).

Taken together, these studies highlight the relevance of the resource-based view of the firm to the study of IT's business value. Business value derives from the interaction between IT assets and business processes rather than from IT assets alone. In addition, the studies show that IT systems can also complement each other. The studies highlight that business value is derived from the emergent capabilities of inimitability, non-substitutability, value, and rarity. However, none of these studies consider how the IT systems were developed and whether Innovation Capabilities can contribute to the development of more valuable software that is inimitable, non-substitutable, valuable, and rare. Thus, leading to the question - what are the effects of a firm's Innovation Capabilities in software development on the business value of their software?

To address this question, the next section outlines the study's research model and presents a set of hypotheses linking agility, creativity, and collaboration in software development to greater business value.

2.5.2. Conceptual Model and Hypotheses

In this section a research model (Figure 7) is proposed to interrelate the selected and the business value of the software developed. In the remainder of this section, the constructs of Innovation Capabilities are defined and relationships between these constructs and the Business Value of Software is hypothesised.

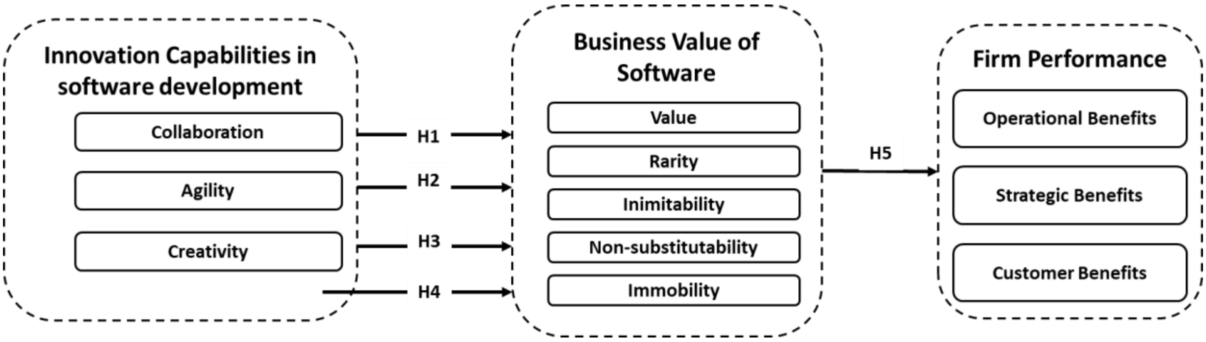

Figure 7. Research Model

2.5.2.1. Business Value of Software

Through the notion of resource complementarity, the combination of innovation capabilities results in the creation of valuable software. The combination of innovation capabilities can be strategically planned with the desire to increase value, rarity, inimitability, non-substitutability, and immobility of software. The value of software innovations results in a firm's ability to produce goods and services to gain and maintain competitive advantage with the intention of improving firm performance. Thus, the value of software can be measured using the principles of the RBV.

Software that has a positive outcome for organisations will show characteristics of value, rarity, inimitability, non-substitutability, and immobility. A software that exhibits these properties will provide an organisation with sustainable competitive advantage, proving to be a valuable software development within the organisation.

The next sections hypothesise the effects of collaboration, agility, and creativity on the Business Value of Software.

2.5.2.2. Collaboration

Collaboration in organisations is a construct defined by the increase in teaming over individual work. In a collaborative work environment, problems are solved with a focus on group participation to increase problem solving capabilities and to diversify ideation. Collaboration has been shown to improve innovation by increasing the chances of combining ideas, parallel validation of concepts and increased speed of delivery of innovations (Inoue and Liu, 2015). The increase in collaboration amongst multidisciplinary teams has been shown to improve innovation efficiency and effectiveness (Schweitzer and Gabriel, 2012). In the innovation process team members from different units within the organisation are required to collaborate with each other to share information and support innovation. The quality of collaboration in IT innovation projects is described through the ability of different units to share goals, communicate well and arrive at mutual understandings (Schweitzer and Gabriel, 2012). High quality collaboration increases the efficiency of innovation projects by enabling teams to focus on reducing risks and seizing opportunities (Aaen, 2008). Cross functional collaboration improves the ability to diffuse knowledge in teams and simultaneously fulfil tasks. This results in shortened development time, reduced costs, and reduced time to market of innovations. These factors improve the effectiveness of IT innovations in organisations (Schweitzer and Gabriel, 2012). By increasing the collaboration capability of the firm, the efficiency and effectiveness of the IT innovation process may be improved. Thus,

> **Hypothesis 1:** There is a positive relationship between the level of collaboration capability in the software development process and the Business Value of Software.

2.5.2.3. Agility

The ability to increase the speed at which companies are able to design, build and adapt their products helps companies drive innovation by overcoming rapidly changing environments (Sampietro, 2016). Through the use of agile software methodologies, companies are able to overcome challenges and drive innovation by dynamically adapting resources, shifting their focus to outcomes and results, and by making continuous incremental progress (Cockburn and Highsmith, 2001; Lewis and Moultrie, 2005; Winter, 2014). Agile organisations focus on overcoming changing requirements by employing iterative software development practices, frequent software releases and requesting frequent customer feedback which should lead to more valuable software.

A firm that can incorporate agility into its products and services while still maintaining the ability to operate will have a greater chance at innovating and not becoming obsolete. Organisations that can benefit from agility are better able to adapt and reconfigure resources according to the changes in the environment. Thus, the following hypothesis is proposed:

> **Hypothesis 2:** There is a positive relationship between the level of agility in the software development process and the Business Value of Software.

2.5.2.4. Creativity

Creativity is important in innovation because people who are encouraged to think creatively tend to become more motivated, increase commitment and strive towards better quality and quantity of work while reducing costs, which ultimately improves the efficiency and effectiveness of the organisation (Schweitzer and Gabriel, 2012). Basadur and Gelade (2006) found that adaptability and flexibility are dependent on actively seeking out new problems, trends, technology, and information to create new processes, products, or services. This activity is described as innovation thinking and organisations focused on innovation have a habit of using knowledge creatively (Basadur and Gelade, 2006). Organisational performance has been identified as being dependent on creativity through the application of superior thinking (Basadur and Gelade, 2006). An organisation that incorporates high levels of creativity in their development process are more likely to be adaptable, flexible, and creative in their use of knowledge to create new processes, products, or services. Thus,

> **Hypothesis 3:** There is a positive relationship between the level of creativity in the software development process and the Business Value of Software.

2.5.2.5. The synergistic effects of innovation capabilities

The RBV explains that capabilities and resources can act synergistically whereby the unique combinations of capabilities and resources can provide economic and strategic potential through the five properties of RBV: value, rarity, inimitability, non-substitutability and immobility (Nevo and Wade, 2011; Wade and Hulland, 2004). While employees who are actively applying the creativity process in their daily lives increase the quality and quantity of products and services, there is also a relationship between creativity and collaboration. Applying several minds to a resource leads to a shared thinking process where individuals apply the 'collective mind' concept to achieve optimal results (Basadur and Gelade, 2006). In a previous study, the use of collaborative software was shown to increase the quantity of ideas generated. Furthermore, collaboration is a key element of agility, where teams are brought closer together and promoted to share information through discussion and whiteboarding (Cockburn and Highsmith, 2001). This improves the efficiency of teams by reducing the movement of information between people as well as reducing the time taken between making decisions (Cockburn and Highsmith, 2001). Thus, an additional hypothesis can be proposed:

> **Hypothesis 4:** The innovation capabilities are complementary capabilities and will have synergistic effects on the Business Value of Software.

2.5.2.6. Firm Performance

The improved Business Value of Software results in a firm's ability to produce products and services to gain and maintain competitive advantage with the intention of improving firm performance. Firm Performance can be measured along the dimensions of operational, strategic and customer performance. Nevo and Wade (2011) showed that improvements in value, rarity, and inimitability in turn has a positive effect on Firm Performance as measured by strategic and operational benefits. Furthermore, Firm Performance is strongly related to the degree to which the organisation uses its IT capabilities to support and enhance core competencies (Ravinchandran and Lertwongsatien, 2005). Software can also contribute to customer performance. For example, in their study, Kim & Baek (2018) found that customer users of mobile-based applications experienced enhanced brand commitment, consumer connection and increased engagement leading to improved customer experience. Even when customers are not direct users, firms can still leverage software to improve customer benefits leading to the retention of customers and attraction of new customers (Kim and Baek, 2018).

Thus, increased Firm Performance along all three dimensions can be realised through the enhancement of the Business Value of Software. The research model presented posits that valuable software reflected inter-alia by its rarity, inimitability, non-substitutability, and immobility will translate into improved operational, strategic and customer benefits. Thus, it follows that:

> **Hypothesis 5:** There is a positive relationship between the Business Value of Software and the firm's operational, strategic and customer performance outcomes.

2.5.3. Control Variables

The following control variables have been identified from previous studies in Information Systems and Technology (Inoue and Liu, 2015; Kim and Baek, 2018) and will also be considered in the research:

- **The size of the software development team**: this may have an influence on the study as larger teams may have more access to resources or find it harder to quickly adapt to changes
- **Industry of the firm**: this can have an influence as service firms are more likely than non-service firms to innovate in software development due to the information intensive nature of their business and the history of innovation with customer and self-service technologies
- **Size of the organisation (derived by the number of employees):** Similarly, to team size, larger organisations have access to more resources, although this may be an obstacle to innovation as larger organisations are perceived to be less adaptable to changes
- **Firm age:** this may have an influence as younger firms are often more likely to seek out opportunities and disrupt older companies who may be more established and entrenched
- **Intent to innovate:** this may have an influence as a firm who intends to innovate would likely score high on any questions related to innovation and innovation activities
- **Internal (operational/enterprise) or external (customer/engagement focused) software development:** this can influence the study as firms who are focused on customer/engagement related software development are competing with external firms for market share, an activity that usually requires higher levels of innovation to attract or draw customers

2.6. Conclusion

This chapter presented a review of the literature related to innovation, software, and innovation capabilities. Innovation Capabilities was conceptualised in terms of three dimensions, namely agility, creativity, and collaboration. The resource-based view of the firm (RBV) was selected as the theoretical background for the study's research model and past applications of RBV in IT value research were then explored. Drawing on this literature, the Business Value of Software was conceptualised as the combination of value, rarity, inimitability, non-substitutability, and immobility. The study's research model was developed, and the hypotheses are summarised as follows:

Table 8. Hypotheses Summary

Hypothesis 1	There is a positive relationship between the level of collaboration capability in the software development process and the Business Value of Software
Hypothesis 2	There is a positive relationship between the level of agility in the software development process and the Business Value of Software
Hypothesis 3	There is a positive relationship between the level of creativity in the software development process and the Business Value of Software
Hypothesis 4	The innovation capabilities are complementary capabilities and will have synergistic effects on the Business Value of Software
Hypothesis 5	There is a positive relationship between the Business Value of Software and the firm's operational, strategic and customer performance outcomes

The next chapter discusses the research methodology used to collect and analyse the data for the purpose of testing the hypothesised research model.

3. CHAPTER 3 – RESEARCH METHODOLOGY

The purpose of the research methodology is to define the techniques and procedures to collect and analyse data that will be used to test the research model and thereby address the study's research question (Bhattacherjee, 2012; Saunders et al., 2009). The research methodology selected for this research proposal is visually outlined using the research onion developed by Saunders et al. (2009), shown in Figure 8. The boxed areas indicate what has been selected for the research methodology.

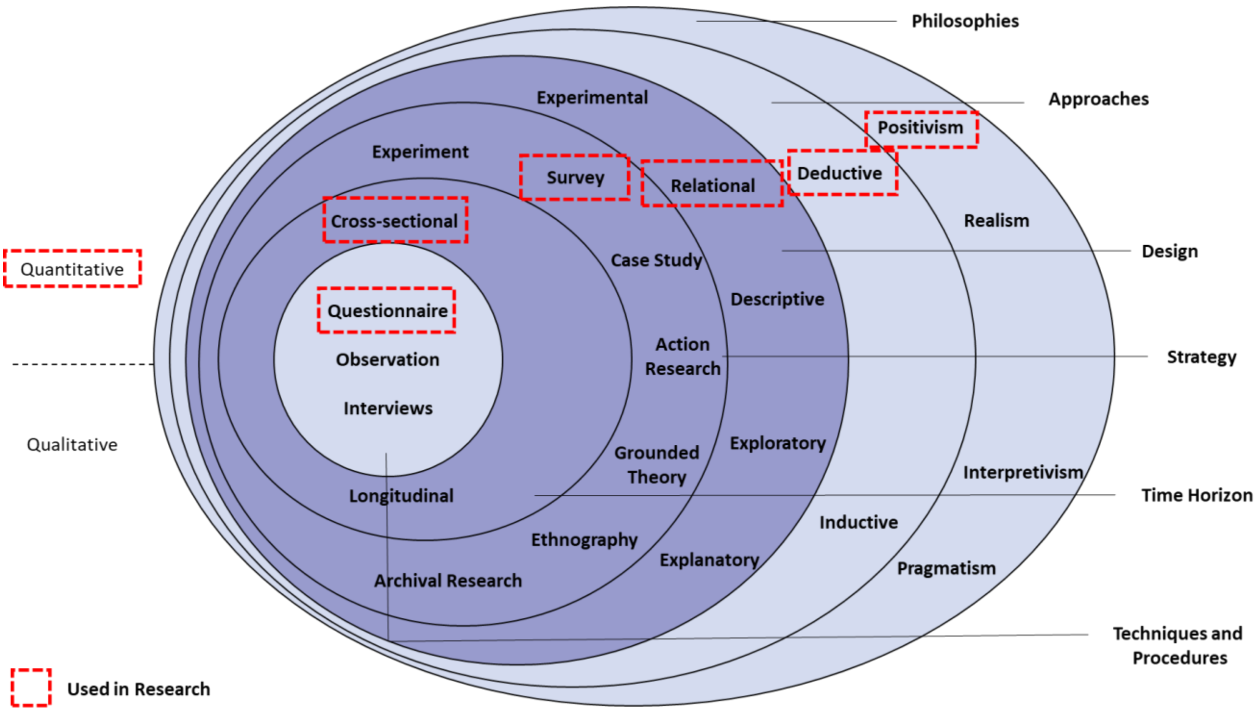

Figure 8.Research Onion adapted from Saunders et al. (2009, p. 108)

3.1. Research Paradigm and Approach

The terms positivism and interpretivism are used to describe two opposing ways researchers view the world. These two views are described by their underlying philosophical paradigms. Ultimately, a philosophical paradigm defines how researchers view the nature of the world and how they gain knowledge about it (Oates, 2006; Wahyuni, 2012). The core components within a philosophical paradigm may differ but the literature consulted all considers ontology, epistemology and methodology at the core, with axiology being mentioned (Bakhit Al Zefeiti and Mohamad, 2015; Holden and Lynch, 2004; Wahyuni, 2012).

Ontology describes the nature of reality and how researchers interpret oneself with respect to reality. Positivists believe that the existence of reality is external and independent (Wahyuni, 2012). Positivists can be described as realists in their belief that the world predates individuals and is external to oneself, being made up of tangible objects that exist regardless of our own existence (Holden and Lynch, 2004). In this regard, a positivist believes that the truth already exists and their role is to uncover a singular reality (Sukamolson, 2007). A positivist researcher achieves this by applying methods from natural sciences which aim to apply deductive logic from theory to measurement (Sukamolson, 2007; Travis, 1999). Interpretivists, on the other hand, believe that reality is dependent on one's interpretations and is made up from individual contributions and human subjectivity (Wahyuni, 2012). An interpretivist believes that there is no truth out there to be objectively uncovered, instead it is partly constructed through observation (Sukamolson, 2007). The act of observation changes and transforms it, therefore an interpretivist believes there are multiple realities dependant on the observer (Sukamolson, 2007; Travis, 1999). Thus, an interpretivist believes that reality is internal and interdependent (Oates, 2006). Interpretivists use qualitative data to develop an in-depth understanding of phenomenon and develop theories through the use of inductive logic (Sukamolson, 2007; Travis, 1999).

One's ontology affects their epistemological assumptions. Epistemology is concerned with the study of knowledge, and hence, how it is possible to gain knowledge of the world (Holden and Lynch, 2004). A researcher's epistemology beliefs determine the ways they generate, understand, and use knowledge. A positivist believes reality is external and independent and that one may only gain knowledge of the concrete external reality via measurements and observation (Holden and Lynch, 2004). The positivist stance is to remain independent from what is being studied in order not to influence the external reality (Sukamolson, 2007; Travis, 1999). An interpretivist, who believes reality is internal and interdependent takes the stance that knowledge cannot be discovered, instead it is subjectively acquired (Holden and Lynch, 2004). An interpretivist interacts with what is being studied; they believe that their findings are a result of the interaction between the researcher and what is being studied (Sukamolson, 2007; Travis, 1999).

Ultimately, it is these philosophical paradigms of researchers that helps understand and select the methodology to be used during research. A positivist uses the deductive process to understand cause and effect relationships which allow them to make generalisations, validated through empirical tests, reliability and validity (Sukamolson, 2007; Travis, 1999). An interpretivist uses the inductive process to observe patterns in a context-bound study, with the aim of developing social constructs that are validated through consensus and verification rather than empirical tests (Sukamolson, 2007; Travis, 1999).

In summary, positivist belief is grounded in natural science using a scientific approach to measure and observe a universal reality that is generalised across contexts, while interpretivists believe that reality is constructed from social actors and their perceptions of it (Wahyuni, 2012). The underlying ontology and epistemology define how positivists and interpretivists choose their methods for generating and validating evidence (Sukamolson, 2007; Travis, 1999).

In this study, the positivist paradigm and deductive approach inform this work to understand the effects of innovation capabilities on firm performance. Through the lens of a positivist researcher, the study aims to deductively measure the effects of Innovation Capabilities on the Business Value of Software. This is a common deductive approach to research, where the researcher tests a previously developed theory using new empirical data (Bhattacherjee, 2012). Through this approach, the research investigates the phenomenon by studying a sample population in order to draw a conclusion deductively and statistically. Thus, the positivist paradigm and deductive approach informed the research study.

3.2. Research Design and Methodology

When performing positivist research, theory is the starting point of the cycle of deductive research. Theories are used to explain why certain things happen through a logical, systematic and coherent explanation (Bhattacherjee, 2012). An analysis of current research theory based on the identified research problem assisted in developing a conceptual framework to structure the research method proposed (Oates, 2006). The theories discovered and selected in the conceptual framework are used to address the research question and form the basis for developing hypotheses (Bhattacherjee, 2012).

The role of hypotheses forces the researcher to think more deeply about the possible outcomes of the research study (Jack R. Fraenkel, 2011). In a way, the hypothesis is a sort of prediction of the outcomes. The hypothesis generated drive the research question and inform the researcher about what data is required to be collected and analysed to inform the research question (Farrugia et al., 2010). Figure 9 shows the research cycle, where positivist research begins with theory.

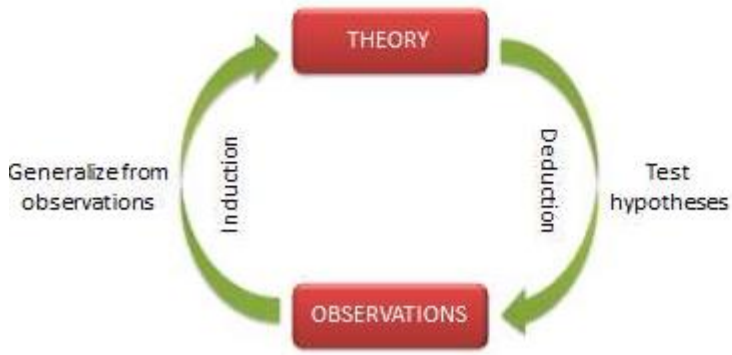

Figure 9. The research cycles (Bhattacherjee, 2012, p. 4)

Research design is concerned with developing a plan to answer the research question and involves the operationalisation of constructs, the research method and the sampling strategy (Bhattacherjee, 2012). Operationalisation is concerned with designing and selecting measures used to evaluate the research constructs. The research method involves selecting a data collection method to assess the research and the associated considerations involved with the collection method. This is usually selected by determining whether the study will be quantitative or qualitative (Bhattacherjee, 2012). Once the data collection method is determined, a sampling strategy that will be identified to collect a subset of data from the target population. The sampling strategy will tie in closely with the unit of analysis defined in the research problem (Bhattacherjee, 2012). The researcher should be wearying of sample bias when performing observations as this limits the generalisability of the findings.

Through quantitative data collected from a survey of the sample population, the research phenomenon can be studied using statistical tests. These tests can be used to understand the magnitude of the relationships between the constructs of Innovation Capabilities and the Business Value of Software. The underlying relationships are described through correlation coefficients used to measure the degree of relatedness between constructs (Fraenkel, 2011). This allows the study to determine the statistical effect of Innovation Capabilities on Firm Performance. As the study does not seek to manipulate the degree of innovation in real-world or simulated software development projects, but rather to understand the statistical relationship between the constructs at a given point in time as they occur in the field, the research study applied a relational cross-sectional survey research design and strategy.

In relational research, the aim is to study the relationship between two or more variables without attempting to manipulate them or explain the causal relationships (Fraenkel, 2011). Relational research investigates the possibility of a relationship through statistical analysis and ultimately, a correlation coefficient (Fraenkel, 2011). Since the study intends to measure both the dependant and independent variables at the same time, a cross-sectional survey strategy was selected (Bhattacherjee, 2012). Unlike experimental studies that manipulate independent variables and establish temporal precedence, causal inferences in relational studies are thus limited and can be made only with reference to theory. However, the advantages of a survey methodology are the ability to remotely collect data about a population that is too large to measure directly (Bhattacherjee, 2012). In addition, surveys have been noted to be unobtrusive and allow one to respond at their own convenience which is preferred by most respondents (Bhattacherjee, 2012). In some cases, including this study, surveys also allow the researcher to bridge geographical boundaries and conduct data collection in places they would not otherwise be able to reach.

3.3. Data Collection Methods

Data collection is the procedure that relates to how a particular phenomenon is observed and recorded (Creswell, 2003). Two primary considerations for data collection in a survey research design are the measurement instruments and the sampling strategy. These are discussed next.

3.3.1. Research Instrument and Measures

As part of research, more so in social science research, researchers propose theories to test the relationship between abstract constructs (Bhattacherjee, 2012). For a researcher to successfully test their theories they need to be able to accurately measure constructs before they can test the relationships within the theories. Operationalisation is concerned with the measurement of constructs. Once a construct has been defined in the conceptualisation phase, operationalisation develops indicators that are used to measure constructs (Bhattacherjee, 2012).

The process of operationalisation required a thorough search through literature to find any pre-validated measures that match the constructs or can be modified to measure the constructs. This approach helped to strengthen the content validity of the measures used in this research (Bhattacherjee, 2012). The items, sources and constructs being measured are summarised in Table 9 and are described in detail in Appendix A. These items were then used to form the questionnaire that was used in pre- and pilot testing before being sent to the sample. A seven-point Likert scale ranging from 1 (strongly disagree) through to 7 (strongly agree) was selected as the scale to measure the constructs in the questionnaire. In total, the research instrument will measure 11 constructs using 68 questions along with 5 control questions. Innovation Capability was measured using 3 constructs, these being Agility, Creativity and Collaboration. Agility was measured using 14 items to reflect the ability to display high levels of effectiveness through efficiency, adaptability, and flexibility (Cockburn and Highsmith, 2001; Misra et al., 2009; Vickery et al., 2010). Creativity was measured using 9 items that reflect the ability to develop new products and services as well as solving problems in a novel way (Schweitzer and Gabriel, 2012). Collaboration was measured using 8 items that reflect the increase in teaming over individual work (Brettel et al., 2011; Kahn, 2018; Schweitzer and Gabriel, 2012). The Business Value of Software was measured using 5 constructs, these being Value, Rarity, Inimitability, Non-Substitutability, and Immobility. Value was measured using 6 items that reflect software having value if it can be used by the firm in implementing strategies to improve efficiency and effectiveness (Nevo and Wade, 2011; Wade and Hulland, 2004). Rarity was measured using 3 items that reflect the limitation of a software, such that it is not simultaneously available to many firms (Nevo and Wade, 2011; Wade and Hulland, 2004). Inimitability was measured using 5 items that reflect the inability to easily replicate a software based on factors such as the software's history, ambiguity, and complexity (Nevo and Wade, 2011; Wade and Hulland, 2004). Non-substitutability was measured using 3 items reflecting how easily other firms can find alternative software to gain competitive advantage (Nevo and Wade, 2011; Wade and Hulland, 2004). Immobility was measured using 4 items that reflect how easily a firm can acquire software that allow it to imitate a rival's competitive advantage (Nevo and Wade, 2011; Wade and Hulland, 2004). Firm Performance was measured using 3 constructs, these being Operational, Strategic and Customer Benefits. Operational Benefits was measured using 9 items that reflect improved efficiency, resulting in increased revenues and cost reduction (Duan and Xu, 2012; Nevo and Wade, 2011). Strategic Benefits were measured using 4 items that reflect improved effectiveness that is likely to improve competitive positioning and enhanced flexibility in responding to market changes (Kim and Baek, 2018; Nevo and Wade, 2011). Customer Benefits was measured using 3 items that reflect the retention and attracting new of customers (Kim and Baek, 2018). The questionnaire is included in Appendix B.

To administer the survey, Google forms was chosen as the survey tool to facilitate the answering and capturing of participant responses. Online surveys have the benefits of being easily distributed, self-administered, cost effective and generally more flexible to changing, adding, or removing questions during data collection (Bhattacherjee, 2012; Jack R. Fraenkel, 2011). However, they are also associated with some disadvantages such as the lack of control over participants and consistency in the administration of the survey (Bhattacherjee, 2012; Jack R. Fraenkel, 2011).

Table 9. Summary of Constructs

Construct	**Operational Definition**	**Number of items**	**Example item ***	**Reference**
Agility	Agility is the ability to display high levels of effectiveness through efficiency, adaptability, and flexibility	14	"We had few problems accepting changing requirements"	Vickery et al. (2010), Sampietro (2016), Cockburn and Highsmith (2001), Misra et al. (2009)
Creativity	The ability to develop new products and	9	"We applied creative approaches towards	Schweitzer and Gabriel (2012)

	services as well as solving problems in a novel way		problem solving (e.g. design thinking, hackathons, new technologies)”	
Collaboration	the increase in teaming over individual work	8	“Our team shared the same vision and goals for projects”	Brettel et al. (2011), Kahn (1996), Schweitzer and Gabriel (2012)
Value	Software is said to have value if it can be used by the firm in implementing strategies to improve efficiency and effectiveness	6	“Users told us that the software we developed is useful”	Nevo and Wade (2011), Wade and Hulland (2004)
Rarity	Software rarity is defined by the limitation of a software, such that it is not simultaneously available to many firms	3	“Our competitors have not been able to implement similar software”	Nevo and Wade (2011), Wade and Hulland (2004)
Inimitability	The inability to easily replicate a software based on factors such as the software’s history, ambiguity, and complexity	5	“The software has given the organisation a competitive advantage that competitors can't match”	Nevo and Wade (2011), Wade and Hulland (2004)
Non-Substitutability	Substitutability defines how easily other firms can find alternative software to gain competitive advantage	3	“The organisation cannot easily replace the software with another solution”	Nevo and Wade (2011), Wade and Hulland (2004)
Immobility	Immobility refers to the degree to which software cannot be transferred between firms to imitate a rival’s competitive advantage.	4	“The software is difficult to acquire because it is specific to our organisation”	Nevo and Wade (2011), Wade and Hulland (2004)
Operational Benefits	Improved efficiency, resulting in increased revenues and cost reduction	9	“The software we built drives increased revenue for the organisation”	Nevo and Wade (2011), Duan and Xu (2012)
Strategic Benefits	Improved effectiveness that is likely to improve competitive positioning and enhanced flexibility in responding to market changes	4	“The software we built helps the business respond more quickly to change”	Nevo and Wade (2011), Kim & Baek (2018)

Customer Benefits	The retention and attracting new of customers	3	"The software represents our company to our customers"	Kim & Baek (2018)
Industry	Industry classification of firm	1	"Please indicate the industry for which the software was developed"	Control
Firm Size	The number of employees the firm has	1	"Please indicate the size of the organisation for which this software was developed, in terms of number of employees"	Control
Team Size	The size of the software development team	1	"Please indicate the size of your software development team (number of permanent team members)"	Control
Organisation Age	Age of the organisation in years	1	"How old is the organisation, in years?"	Control
Development Focus	Classification of type of software being developed	1	"Would you consider the software developed to be internally focused (operational/enterprise) or externally focused (customer facing application)?"	Control

* All multi-item scales measured on 7-point Likert-scale from 1 (strongly disagree) to 7 (strongly agree)

3.3.2. Sampling, Population and Respondents

In a perfect world, researchers would choose to study the entire population that is relevant to their question being investigated. However, due to feasibility and cost, the entire population cannot be studied. Instead, researchers select a smaller subset of the population that is representative of the entire population being studied (Fraenkel, 2011). This is what is known as a sample. Researchers use samples to make statistical inferences about the population (Bhattacherjee, 2012). In order to effectively draw a sample of the population, the unit of analysis as well as the sampling method of choice needs to be specified.

In order to test this study's hypotheses, a sample population is required to provide information on the Business Value of Software as well as their Innovation Capabilities in software development. The unit of analysis is thus the software development project. Given such requirements, a key informant approach will be used to provide an informed perspective of Innovation Capabilities as well as the Business Value of Software within software projects across a range of firms.

There are two options for sampling from the population. Probability sampling and non-probability sampling. Probability sampling refers to the method by which participants are identified through a random non-zero chance. In non-probability sampling, not all members of the population partake in the survey, being restricted to a known population by the researcher (Bhattacherjee, 2012; Jack R. Fraenkel, 2011). The key informant approach selected for this study follows a non-probability strategy in the form of convenience and snowball sampling. Convenience sampling is a non-random non-probability sampling method where a sample is drawn from a part of the population that is readily available or convenient (Bhattacherjee, 2012). The convenience sampling approach was used where senior software development professionals were identified through web-based channels such as LinkedIn or through software development forums. This approach allowed individuals to be identified through their titles, ensuring a higher chance of targeting the correct sample population. The key informants were represented by senior software development professionals involved with software development teams within their respective firms as these individuals were considered most informed of the software projects, products and services developed by their department. As an initial strategy, advanced search was used in LinkedIn to identify potential participants by their title. Participants were identified by their roles as either senior software engineers/developers, managers, leads, project managers, scrum masters or product owners. Participants were identified across multiple countries. Further, the research aimed to only survey participants that work with in-house software development teams within their respective firms. Specifically focusing on medium to large organisations, as most medium to large organisations have developed varying degrees of in-house software development capabilities. Advanced search was applied where candidates were shortlisted based on their title and whether they worked for a medium to large organisation. The size of organisations was identified by the researcher’s knowledge of the market, giving preference to publicly listed companies and their known subsidiaries.

These senior software development professionals represented the most informed group of individuals which could provide insight into Innovation Capabilities as well as the value of the software they produce. In summary, the key informants were selected because they were a senior professional or managed at least one team of software developers. As senior professionals or managers they were considered to have adequate knowledge of the value of the software developed by their team(s). Moreover, each key informant selected had several months experience within their team(s). This was to ensure the senior professional or manager had experienced multiple projects.

In addition, a snowball sampling approach was applied as an additional non-probability sampling strategy to supplement convenience sampling. Snowballing was achieved by requesting participants to forward the survey onto other senior software development colleagues in their networks. While non-probability methods of convenience and snowball sampling have disadvantages such as lower levels of generalisation due to lack of representation and potential bias in the sample, they had the benefit of being more practical, faster, and easier to conduct, allowing the researcher to target participants across a number of companies, countries, and contexts for which no readily available sampling frame existed.

The total target sample size was set based on previous research in software development outcomes such as those by Gorla and Lin (2010) as well as Lee and Chen (2017) who had sample sizes of 127 and 125 respectively. In order to obtain a similar number of participants, a larger sample frame was constructed to compensate for any participants that chose not to partake or opt out during the survey. A total of 207 invitations to participate in the study were sent out over a 10-month period from late 2020 to mid-2021. In addition, the survey was shared with three online software development related groups on LinkedIn.

3.3.3. Pre and Pilot Testing

3.3.3.1. Pre-Testing

The purpose of pre-testing is to support the literature review in establishing the content validity of items used. The pre-test of the questionnaire may reveal any ambiguity and poorly phrased questions as well as indicate whether the choices and structures are clearly understood by the respondents (Bhattacherjee, 2012; Fraenkel, 2011). This is important to eliminate potential irregularities before the questionnaire goes out for pilot testing or the final sample. Pre-testing is typically achieved by presenting the initial questionnaire to a small sample of respondents (Fraenkel, 2011).

For this study, a small pre-test was conducted with four participants. These included one academic, a senior IT executive, an owner of a software company and one software engineering team lead. As the target population are software development professionals, the pre-pilot targeted a broad range of professionals to ensure that the questions would be understood by most participants in the population.

3.3.3.2. Pilot Testing

The purpose of pilot testing (pilot study), sharing similar aspects to a pre-test, aims to ensure the questionnaire is well received by respondents. This ensures that there are no problems in answering questions and recording data (Saunders et al., 2009). Pilot testing primarily supports the face validity of measures, ensuring they are accessible and can be understood by participants. Pilot testing can also help assess the validity and reliability of the research instrument by allowing the researcher to run preliminary tests on the data, ensuring that the data collected will answer the research question (Bhattacherjee, 2012; Saunders et al., 2009). A small subset of the target population was identified for pilot testing in the research study, with ten responses considered adequate for the pilot. After the analysis of the ten responses, eleven additional items were added to the survey. Four of the additional items were added by splitting questions into two parts in order to remove ambiguity, while seven items were added to improve the strength of the measures due to low variation in responses received from pilot testers.

3.3.4. Questionnaire Administration

The questionnaire instrument was self-administered. A cover letter and invitation with a URL link to the survey was sent to the sampled participants (refer Appendix B). Google Forms was used to administer the questionnaire. The use of Google Forms was chosen to help ensure that the survey is made available to all participants regardless of geographic location, especially considering the research study may include participants throughout the world. However, a possible drawback of this self-administration method and use of an online tool is the lack of control over participants and consistency in the administration of the survey. To control for this drawback, questions were added such as on the job title of the participant to filter out any responses that might come from individuals outside the target population of the study.

3.4. Data Analysis Methods

In a survey study, two main components of data analysis that occur subsequent to initial data cleaning and screening are the tests for reliability and validity of the questionnaire instrument and hypothesis testing. These are discussed next.

3.4.1. Reliability and Validity

Before interpreting results of the research, the measures employed in the questionnaire should be judged on their reliability and construct validity (Bhattacherjee, 2012; Oates, 2006).

Scale reliability and construct validity are jointly used to measure the adequacy and accuracy of measurements used in survey research. Scale reliability is used to understand the degree of consistency or dependability of variables, while construct validity seeks to understand if items intended to measure a specific construct are correlated with each other (convergent validity) and not correlated with other items intended to measure different constructs (discriminant validity) (Bhattacherjee, 2012).

To test for reliability, internal consistency was assessed using Cronbach's alpha. When Cronbach's alpha is above 0.7, the scale is said to have an acceptable scale reliability. Measuring convergent and discriminant validity can be done using several techniques. The outcomes of these tests all aim to understand the correlation between items (inter-item correlations) or the relationships between items/variables and components to understand underlying structures (Bhattacherjee, 2012). In this study, principal components analysis (PCA) was used to test for convergent and discriminant validity. Convergent validity is achieved when items measuring constructs load onto their intended factors, with loadings above 0.60, and discriminant validity is achieved when items load below 0.40 on factors representing the constructs they are not intended to measure. Once satisfied with reliability and convergent and discriminant validity, composite scores can be calculated for use in subsequent hypothesis testing.

3.4.2. Hypothesis Testing

During hypothesis testing, the five main hypotheses (refer Table 8) were tested. The variables reflecting the constructs were measured using an interval scale, for which correlation, multiple regression and hierarchical regression analysis were used to test the hypothesis. Correlations were used to reach preliminary conclusions on relationships among variables. Thereafter, multiple regression analysis was carried out to test effects of multiple predictor variables(Bhattacherjee, 2012). The p-value associated with the beta-coefficients from the multiple regression analysis were used to determine if any conclusions could be drawn on the significance of the relationship between the independent and dependent variables. A p-value of < 0.10 was selected as indicative of a statistically significant finding. Hypotheses 1 to 3 were tested with Value, Rarity, Inimitability, Non-Substitutability/Immobility, Operational Benefits, and Strategic and Customer Benefits as the dependent variables while Agility, Creativity, and Collaboration were the independent variables.

Hypothesis four (4) was tested using hierarchical regression to control for the controlling variables as well as test the various complementary relationships between Innovation Capabilities. Hypothesis 5 was tested using Value, Rarity, Inimitability, Non-Substitutability/Immobility and a Business Value of Software composite as independent variables and Operational Benefits, and Strategic and Customer Benefits as the dependent variables.

3.5. Ethical Considerations

In conducting research, several ethical considerations were considered. These issues can be broken down into ethical considerations when conducting research and collecting results as well as when analysing data and reporting the results.

3.5.1. Ethical Issues in Conducting Research and Collecting Data

Poor quality of research design may lead to unwarranted and inaccurate conclusions. Overcoming poor research design involves understanding and evaluating research design methods with the help of university supervisors. Careful consideration was given to think about and assess the impact of the design choice and how it may affect the conclusions. The focus was placed on ensuring the research design suited the research question (Rosenthal, 1994). The advantages and disadvantages of survey methods, convenience sampling and use of self-administered online questionnaires were noted in this chapter.

Hyperclaiming and causism may lead to participants giving their time, attention and cooperation as well as possible participant bias (Rosenthal, 1994). To ensure that there is no volunteer bias in the study, the research will refrain from making grand claims (hyperclaiming) to achieve goals that are not realistic or to infer causal relationships (causism) that do not exist or have not been supported (Rosenthal, 1994). Characteristics of causism include a lack of evidential base, presence of language implying cause and self-serving benefits. The focus is to portray the truth of the findings, removing any hype, with the aim to increase transparency for the participants, and not waste their time (Rosenthal, 1994). During recruitment, participates were assured they:

- Had the option to voluntarily participate and withdraw at any time without risk or loss
- Gave informed consent by providing full information about the purpose of the study including what participation in the study will involve
- Had and will continue to have confidentiality in their responses where data will not be shared with third parties
- Had anonymity of responses where no identifying data was collected, and no attempt was made to identify and link respondents with their responses

As LinkedIn may be used to contact the participants, a disclaimer was included to remove any association with the researcher's personal professional profile and current or past employment.

Bad research is a waste of participants' time, effort as well as monetary values associated with the research. Bad research also makes for poor education. Like the issue of design, bad science was reviewed through the development of the research proposal under advice from a supervisor. Many research texts were consulted where research methods were investigated, best practice examples were reviewed and together were drawn on to develop the research approach. The research also underwent supervisor guidance to ensure the credibility of research design and methodology. In addition, both the proposal defence and clearance from the relevant university ethics committee further strengthened and validated the research standards. The university ethics committee issued an ethics clearance certificate protocol number CBUSE/1784, which is included as Appendix C.

3.5.2. Ethical Issues in Analysing the Data and Reporting the Results

Data dropping involves excluding data, including outliers, and not reporting the effects of doing so or explaining why they were excluded (Rosenthal, 1994). All data collected through questionnaires were included in the data analysis to reduce concerns over researcher bias during data collection. Where required, the study included context of how outliers were dealt with in the data analysis, to allow the reader to judge the merit of this decision.

Exploitation involves over analysing data to uncover results in something new and interesting not intended for study (Rosenthal, 1994). The data collection and analysis approach were thus developed closely with the hypotheses. This ensured that the right data is collected and analysed.

Ethical research also avoids both intentional and unintentional misrepresentation of data or representing false truth through error (Rosenthal, 1994). To reduce any intentional or unintentional misrepresentations, careful consideration was applied when selecting a sample population as well as the use of pre- and pilot testing. In addition, data was captured through an online survey tool to avoid transcription errors, data cleaning steps were clearly described, data analysis steps were reported in full, and results of analysis were presented in detail to avoid any unintentional misrepresentation of findings.

3.6. Limitations

Understanding and outlining the limitations of the research study is important for researchers to assess the quality of the research proposal and any possible flaws or shortcomings.

3.6.1. Threats to Internal and External Validity

Internal and external validity are used to assess the quality of research designs and are made up of several attributes (Bhattacherjee, 2012).

As positivist research aims to produce generalisable results, external validity seeks to understand if the researchers findings are generalisable (Oates, 2006). On the other hand, internal validity is concerned with whether the casual relationships stated by the researcher actually exist in reality, or if they could be a result of unrelated variables (Bhattacherjee, 2012; Oates, 2006).

There is belief amongst researchers that there is a trade-off between internal and external validity, sacrificing one for the other (Bhattacherjee, 2012), with some research designs better at promoting internal than external validity and vice-versa. This is shown in Figure 10.

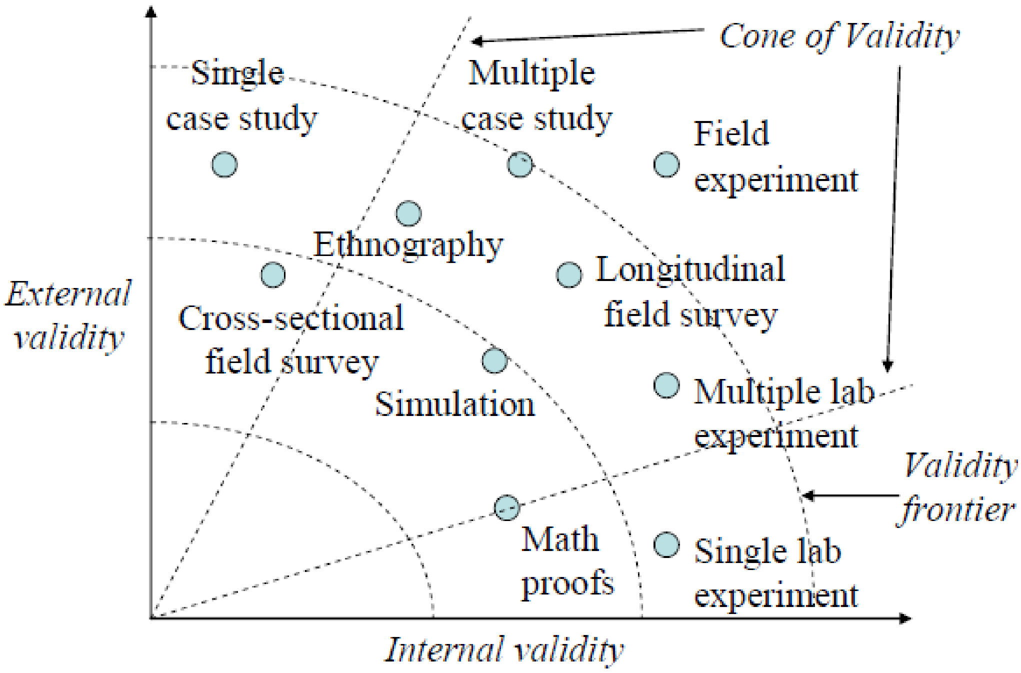

Figure 10. External vs Internal validity of research methods (Bhattacherjee, 2012, p. 36)

The research method of this study was a relational cross-sectional field survey. As seen in Figure 10, the choice of cross-sectional field surveys is associated with high external validity, but only when random sampling of a representative subset of the population is employed, and with low internal validity, due to the lack of temporal precedence and control over confounding effects.

With some cross-sectional field surveys, lower external validity results from the use of non-probability sampling techniques (Bhattacherjee, 2012). The use of non-probability samples may introduce risk to inferring general laws and patterns across the population. Because this study employs a key informant convenience sampling technique, external validity is threatened and therefore no strong claims can be made about the generalisability of results. The sampling method identified focuses on key informants that manage software development within firms. This approach may prove difficult in finding key informants that match the sampling criteria as firms do not make public their software development departments. Not being able to source a representative sample of software projects does pose a threat to the external validity, i.e., generalisability, of the research study results (Bhattacherjee, 2012). Nonetheless, the participants represent an important sample of projects and provide the ability to generate key insights into relationships among the study's variables.

Internal validity of the study is threatened by the cross-sectional approach applied, i.e., data about independent and dependent variables was collected at the same point in time from a single key informant. Studies that measure the cause-and-effect variables at the same time remove the ability to measure the preceding effect of time, ultimately making the cause-and-effect relationship between variables questionable (Bhattacherjee, 2012). To increase the internal validity of the study, elimination of extraneous variables was applied by holding them constant across the study. This was accomplished by restricting the study to key informants that manage Innovation Capabilities within a firm. Control variables such as the size of the company, specific industry as well as size of software teams were also included to better isolate the effects of the hypothesised independent variables.

Other limitations of surveys are also acknowledged. These include:

- Response pattern – the tendency for a participant to answer questions based on a non-random pattern (Bhattacherjee, 2012)
- Response bias - the tendency for a participant to inaccurately answer the survey questions (Bhattacherjee, 2012)
- Non-response bias – this may occur when a participant does not respond to the survey or partially completes the survey due to factors that differ systematically from those who did respond (Saunders et al., 2009)
- Common-methods bias – this occurs when the observed relationships between factors are attributed to their incorporation in a single research instrument (the method) rather than because they actually covary in the real-world (Bhattacherjee, 2012)

3.7. Conclusion

This chapter outlined the research methodology and approach as it pertains to the study. Firstly, the research paradigm was introduced and discussed, followed by the research design and methodology. The data collection method introduced the research instrument, the sample population and the pre-, pilot and questionnaire administration approach. The data analysis approach was introduced and finally the ethical considerations and limitations of the study were discussed.

4. CHAPTER 4 – DATA ANALYSIS

4.1. Introduction

This chapter of the report presents the results of the data analysis. Firstly, the data is screened, then missing data and outliers are handled and, finally, the data is checked for any response patterns. After the initial screening, a response profile is presented using descriptive analysis of responses, after which, reliability and validity testing of the instrument is presented. The last section of the chapter presents the correlation and regression analyses performed for hypothesis and mediation testing.

4.2. Data Screening

The data was collected using the method previously outlined in the research methodology section. The survey resulted in 68 responses, 10 of which were part of the pilot study, which were excluded. The overall response rate was lower than the target response rate. This was despite the study employing a convenience and snowball strategy which relied on participants reaching out to their networks. Data was collected over the course of 10 months. Of 58 responses, 2 responses were excluded from the analysis due to having substantial amounts of missing data in their responses. Therefore, a total of 56 remaining responses were included for further analysis.

4.2.1. Missing Data

An analysis was done to understand the extent of missing data across the remaining 56 responses. A descriptive frequency table of each question was produced (Appendix D). The results show that most participants completed all the questions and only 4 of the 56 useable responses were missing only 1 question each.

Table 10. Distribution of Total Missing Responses

Number of questions with missing data	**Count**
0	52
1	4

To handle these missing data points, an independent sample T-test was run to ensure there were no relationships between the missing data and other variables. The results confirmed that the missing responses were random and not due to other variables. The decision was made to use a simple series mean to impute the missing data on those 4 questions. This resulted in a dataset with no missing values and final participant count of 56 for inclusion in the next stage of analysis.

4.2.1. Outlier Analysis

Outlier analysis is necessary to ensure that all responses fall within the study's population. The analysis can help identify any unusually high or low values which may indicate that a participant was not from the population of interest. The SPSS Standardised Score function was used to calculate the z=scores of the responses. Bhattacherjee (2012) advises that standardised scores ±3 standard deviations from the mean should be treated as extreme values. However, a determination needs to be made when considering if a response is a true outlier before eliminating them from further analysis. The presence of several extreme responses within the same constructs may be indicative of an outlier. The standardised score indicated that 2 participants were outliers as seen by the box and whisper plots shown in Appendix E. Reponses 19 and 23 scored outside 3 standard deviations on 6 and 5 questions respectively (Table 11) and were thus removed from the study.

Table 11. Breakdown of outliers

Respondent	Construct	Count	% of Construct Items
19	Collaboration	3	38%
	Agility	3	21%
23	Collaboration	5	63%

4.2.2. Other Considerations

No questions used reverse scoring and thus no responses were reversed in the data preparation process. In addition, the analysis did not show any response patterns that would have suggested respondents did not respond conscientiously to the instrument. After all cleaning and preparations steps described above, 54 useable responses remained and were included for analysis in the study.

4.3. Respondent Profile

4.3.1. Job Titles

The 54 respondents were classified by their self-reported job titles and the summary statistics for these job titles are presented below in table 12:

Table 12. Job Title Statistical Distribution

Title	Number	Percentage (%)
Software Development Manager/Lead*	12	22%
Senior Software Developer*	19	35%
Project Manager\Scrum Master	12	22%
IT Manager\Lead**	9	17%
Product Manager	1	2%
Product Owner	1	2%

** Includes engineers, developers, and application developers*
*** Includes Heads of Departments, Program\Practice Leads*

Senior professionals involved with software development were the target audience, which accounted for majority of the responses. Overall, the job titles used suggested respondents would be sufficiently familiar with the software development processes and thus appropriate informants for the survey.

4.3.2. Cities and Regions

The city field (“Please indicate in which city you work?”) resulted in several abbreviations such “Jhb”, as well as city names that included country. After correcting and mapping the city names, the results were as follows:

Table 13. City Statistical Distribution

City	Number	Percentage (%)
Johannesburg	29	54%
London	13	24%
Cape Town	3	6%
Petah Tikva	1	2%
Hong Kong	1	2%
Washington	1	2%
Frankfurt	1	2%
Brisbane	1	2%
Pretoria	1	2%
Oirsbeek	1	2%
Kuala Lumpur	1	2%
Bratislava	1	2%

In addition to the city mapping, region was derived by mapping each city to MEA, Europe, Americas, and Asia to assist with grouping responses for regional analysis. The results are shown below:

Table 14. Region Statistical Distribution

Region	Number	Percentage (%)
MEA	34	63%
Europe	16	30%
Asia	3	6%
Americas	1	2%

The distribution of cities and regions aligns to the target audience. In this instance, surveys were global but with a larger emphasis on the South African market. South Africa accounts for 60% of the responses with the remaining 40% distributed across Europe, Asia, and North America.

4.3.3. Industry

Responses were grouped into broad industry sectors. As an example, banking, insurance and finance were classified into financial services. A summary of the broad industries is presented below:

Table 15. Industry Statistical Distribution

Industry	Number	Percentage (%)
Financial Services	26	48%
IT	12	22%
Telecommunications	4	7%
Manufacturing	4	7%
Public Sector	2	4%
Retail	2	4%
Legal	1	2%
Logistics	1	2%
Agriculture	1	2%
Healthcare	1	2%

The results were somewhat skewed toward financial services. This is likely due to the more information intensive nature of financial services, with many software projects in development among banks and insurers as well as fintech start-ups and digital-only banks. In addition, the financial services sector is considered among the most under pressure to innovative (Bos et al., 2013).

4.3.4. Team Size

The results of the team size distribution are presented in Figure 11 with the use of a histogram. The bin size of 5 was selected to group team sizes. The results show a right-skewed histogram with most teams between 0 and 10 team members in size. The average team size is 22.85 and the median is 7.5. The average team size was skewed by three teams with greater than 50 members. In software projects, team size tends to be correlated with the complexity of code, as measured in number of functions and effort hours (Heričko et al., 2008). Optimal team sizes vary between 2 and 18 developers with a middle ground of 7 being optimal in most cases (Heričko et al., 2008). This supports the distribution of team size seen in the sample population.

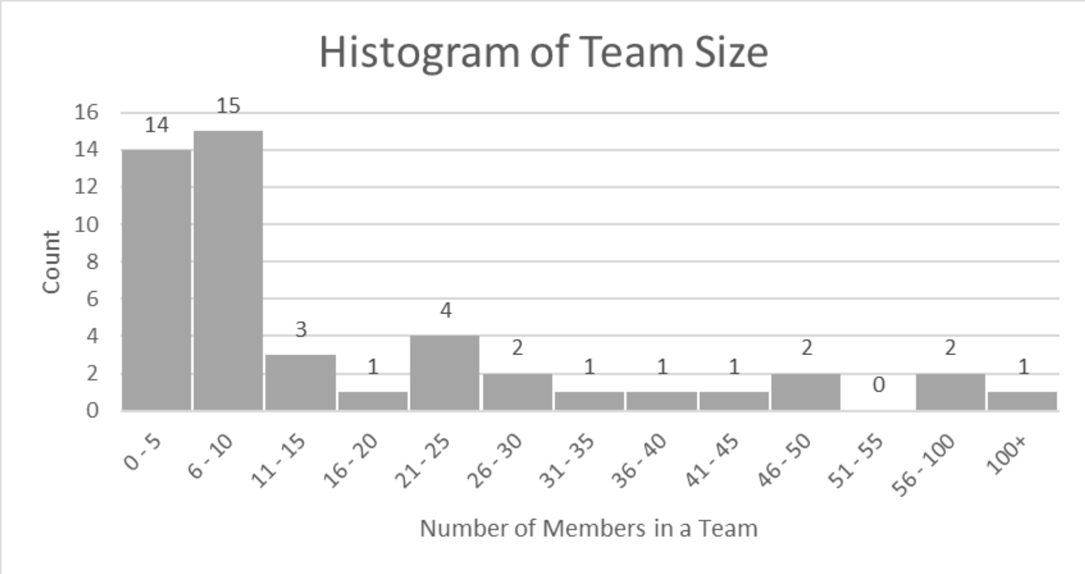

Figure 11. Team Size – Histogram

4.3.5. Organisational Size

The size of organizations varied from medium software start-up companies to large global multinationals. Majority of the respondents were represented by companies with less than 3000 employees.

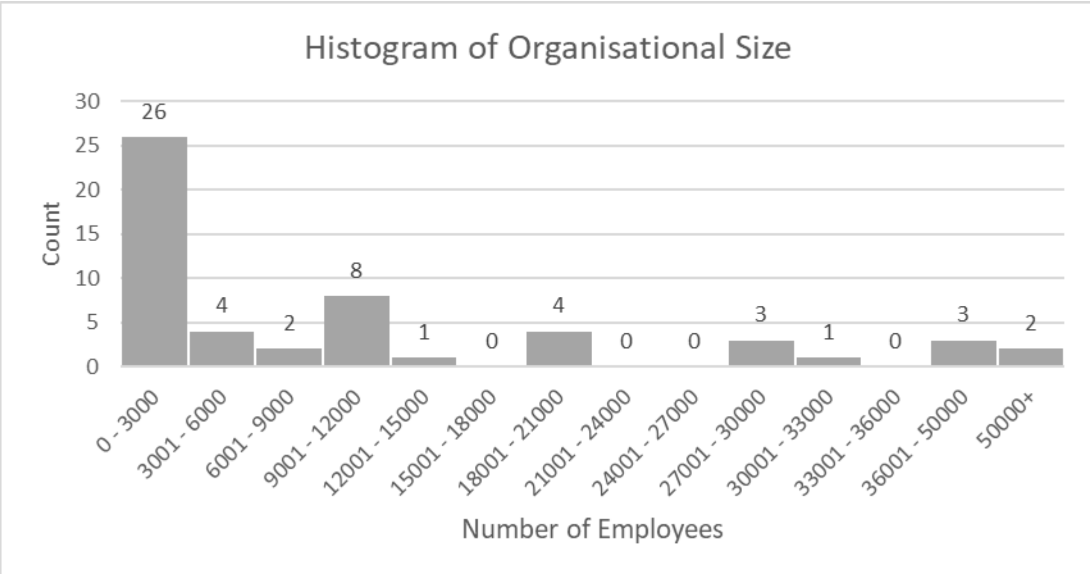

Figure 12. Organisational Size – Histogram

4.3.6. Organisational Age

The organisational age is skewed towards older companies that have been operating for more than 10 years, with a majority in operation for more than 50 years.

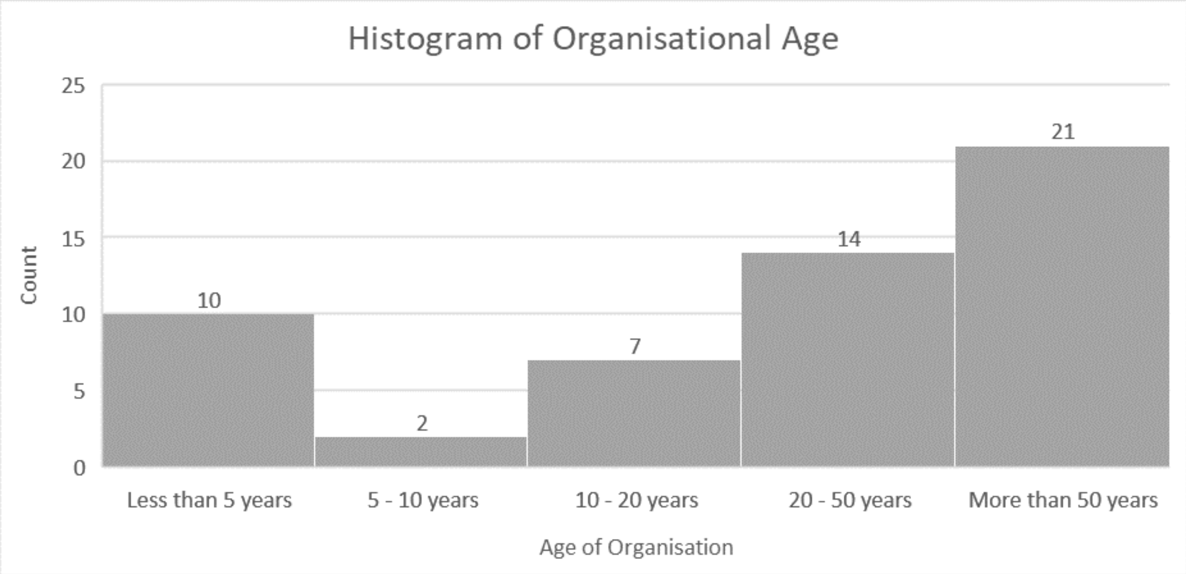

Figure 13. Organisational Age – Histogram

4.3.7. Intent to Innovate

The majority of the respondents indicate that the software development project to which they referred had an intention to innovate and were thus considered appropriate for the study.

Table 16. Intent to Innovate Distribution

Intent to Innovate	Number	Percentage (%)
Yes	49	90.7
No	5	9.3

4.3.8. Development Focus

The development focus of organisations was split between Internal, External and a combination of the two when determining the purpose of the software developed. The results indicated that most projects were internally focused.

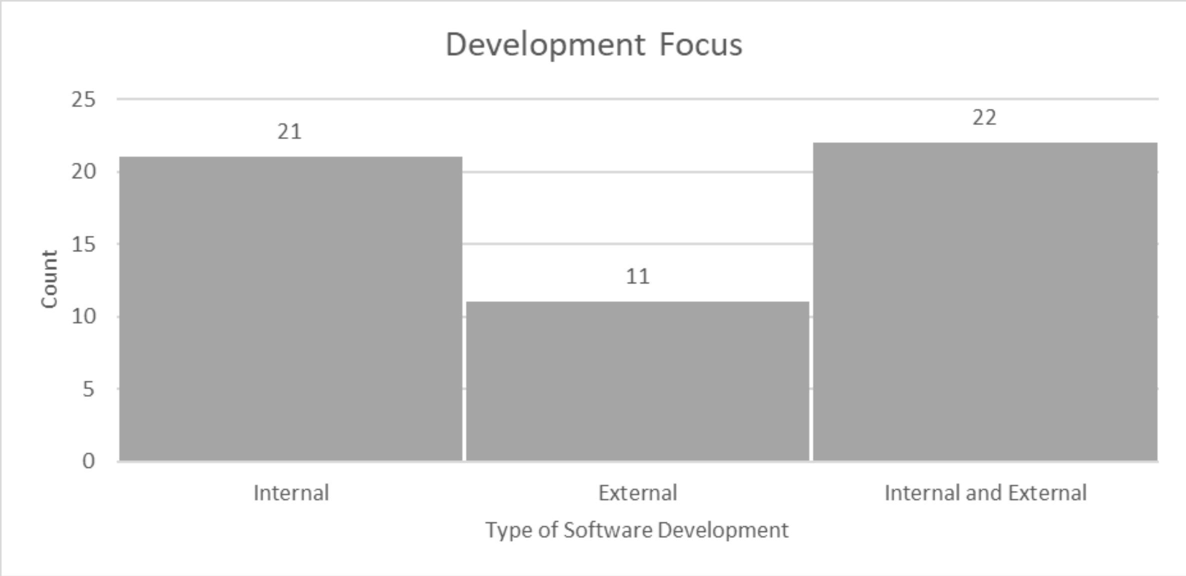

Figure 14. Development Focus

Overall, the respondents were largely senior software developers, team leads and product managers from a range of medium through large companies operating across countries and regions but with a skew towards South Africa and a strong representation of financial services firms. The average team size is 22.85, skewed with most teams being smaller than 10 members and the median team size being 7.5. The team sizes are within with expected range for software development. The types of projects were split between internal, external and a combination of the two, with more projects being internally focused. Overall, the response profile sufficiently describes the target audience for the study.

The next step in the data analysis process is to consider the descriptive statistics for each of the questionnaire items associated with the Innovation Capabilities in the Software Development construct.

4.3.9. Descriptive Statistics on Innovation Capabilities in Software Development

Innovation Capabilities in Software Development was conceptualised through three constructs, these being Collaboration, Creativity, and Agility.

4.3.9.1. Collaboration

Initially, eight (8) items were used to measure collaboration. The descriptive statistics suggested that most firms were sharing information between team members and working together towards a shared project goal. However, there was less agreement that teams relied on informal and ad-hoc approaches to work together.

Table 17. Collaboration Descriptive Statistics.

Item	Wording	Mean	Std. Deviation
Collaboration1	Our team members interacted in an informal way (e.g., irregular or unscheduled meetings)	4.37	1.794
Collaboration2	Our team members worked together on an ad-hoc basis	4.72	1.731
Collaboration3	We promoted sharing of information amongst team members	6.44	.691
Collaboration4	We used informal methods (e.g. Micrososft Teams channels) where team members could share information	6.00	1.197
Collaboration5	We used formal methods (e.g. documentation repositories) where team members could share information	5.50	1.551
Collaboration6	We promoted sharing and exchanging of resources and work results between team members (e.g. blanks, prototypes)	5.76	1.288
Collaboration7	Our team shared the same vision and goals for projects	5.72	1.123
Collaboration8	We worked together as a team to achieve the project goals	6.20	.998

Figure 15 (see page 63) shows the collaboration practices ordered from highest to lowest based on their mean values, along with the percentage of respondents agreeing or strongly agreeing with their use of the practice.

4.3.9.2. Creativity

Nine (9) items were used to measure creativity. The descriptive statistics suggested that respondents tended to agree they were applying creative problem-solving approaches with their development of software, however, few additional resources or incentives are used to motivate teams to apply creative problem-solving techniques.

Table 18. Creativity Descriptive Statistics

Item	Wording	Mean	Std. Deviation
Creativity1	We applied creative approaches towards problem solving (e.g. design thinking, hackathons, new technologies)	5.19	1.716
Creativity2	We actively encourage creative and innovative approaches	5.72	1.352
Creativity3	Tangible (eg. cash incentives, bonus, prizes and other such rewards with financial value) rewards were used to encourage creative and innovative approaches	2.80	2.013
Creativity4	Intangible (eg. Praise, thanks, public acknowledgment/recognition) rewards were used to encourage creative and innovative approaches	5.09	1.708
Creativity5	Our team generated creative solutions	5.61	1.235
Creativity6	Time was allocated to team members for generating new/unique ideas	4.39	1.774
Creativity7	Resources were allocated to teams for generating ideas	4.19	1.894
Creativity8	The team created novel and useful ideas on task-related issues	5.02	1.486
Creativity9	The team created knowledge that had not existed before the team was formed	5.30	1.586

Figure 16 (see page 63) shows the creativity practices ordered from highest to lowest based on their mean values, along with the percentage of respondents agreeing or strongly agreeing with their use of the practice.

4.3.9.3. Agility

Agility was represented by fourteen (14) items. The descriptive statistics suggest that respondents reported more agreement on their teams' ability to release software frequently, incorporate customer feedback and accommodate changing requirements. However, teams reported not to depend on face-to-face interactions to achieve agility and scored low on the speed to deliver software. Accepting changing requirements is not uncomplicated and can be a problem for some teams.

Table 19. Agility Descriptive Statistics

Item	Wording	Mean	Std. Deviation
Agility1	We had few problems accepting changing requirements	4.35	1.519
Agility2	We were open to changing requirements	5.50	1.112
Agility3	We took an approach that allowed us to easily adjust to unexpected changes/events	5.52	1.177
Agility4	We were able to easily overcome issues during software development	5.06	1.156
Agility5	We produced the software in a short period of time	4.67	1.614
Agility6	We used short development iterations	5.74	1.119
Agility7	We initially used rough design specifications for software products	5.30	1.298
Agility8	We frequently released working versions of software during development	5.33	1.554
Agility9	We used working software as our measure of progress	5.26	1.482
Agility10	We chose to prioritise items from a product backlog	5.78	1.254
Agility11	We frequently collaborated with our customers	5.44	1.679
Agility12	We requested frequent feedback from our customers	5.54	1.551
Agility13	We worked closely with businesspeople	5.48	1.489
Agility14	We relied on face-to-face conversations	3.72	1.837

Figure 17 (see page 64) shows the agility practices ordered from highest to lowest based on their mean values, along with the percentage of respondents agreeing or strongly agreeing with their use of the practice.

Overall, the descriptive statistics associated with Innovation Capabilities in Software Development, described by collaboration, creativity and agility showed that most teams worked together towards a shared project goal, applied creative problem-solving approaches, released software frequently, incorporate customer feedback and accommodated changing requirements. However, few teams achieved innovation by interacting in ad-hoc ways, relying on face-to-face interactions, or extrinsic incentives to produce creative solutions to problems. The statistics showed that teams scored slightly higher for collaboration and agility items when compared to creativity.

Given the previous descriptive analysis, the next step in the data analysis was to verify the reliability and validity of the measures used to capture the study's constructs. Results of this analysis are presented next.

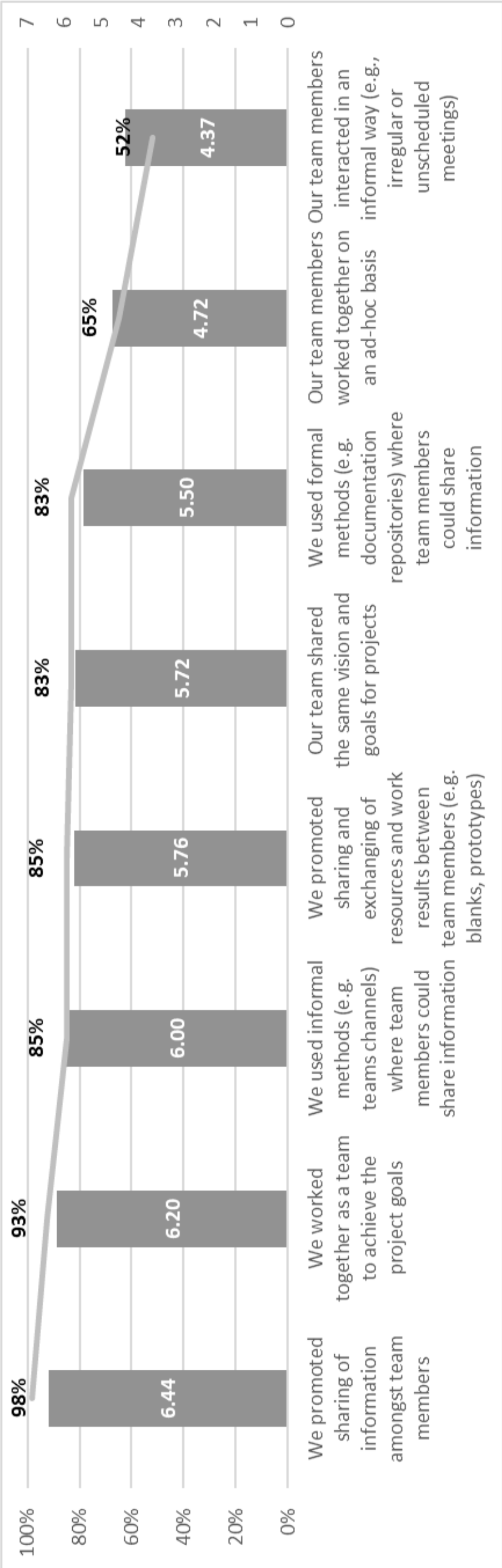

Figure 15. Collaboration Mean vs Agreement Response

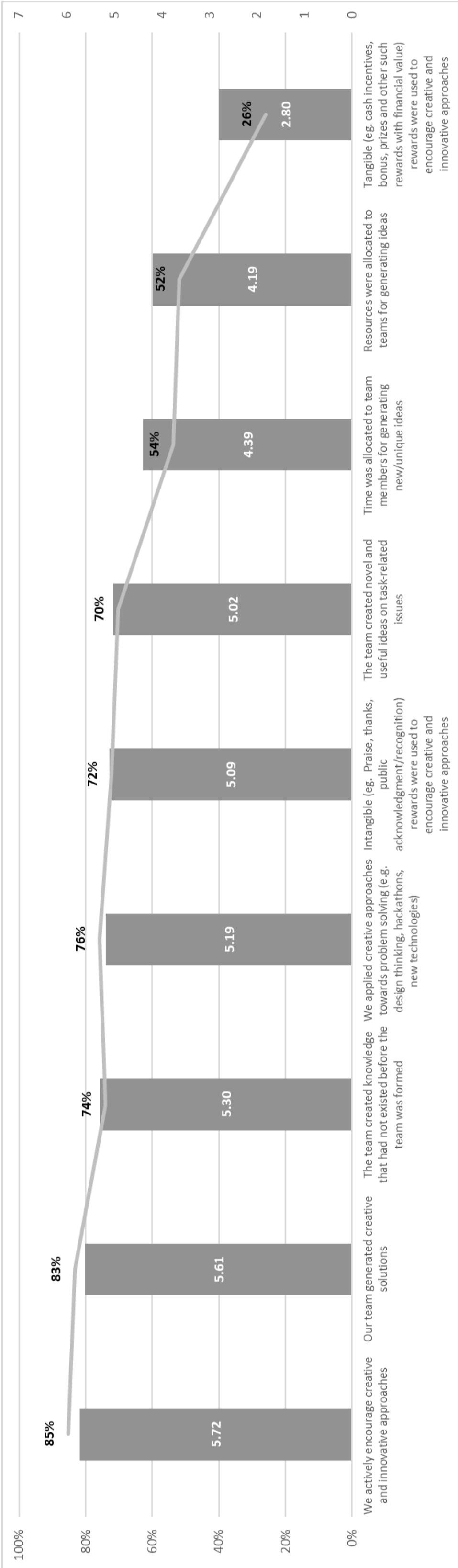

Figure 16. Creativity Mean vs Agreement Response

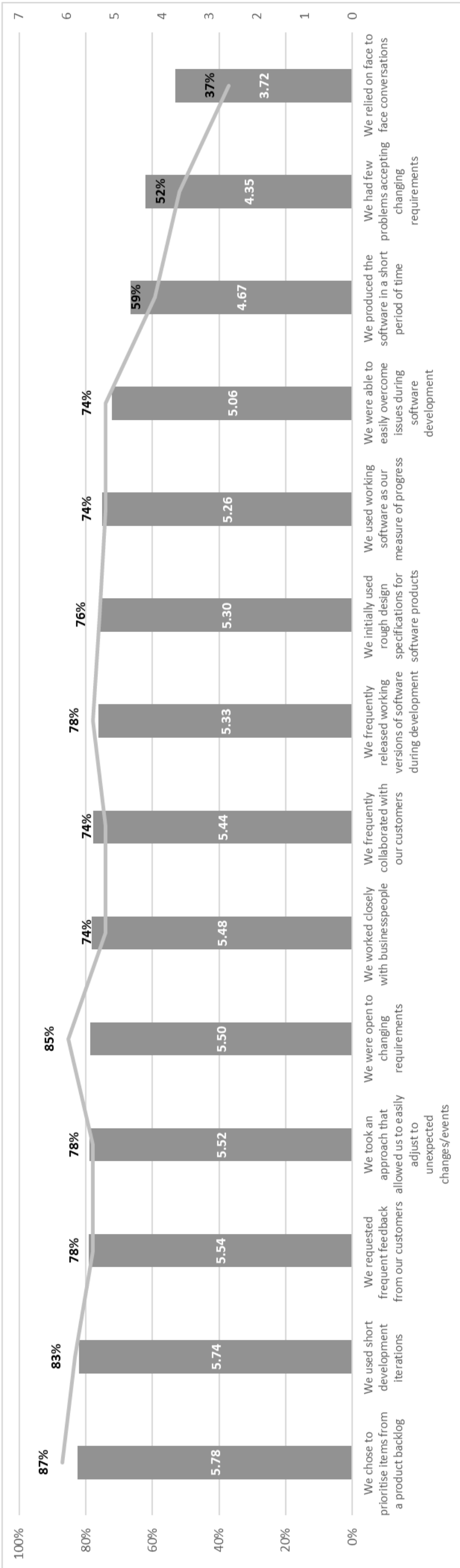

Figure 17. Agility Mean vs Agreement Response

4.4. Scale Validity and Reliability

An initial review was conducted by performing a bivariate correlation, reliability test and principal components analysis (PCA) on each construct as well as on sets of constructs. A bivariate analysis on items is used to understand how well items from the same construct correlate with each other. Items from the same construct should be more highly correlated (convergent validity) when compared to different constructs (discriminant validity). Principal components approach to factor analysis is used to measure unidimensionality by showing that a variable's measurement items load strongly onto a single component. This also provides evidence of convergent and discriminant validity by showing items' load onto their own construct and not onto others. The factor analysis procedure also provides the Kasier-Meyer-Olkin (KMO) measure of sampling adequacy, where the minimum acceptable value is 0.6 but ideally should be greater than 0.8, and the communalities of items. Together, these scores provide an indication that the items are factorable and can be used with Principal Component Analysis (PCA). Lastly, the SPSS reliability test provides a measure of internal consistency as defined by Cronbach's Alpha, used to assess scale reliability.

4.4.1. Innovation Capabilities in Software Development sub-group analysis

Each of the three dimensions of Innovation Capabilities in Software Development, i.e. Collaboration, Creativity and Agility, were subjected to initial tests of reliability and validity.

4.4.1.1. Collaboration

The construct to measure collaboration consisted of eight (8) items. An initial test of reliability using Cronbach's alpha along with an initial PCA to confirm unidimensionality revealed a low Cronbach's Alpha (0.56) with the PCA results showing items loading across three components, as opposed to a single component. The initial PCA results are shown below (Table 20):

Table 20. PCA with Varimax Rotation

Rotated Component Matrix[a]

	Component		
	1	2	3
Collaboration1		.827	
Collaboration2		.829	
Collaboration3			.631
Collaboration4			.839
Collaboration5	.757		
Collaboration6	.846		
Collaboration7	.700		
Collaboration8	.692		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 7 iterations.

The results above imply that the items used to measure collaboration were measuring different dimensions of collaboration. Collaboration, as defined in this study, is the increase in teaming over individual work. The PCA was rerun forcing a one-factor solution, which suggested items 1, 2, and 4 be omitted. Thus, after reviewing the definition and the result questions, items 3, 5, 6, 7 and 8 were kept and the resulting items loaded against one construct with a Cronbach's Alpha of 0.751 and KMO score 0.677. Although item 3 scored below the threshold of 0.6, a value of 0.596 was considered close enough to retain item 3. The results are shown below. The retained items relate to sharing of information, shared goals and working together as a team.

Table 21. Forced one factor solution

Component Matrix[a]

	Component
	1
Collaboration1	
Collaboration2	
Collaboration3	.596
Collaboration4	
Collaboration5	.635
Collaboration6	.731
Collaboration7	.793
Collaboration8	.797

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Table 22. Final loading of retained collaboration items

Component Matrix[a]

	Component
	1
Collaboration3	.585
Collaboration5	.669
Collaboration6	.763
Collaboration7	.785
Collaboration8	.785

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.1. Creativity

The analysis of creativity revealed a strong initial Cronbach Alpha of 0.863 however PCA results showed items loading across two components (Table 23).

Table 23. PCA with Varimax Rotation

Rotated Component Matrix[a]

	Component	
	1	2
Creativity1		.617
Creativity2		.805
Creativity3		
Creativity4		.878
Creativity5		.774
Creativity6	.746	
Creativity7	.862	
Creativity8	.882	
Creativity9		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Although the Cronbach Alpha was above the recommended threshold of 0.7, loading onto two components resulted in the items being reviewed against the definition of creativity as defined in this study. Creativity is focused on the ability to develop new products and services as well as solving problems in a novel way. Thus, items 1 through 5 were omitted, as well as item 9. The resulting Cronbach Alpha measured at 0.83 and items 6, 7 and 8 loading onto a single component accounting for 75.5% variance and a KMO score of 0.72. The results are shown in table 24. The retained items relate to the allocation of time and resources for generating ideas as well as the creation of novel and usual ideas.

Table 24. Final loading of retained creativity items

Component Matrix[a]

	Component
	1
Creativity6	.858
Creativity7	.893
Creativity8	.855

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.1. Agility

The construct of Agility was made up from fourteen (14) items. An initial reliability test in SPSS revealed that 3 items had an item-to-total correlation below the recommended threshold of 0.4 and were omitted before further analysis was performed. The resulting analysis of the 11 items showed a Cronbach Alpha of 0.83, however the PCA results showed loading onto three components.

Table 25. PCA with Varimax Rotation

Rotated Component Matrix[a]

	Component		
	1	2	3
Agility2		.803	
Agility3		.794	
Agility4		.576	
Agility5			
Agility6	.574		
Agility8		.581	.531
Agility9			.693
Agility10			.868
Agility11	.871		
Agility12	.855		
Agility13	.749		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

A similar process was followed as with Collaboration and Creativity. The items used were reviewed against the definition of Agility and the items that were closely aligned were kept and the analysis was run again. As a result, items 2, 3, 4 and 8 were kept in the study. The PCA on the four items revealed that item 4 loaded poorly and removing item 4 would result in an improved final alpha. Thus, item 4 was omitted from the study. The three remaining items resulted in a Cronbach Alpha of 0.59 and loading onto one component which accounted for 66.41% of the variance and a KMO score of 0.64. The results are shown below. The retained items relate to changing requirements, ease of overcoming difficulties and releasing frequent working versions of software.

Table 26. Final loading of retained Agility items

Component Matrix[a]

	Component
	1
Agility2	.874
Agility3	.827
Agility8	.738

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.1. Innovation Capabilities in Software Development

The remaining items for each of the three constructs associated with Innovation Capabilities in Software Development were subsequently analysed using PCA and KMO. The results are presented in table 27 below:

Table 27. PCA with Varimax Rotation

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Collaboration3			.578	
Collaboration5				.887
Collaboration6				.611
Collaboration7			.833	
Collaboration8			.801	
Creativity6	.724			
Creativity7	.884			
Creativity8	.789			
Agility2		.871		
Agility3		.791		
Agility8		.660		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 7 iterations.

The resulting PCA on Innovation Capabilities in Software Development suggested that collaboration 5 and 6 were not loading with 3, 7 and 8. Thus, these two items were omitted from the study to produce a stable solution, as per table 28.

Table 28. Stable solution PCA with Varimax Rotation

Rotated Component Matrix[a]

	Component		
	1	2	3
Collaboration3			.639
Collaboration7			.848
Collaboration8			.787
Creativity6	.779		
Creativity7	.910		
Creativity8	.747		
Agility2		.892	
Agility3		.799	
Agility8		.634	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.

The analysis shows that the constructs used for Innovation Capabilities in Software Development were not unidimensional. The analysis of each of the constructs revealed that items needed to be omitted to produce a stable solution for Innovation Capabilities in Software Development. In addition to the final PCA results presented above, the components accounted for 71.3% of the variance and had a KMO score of 0.73. An overall summary is presented below:

Table 29. Innovation Capabilities in Software Development Summary

Construct	No. of original items	No. of surviving items	Cronbach's alpha	Mean of Composite	Std Dev of Composite	Skewness	Kurtosis
Collaboration	8	3	0.751	6.1235	.76423	-.631	-.529
Creativity	9	3	0.83	4.5309	1.49565	-.454	-.578
Agility	14	3	0.59	5.4506	1.03838	-.656	-.148

The three items for collaboration reflected information sharing, a shared vision and achieving goals collectively. The three items for creativity reflected time available for idea generation, resources available for idea generation and novel and useful idea. The three items for agility reflected handling changing requirements, adjusting to unexpected events and frequent releases of working software.

4.4.2. Business Value of Software sub-group analysis

4.4.2.1. Value

The Value construct consists of six (6) items. These items adequately described the Value construct with a Cronbach's Alpha of 0.92, KMO score of 0.82 and loading onto one component which described 72.6% of the variance. No items were omitted because of the findings.

Table 30. Value items component matrix

Component Matrix[a]

	Component 1
Value1	.789
Value2	.878
Value3	.841
Value4	.877
Value5	.866
Value6	.858

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.2.2. Rarity

The Rarity construct consists of three (3) items. These items adequately described the Rarity construct with a Cronbach's Alpha of 0.89, KMO score of 0.74 and loading onto one component which described 81.5% of the variance. No items were omitted because of the findings.

Table 31. Rarity items component matrix

Component Matrix[a]

	Component 1
Rarity1	.903
Rarity2	.922
Rarity3	.882

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.2.3. Inimitability

The Inimitability construct consists of five (5) items. These items adequately described the Inimitability construct with a Cronbach's Alpha of 0.86, KMO score of 0.81 and loading onto one component which described 64.5% of the variance. No items were omitted because of the findings.

Table 32. Inimitability items component matrix

Component Matrix[a]

	Component 1
Inimitability1	.811
Inimitability2	.829
Inimitability3	.881
Inimitability4	.725
Inimitability5	.761

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.2.4. Non-substitutability

The Non-substitutability consists of three (3) items. These items adequately described the Non-substitutability construct with a Cronbach's Alpha of 0.79, KMO score of 0.71 and loading onto one component which described 70.9% of the variance. No items were omitted because of the findings.

Table 33. Non-substitutability items component matrix

Component Matrix[a]

	Component 1
Non-substitutability1	.836
Non-substitutability2	.834
Non-substitutability3	.856

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.1. Immobility

The Immobility construct consists of four (4) items. These items adequately described the Inimitability construct with a Cronbach's Alpha of 0.75, KMO score of 0.73 and loading onto one component which described 57.8% of the variance. No items were omitted because of the findings.

Table 34. Immobility items component matrix

Component Matrix[a]

	Component 1
Immobility1	.678
Immobility2	.802
Immobility3	.702
Immobility4	.846

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.1. Business Value of Software

Each of the surviving items associated with the constructs for Business Value of Software were then analysed using PCA, KMO and Cronbach's Alpha. The results found that two items from Inimitability loaded onto Rarity and these were thus omitted from the study. One item from Non-substitutability loaded against two components and was also omitted. One item from Immobility did not meet the coefficient cut-off and was omitted. Further analysis revealed that Non-substitutability and Immobility loaded onto one construct. As both these constructs measure the degree to which a business can source alternative software products, either through imitation or acquisition, the loading was acceptable and could be combined to form a new construct. The results are shown in table 35:

Table 35. PCA with Varimax Rotation

Rotated Component Matrix[a]

	Component 1	2	3	4
Value1	.774			
Value2	.892			
Value3	.826			
Value4	.836			
Value5	.824			
Value6	.844			
Rarity1			.882	
Rarity2			.798	
Rarity3			.739	
Inimitability3				.603
Inimitability4				.877
Inimitability5				.763
Non-substitutability2		.674		
Non-substitutability3		.718		
Immobility2		.551		
Immobility3		.892		
Immobility4		.566		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

The analysis shows that the constructs used for the Business Value of Software were unidimensional and loaded well, except for Non-substitutability and Immobility which loaded onto one construct. In addition to the above PCA, the components accounted for 73.1% of the variance and had a KMO score of 0.79. An overall summary is presented below:

Table 36. Business Value of Software Summary

Construct	No. of original items	No. of surviving items	Cronbach's alpha	Mean of Composite	Std Dev of Composite	Skewness	Kurtosis
Value	6	6	0.92	5.9074	1.06481	-.980	.291
Rarity	3	3	0.89	4.1111	1.64833	.020	-.877
Inimitability	5	3	0.78	3.2593	1.51812	.593	-.384
Immobility and non-substitutability	7	5	0.83	4.2733	1.45339	.010	-.476

4.4.2. Firm Performance sub-group analysis

4.4.2.1. Operational Benefits

Operational benefits were tested using 9 items. The analysis revealed good scores for Cronbach's Alpha and KMO, however, the items were not unidimensional and loaded across three components.

Table 37. Initial loading of operational benefits

Rotated Component Matrix[a]

	Component		
	1	2	3
Operational-benifits1		.757	
Operational-benifits2			.967
Operational-benifits3		.735	
Operational-benifits4		.856	
Operational-benifits5	.860		
Operational-benifits6	.591	.545	
Operational-benifits7	.905		
Operational-benifits8	.852		
Operational-benifits9	.941		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.

A review of the items favoured those that tested the actual operational performance of the software and thus items 5, 6, 7, 8 and 9 were kept in the study. The resulting items loaded against one component that accounted for 77.6% of the variance, a KMO score of 0.79 and a Cronbach's Alpha of 0.927 (results below). The retained items are associated with improved quality, reliability, and speed of operations.

Table 38. Final loading of retained operational benefits items

Component Matrix[a]

	Component 1
Operational-benifits5	.868
Operational-benifits6	.769
Operational-benifits7	.940
Operational-benifits8	.877
Operational-benifits9	.939

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.2.2. Strategic Benefits

The analysis of the four items associated with Strategic Benefits found that item 2 scored poorly on the corrected item-total correlation and was omitted from the study. The resulting three items had a Cronbach's Alpha of 0.79, a KMO score of 0.7 and loaded onto one component which accounted for 71% of the variance. The results are shown below.

Table 39. Final loading of retained strategic benefits items

Component Matrix[a]

	Component 1
Strategic-benifits1	.861
Strategic-benifits3	.855
Strategic-benifits4	.810

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.2.3. Customer Benefits

The customer benefits construct was made up of three items which adequately described the construct. The items had a Cronbach's Alpha of 0.86, a KMO score of 0.67 and the one component accounted for 78.5% of the variance.

Table 40. Customer benefits items component matrix

Component Matrix[a]

	Component 1
Customer-benifits1	.800
Customer-benifits2	.932
Customer-benifits3	.919

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.4.2.1. Firm Performance

The surviving items from the three constructs associated with Firm Performance were then tested using PCA, KMO and Cronbach's Alpha. The results found that Strategic and Customer benefits loaded against a single component. The items associated with these constructs are closely related, in the way that the strategic benefits such as growing market share and improving competitive advantage are aligned to building long term customer relationships and representing the company to their customers. These items were combined to express a larger construct of strategic value which incorporated customer benefits. The resulting two constructs had a Cronbach's Alpha of 0.88, a KMO score of 0.81 and accounted for 71.1% of the variance.

Table 41. PCA with Varimax Rotation

Rotated Component Matrix[a]

	Component 1	Component 2
Operational-benifits5		.919
Operational-benifits7		.934
Operational-benifits9		.913
Strategic-benifits1	.630	
Strategic-benifits3	.829	
Strategic-benifits4	.689	
Customer-benifits1	.712	
Customer-benifits2	.848	
Customer-benifits3	.836	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

An overall summary is presented below:

Table 42. Firm Performance Summary

Construct	No. of original items	No. of surviving items	Cronbach's alpha	Mean of Composite	Std Dev of Composite	Skewness	Kurtosis
Operational Benefits	9	3	0.927	5.0556	1.53471	-.940	.542
Strategic and Customer Benefits	7	6	0.872	5.0741	1.41816	-.365	-.952

4.5. Hypothesis Testing

4.5.1. Correlation Analysis on Composite Scores

Standardised and Composite scores were calculated for Collaboration, Creativity, Agility, Value, Rarity, Inimitability, Immobility and Non-substitutability, as well as Operational Benefits, Strategic and Customer Benefits. Immobility and Non-substitutability were combined into a single variable along with Strategic and Customer Benefits. The scores were calculated using the arithmetic mean of items that remained, following PCA and reliability analysis. The correlation analysis was performed using the Pearson correlation as the study contained ratio measures and the skewness and kurtosis measures were within a reasonable range. The strength of the linear relationship is denoted by the correlation coefficient (r). The r value can be positive or negative which demonstrates the direction of the linear relationship.

Table 43. Pearson Correlations (R-squared) – Innovation Capabilities in Software Development vs Business Value of Software

	Collaboration	Creativity	Agility
Value	0.304*	0.079	0.214
Rarity	0.403**	0.374**	0.287*
Inimitability	0.261	0.195	0.212
Non-substitutability / immobility	0.233	0.184	0.269*
Operational Benefits	0.146	0.121	0.048
Strategic and customer benefits	0.200	0.127	0.141

* p<0.05; ** p<0.01

The initial results of the correlation analysis showed that collaboration had strong significant positive relationships with Value and Rarity. Creativity had a strong significant positive relationship with Rarity alone, while Agility expressed a strong significant positive relationship with Rarity and the Non-substitutability/Immobility composite. While all relationships may not be statistically significant, the dimensions of innovation capability expressed statistical relationships across three of the four Business Value of Software variables, and all were associated with rarity.

4.5.2. Regression Analysis

Further analysis was performed using multiple regression. Before running the multiple regression analysis, the dataset was further prepared to incorporate control variables as well as a combined 'Business Value of Software' construct.

First, the research model identified team size, organisational size, industry, development focus and location as possible control variables. Industry was recoded into services vs non-services and location into MEA and non-MEA regions. A one-way ANOVA was conducted to compare the development focus on collaboration and Business Value of Software constructs. There was no significant effect of development focus on collaboration and Business Value of Software at the p<.05 level for Internal, External, or Internal and External development focuses. Post hoc comparison was conducted using Turkey HSD test which indicated that none of the development focuses differed significantly from any others in terms of collaboration and Business Value of Software. The results of these tests, as well as the means and standard deviations for each of the groups, are reported in Appendix F.

Second, an overall Business Value of Software construct was formed as the composite of the four underlying dimensions of the Business Value of Software. An analysis of the components showed that they could be combined into an overall score, as seen in the below component matrix (Table 44) with a one factor forced solution. The new construct had a Cronbach's Alpha of 0.774. The new construct was labelled Business Value of Software (BVS).

Table 44. Business Value of Software Component Matrix

Component Matrix[a]

	Component 1
CompValue	.584
CompRarity	.836
CompInimit	.802
CompImmoNonSub	.841

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

4.5.2.1. Regression Analysis: Hypothesis 1 – 3

As a final test of hypotheses one (1), two (2) and three (3), a set of multiple regression analyses was then carried out with results summarised in Table 45. The various business value dimensions along with the overall Business Value of Software (BVS) constructs were used as dependent variables and the controls and Innovation Capabilities were the independent variables.

Table 45. Multiple Regression beta values

	Value	**Rarity**	**Inimitability**	**Non-substitutability / Immobility**	**Business Value of Software**
Control 1 (team size)	0.022	0.115	0.235	0.162	0.174
Control 2 (org size)	0.126	-0.175	-0.003	0.004	-0.016
Control 3 (Region)	0.231	0.151	0.215	0.180	0.253^{+}
Control 4 (Industry)	-0.135	0.036	0.040	0.031	-0.009
Collaboration (H1)	0.345^{*}	0.282^{+}	0.204	0.160	0.322^{*}
Agility (H2)	0.202	0.098	0.130	0.213	0.209
Creativity (H3)	-0.166	0.219	0.035	0.013	0.033
R-squared	0.212	0.291*	0.199	0.160	0.306*

$^{+}$ P<0.1; * p<0.05; ** p<0.01

The above correlation analysis and regression analysis were used to determine support for or against hypothesis one (1), two (2) and three (3). A recap of the hypotheses is shown below:

Hypothesis 1 (H1)	There is a positive relationship between the level of collaboration capability in the software development process and the Business Value of Software
Hypothesis 2 (H2)	There is a positive relationship between the level of agility in the software development process and the Business Value of Software
Hypothesis 3 (H3)	There is a positive relationship between the level of creativity in the software development process and the Business Value of Software

The results from Table 45 show some support for hypothesis one (1), while showing little support for hypothesis (2) and hypothesis (3). Collaboration had significant beta-coefficients for outcomes of Value, Rarity, and overall Business Value of Software (BVS). The results were only indicative for hypothesis two (2). Agility showed a non-significant beta-coefficient in the multiple regression for Business Value of Software (β=0.191). Although Agility was not significant in the regression, it had significant positive correlations with Rarity and Non-substitutability/Immobility composite (refer Table 43). The regression analysis did not show statistical significance for hypothesis three (3), however, the correlation analysis showed a strong significant positive relationship of Creativity with Rarity. The results indicated that region as a control variable was significant for overall BVS.

The test of assumption for the regression analysis is shown in Appendix (F).

4.5.2.2. Regression Analysis: Hypothesis 4

Finally, a number of two-way and three-way complementarity scores were calculated for Innovation Capabilities using the product of z-scores, i.e., as interaction terms. The two-way and three-way complimentary scores were used in testing of hypothesis four (4) related to the complimentary nature of the three Innovation Capabilities.

Hierarchical regression was performed to control for the control variables when testing hypothesis four (4). Five models were analysed to measure the interactions between Innovation Capabilities and the effect on the overall Business Value of Software (BVS). This analysis involved using the Business Value of Software (BVS) composite construct. The Table 47 shows the effects of the control variables, the individual effects as well as the interaction combinations of Innovation Capabilities on the Business Value of Software.

In addition to the hierarchical regression performed to measure the interactions between Innovation Capabilities and the effect on the overall Business Value of Software (BVS), the additive effect was tested using the composite score of Innovation Capability constructs. The additive effect was tested using multiple regression and the results shown in Table 46.

Table 46. Multiple Regression beta values

	Business Value of Software
Control 1 (team size)	0.152
Control 2 (org size)	-0.013
Control 3 (Region)	0.286*
Control 4 (Industry)	0.049
Innovation Capabilities Composite	0.417**
R-squared	0.268**

$^{+}$ P<0.1; * p<0.05; ** p<0.01

The results from Table 47 were used to determine support for hypothesis four (4). Hypothesis four (4) is shown below:

Hypothesis 4	The Innovation Capabilities are complementary capabilities and will have synergistic effects on the Business Value of Software

The results from Table 47 show that the control variable was not significant while the inclusion of the Innovation Capabilities constructs resulted in a significant increase in R2. However, the inclusion of the complimentary interactions was not statistically significant and therefore hypothesis four (4) was rejected. There were no significant two or three-way interactions between the Innovation Capabilities. However, the analysis of the additive effect indicated that Innovation Capabilities don't interact to strengthen each other but they do combine to create an additive effect.

Table 47. Innovation Capabilities interaction testing using hierarchical regression

Restricted model Control variables regressed against Business Value of Software		**Full Models Control variables plus complimentary dimensions of Innovation Capabilities Regressed against overall Business Value of Software (BVS)**				
		Model 1	Model 2	Model 3	Model 4	Model 5
		Innovation Capabilities	Collaboration X Agility	Collaboration X Creativity	Creativity X Agility	Collaboration X Creativity X Agility
Control Variables						
Service Based Industry	0.068	-0.009	-0.01	-0.013	-0.01	-0.003
Region	0.21	0.253^+	0.253^+	0.253^+	0.25^+	0.24^+
Team Size	0.231	0.174	0.173	0.17	0.172	0.182
Firm Size	0.004	-0.016	-0.017	-0.017	-0.013	-0.013
Innovation Capabilities						
Collaboration		0.322*	0.321*	0.332*	0.344*	0.326^+
Creativity		0.033	0.034	0.034	0.023	-0.001
Agility		0.209	0.209	0.205	0.194	0.167
Complimentary Dimensions						
Collaboration X Agility			-0.015	-0.03	-0.019	0.02
Collaboration X Creativity				0.033	0.045	0.071
Creativity X Agility					-0.042	-0.053
Collaboration X Creativity X Agility						0.069
F-ratio	1.43	2.90*	2.49*	2.17*	1.92	1.73
R^2	0.10	0.31	0.31	0.31	0.31	0.31
F-ratio testing delta in R^2 between full and partial model	1.43	4.46**	0.018	0.05	0.06	0.22

+ p<0.1; * p<0.05; ** p<0.01

4.5.2.3. Correlation Analysis: Hypothesis 5

A recap of hypothesis five (5) is shown below:

Hypothesis 5	There is a positive relationship between the Business Value of Software and the firm's operational, strategic and customer performance outcomes

The below correlation analysis shows mixed support for H5. For Operational Benefits, only Value and Inimitability showed a strong significant positive relationship. However, Business Value of Software, composite BVS and individual dimensions, were strongly and significantly correlated with Strategic and Customer Benefits.

Table 48. Pearson Correlations - Business Value of Software vs Firm Performance

	Operational Benefits	**Strategic and Customer Benefits**
Value	0.393**	0.325*
Rarity	0.119	0.451**
Inimitability	0.330*	0.486**
Non-substitutability / immobility	-0.025	0.413**
Business Value of Software (BVS) Composite	0.266	0.545**

* $p<0.05$; ** $p<0.01$

4.6. Conclusion

In this section, the data was analysed, and the results presented. The results found statistical significance for Collaboration as a determinant of Business Value of Software. Agility did not show significance in the regression analysis but had significant positive correlations with Rarity and Non-substitutability/Immobility. Creativity was not supported by the analysis. The results did not support the complimentary effects of Innovation Capabilities on the Business Value of Software. However, the analysis of the additive effect indicated that Innovation Capabilities combine to create an additive effect. Further, the results found strong statistical significance between the Business Value of Software and Strategic and Customer Benefits. However, the results did not largely support Business Value of Software and Operational Benefits. A summary of the hypothesis conclusions is presented below:

Table 49. Summary of hypothesis results

Hypothesis	**Description**	**Outcome**
Hypothesis 1	There is a positive relationship between the level of collaboration capability in the software development process and the Business Value of Software	Supported in respect of multiple regression analysis with BVS and controls
Hypothesis 2	There is a positive relationship between the level of agility in the software development process and the Business Value of Software	Only supported in respect of bivariate relationships with Rarity and Non-substitutability/Immobility
Hypothesis 3	There is a positive relationship between the level of creativity in the software development process and the Business Value of Software	Rejected
Hypothesis 4	The Innovation Capabilities are complementary capabilities and will have synergistic effects on the Business Value of Software	Rejected
Hypothesis 5	There is a positive relationship between the Business Value of Software and the firm's operational, strategic and customer performance outcomes	Only supported in respect of bivariate relationships with Strategic and Customer Benefits

The next chapter will discuss the results in greater detail. The chapter will consider each proposed hypothesis, presenting a discussion and interpretation of the results using academic literature and the results from this chapter.

5. CHAPTER 5 – DISCUSSION AND IMPLICATIONS

This chapter will discuss in detail the results which were presented in the previous section. Each hypothesis is discussed and presented along with a brief discussion of the control variables.

5.1. Discussion

Drawing on innovation literature and recent work into innovation capabilities in software development (Aaen, 2008; Basadur and Gelade, 2006; Cockburn and Highsmith, 2001; Cocu et al., 2015; Dervitsiotis, 2010; Fecher et al., 2018; Inoue and Liu, 2015; Lewis and Moultrie, 2005; Magadley and Birdi, 2009; Memon et al., 2018; Sampietro, 2016; Saunila and Ukko, 2012; Schweitzer and Gabriel, 2012), the three most cited innovation capabilities are creativity, agility and collaboration. These three capabilities describe the way in which teams develop innovative software, and may be emphasised to greater or less degrees in different software development methodologies. Agility describes the way in which teams are able to overcome changing requirements, develop software in short and frequent interactions and incorporate frequent customer and business feedback (Basadur and Gelade, 2006; Cockburn and Highsmith, 2001; Dervitsiotis, 2010; Fecher et al., 2018; Lewis and Moultrie, 2005; Sampietro, 2016). Agility is emphasised in agile software development methodologies such as Scrum. Creativity is associated with creating novel solutions to problems and generating new knowledge that had not existed before (Basadur and Gelade, 2006; Cocu et al., 2015; Lewis and Moultrie, 2005; Magadley and Birdi, 2009; Memon et al., 2018; Saunila and Ukko, 2012; Schweitzer and Gabriel, 2012). Collaboration involves how teams interact, work together, and the nature of their interactions (Aaen, 2008; Cockburn and Highsmith, 2001; Cocu et al., 2015; Inoue and Liu, 2015; Lewis and Moultrie, 2005; Magadley and Birdi, 2009; Memon et al., 2018; Saunila and Ukko, 2012; Schweitzer and Gabriel, 2012).

These innovation capabilities were theorised to be important to increasing business value of software. Drawing on the resource-based view of the firm (Nevo and Wade, 2011; Schryen, 2013; Wade and Hulland, 2004), the Business Value of Software was conceptualised through five (5) constructs, these being Value, Rarity, Inimitability, Non-substitutability, and Immobility (Nevo and Wade, 2011; Wade and Hulland, 2004). PCA analysis, however, showed that the Non-substitutability and Immobility dimensions of software value could not be distinguished in this study's context of software resources. During reliability and validity testing, both Non-substitutability and Immobility clustered onto the same component and were thus merged into one construct. Substitutability defines how easily other firms can find alternative resources to gain competitive advantage while mobility refers to how easily a firm can acquire resources that allow it to imitate a rival's competitive advantage (Nevo and Wade, 2011; Wade and Hulland, 2004). This may explain the clustering together as these constructs measure the degree to which a business can source alternative software products, either through imitation or acquisition.

Drawing further on the resource-based view of the firm, firm performance is identified as the outcome associated with increased Business Value of Software (Nevo and Wade, 2011; Wade and Hulland, 2004). Firm Performance was conceptualised through three (3) constructs, these being

Operational benefits, Strategic benefits, and Customer benefits (Kim and Baek, 2018; Nevo and Wade, 2011; Ravinchandran and Lertwongsatien, 2005; Wade and Hulland, 2004). PCA analysis, however, showed that the Strategic and Customer benefits dimensions of Firm Performance could not be distinguished. During reliability and validity testing, both Strategic and Customer benefits clustered onto the same component and were thus merged into one construct. Strategic benefits are associated with the firm's effectiveness, likely improving the firm's competitive positioning and enhanced flexibility in responding to market changes. On the other hand, Customer benefits are associated with the attraction and retention of customers. The clustering may be explained as these two constructs are closely related, in the way that the strategic benefits such as growing market share and improving competitive advantage are aligned to building long term customer relationships and representing the company to their customers.

The effects of the three Innovation Capabilities on the Business Value of Software was tested and is discussed next.

5.1.1. Hypothesis 1

Hypothesis one (1) stated that there is a positive relationship between the level of collaboration capability in the software development process and the Business Value of Software. This was theorised because collaboration has been identified to increase innovation by increasing the chances of combining ideas, parallel validation of concepts and increased speed to delivery of innovations (Inoue and Liu, 2015). Cross functional collaboration improves the ability to diffuse knowledge in teams and simultaneously fulfil tasks. The increase in collaboration amongst multidisciplinary teams has been shown to improve innovation efficiency and effectiveness (Schweitzer and Gabriel, 2012). High quality collaboration increases the efficiency of innovation projects by enabling teams to focus on reducing risks and seizing opportunities (Aaen, 2008). Overall, this results in shortened development time, reduced costs, and reduced time to market of innovations.

In order to accept or reject the hypothesis, both correlation analysis and multiple regression analysis were used. Collaboration, as defined in this study, is the increase in teaming over individual work (Brettel et al., 2011; Kahn, 1996; Schweitzer and Gabriel, 2012), and was measured using eight (8) items in the questionnaire. After testing for reliability and validity, three (3) items were preserved for use in the data analysis These items are presented below:

Table 50. Collaboration Questionnaire Items

Item	Item Question
Collaboration 3	We promoted sharing of information amongst team members
Collaboration 7	Our team shared the same vision and goals for projects
Collaboration 8	We worked together as a team to achieve the project goals

The collaboration construct was formed using the means average across the three retained items. The collaboration construct was then tested against each of the Business Value of Software constructs as well as the combined Business Value of Software (BVS) construct to determine support for or against hypothesis 1. The results show that Collaboration has a strong positive significant relationship with Business Value of Software (BVS). The results further show that Collaboration has a strong positive significant relationship with both value and rarity.

Software is said to have value if it can be used by the firm in implementing strategies to improve efficiency and effectiveness while software rarity is defined by the limitation of a software, such that it is not simultaneously available to many firms (Nevo and Wade, 2011; Wade and Hulland, 2004). The results show that a firm wanting to improve or increase the usefulness, importance, value, and uniqueness of software, while limiting the availability of the software to competing firms, should look towards increasing collaboration. This can be achieved by promoting sharing of information among team members, ensuring that software teams have a shared goal and vision and increasing the amount of times teams work together to achieve goals.

5.1.2. Hypothesis 2

Hypothesis two (2) set out to test if there is a positive relationship between the level of agility in the software development process and the Business Value of Software. This was considered because the ability to increase the speed at which companies are able to design, build and adapt their products helps these companies drive innovation by overcoming rapidly changing environments (Sampietro, 2016). Through the use of agile software methodologies, companies are able to overcome challenges and drive innovation by dynamically adapting resources, shifting their focus to outcomes and results, and by achieving continuous incremental progress (Cockburn and Highsmith, 2001; Lewis and Moultrie, 2005; Winter, 2014).

The operational definition of agility used in this study is defined as the ability to display high levels of effectiveness through efficiency, adaptability, and flexibility (Cockburn and Highsmith, 2001; Misra et al., 2009; Sampietro, 2016; Vickery et al., 2010). The construct of Agility was made up from fourteen (14) items. After reliability and validity testing, three items were preserved for use in the data analysis. These three items were combined using a simple weighted average. The three items are shown below:

Table 51. Agility Questionnaire Items

Item	Item Question
Agility 2	We were open to changing requirements
Agility 3	We took an approach that allowed us to easily adjust to unexpected changes/events
Agility 8	We frequently released working versions of software during development

The results show that Agility has a positive non-significant relationship with the Business Value of Software. However, without significance in the multiple regression analysis, the results are only indicative of hypothesis 2. Although the results are only indicative, the correlation analysis has shown a strong positive significant relationship with both Rarity and Non-substitutability / Immobility. The overall analysis of Agility as a construct indicates an improvement in the Business Value of Software while also showing a strong positive relationship with improving Rarity and Non-substitutability / Immobility.

The results show that a firm wanting to reduce the likelihood of their software being acquired or replicated by their competition, while limiting the availability of the software to competing firms, should look towards increasing Agility. This can be achieved by adopting a team attitude that embraces or accommodates changing requirements, working in a way that allows teams to easily adjust to unexpected changes and promoting teams to release frequent working versions of their software during development.

5.1.3. Hypothesis 3

Hypothesis three (3) set out to test if there is a positive relationship between the level of Creativity in the software development process and the Business Value of Software. The relationship was hypothesized because people who are encouraged to think creatively tend to become more motivated, increase commitment and strive towards better quality and quantity of work while reducing costs which ultimately improves the efficiency and effectiveness of the organisation (Schweitzer and Gabriel, 2012). Basadur and Gelade (2006) found that adaptability and flexibility are dependent on actively seeking out new problems, trends, technology, and information to create new processes, products, or services. This activity is described as innovation thinking and organisations focused on innovation have a habit of using knowledge creatively (Basadur and Gelade, 2006). An organisation that incorporates high levels of creativity in their development process are more likely to be adaptable, flexible, and creative in their use of knowledge to create new process, products, or services.

The operational definition of Creativity is the ability to develop new products and services as well as solving problems in a novel way (Schweitzer and Gabriel, 2012). The construct of Creativity was made up from nine (9) items. After reliability and validity testing, three items were preserved for use in the data analysis. These three items were combined using a simple weighted average. The three items are shown below:

Table 52. Creativity Questionnaire Items

Item	Item Question
Creativity 6	Time was allocated to team members for generating new/unique ideas
Creativity 7	Resources were allocated to teams for generating ideas
Creativity 8	The team created novel and useful ideas on task-related issues

The results show that Creativity has a neutral non-significant relationship with Business Value of Software. Based on the overall results from the multiple regression analysis and correlation analysis, hypothesis three (3) should be rejected.

It was initially expected creativity was important as creativity increases the ability to develop new products and services as well as solving problems in a novel way (Schweitzer and Gabriel, 2012). However, creativity seems to have little influence on the Business Value of software or on its Value, Rarity, Non-substitutability, Inimitability, and Non-substitutability/Immobility. It may be that creativity is only relevant for some types of software but for others the extra cost of creativity may not be recouped. For example, high levels of creativity may not be necessary for software that is well-defined or uses standard well-known technologies and design patterns.

5.1.4. Hypothesis 4

Hypothesis four (4) set out to test whether Innovation Capabilities are complementary capabilities and will have synergistic effects on the Business Value of Software. This was based on the logic of the resource based view of the firm that resources can act synergistically, whereby the different combinations of capabilities and resources can provide economic and strategic potential through the five properties of RBV: Value, Rarity, Inimitability, Non-substitutability and Immobility (Nevo and Wade, 2011; Wade and Hulland, 2004).

To test these effects, the complimentary effects of Innovation Capabilities were developed using the product of each of the Innovation Capabilities. The product of Innovation Capabilities was used to test for the effects of the interactions between Innovation Capabilities on the Business Value of Software. The four combinations of complimentary effects were tested using hierarchical regression where five models were tested. The results did not show any statistical significance across any of the two-way or three-way combinations and thus, hypothesis 4 is rejected.

However, an additional multiple regression test was performed to measure the additive effect of Innovation Capabilities on the Business Value of Software. The additive effect was tested using the three-way composite of Innovation Capabilities and was found to have a strong positive significant relationship with the Business Value of Software. This indicates that the combination of Innovation Capabilities does not produce any emergent or complimentary capabilities, but instead has additive capabilities which combine to increase the Business Value of Software. Thus, a company that incorporates various innovation capabilities would expect to see additive effects on the Business Value of Software over and above the direct effect of the individual Innovation Capabilities.

Overall, this study argued that while prior works suggests that innovative software could drive competitive advantage and improve business outcomes (Kark, 2016; Liebeskind, 1996; Quinney, 2015), few studies had examined how software with greater business value could be developed. This study suggested innovation was important and that the three Innovation Capabilities of Collaboration, Agility and Creativity could support the development of software with greater business value.

The results are not entirely conclusive that the three Innovation Capabilities are necessary. There is sufficient support to conclude that Collaboration is the most important of the three capabilities and that Agility can also be useful for supporting selected dimensions of value. In particular, Collaboration seems to be an important requirement for producing software with greater business value. Teams must learn to share information, share a common vision, and work together to achieve the goal of creating valuable software. While Creativity is an often-cited element of innovation (Basadur and Gelade, 2006; Cocu et al., 2015; Lewis and Moultrie, 2005; Magadley and Birdi, 2009; Memon et al., 2018; Saunila and Ukko, 2012; Schweitzer and Gabriel, 2012), the results do not provide strong support for Creativity as a requirement for producing software with greater business value.

5.1.5. Hypothesis 5

The study's final hypothesis, hypothesis five (5) stated that there is a positive relationship between the Business Value of Software and the firm's operational, strategic and customer performance outcomes. This was theorised based on the logic of the resource-based view of the firm such that improvements in Value, Rarity, and Inimitability in turn have a positive effect on Firm Performance as measured by Strategic and Operational Benefits (Nevo and Wade, 2011; Wade and Hulland, 2004). Furthermore, Firm Performance is strongly related to the degree to which the organisation uses its IT capabilities to support and enhance core competencies (Ravinchandran and Lertwongsatien, 2005).

To test the hypothesis, a correlation analysis was conducted on the four constructs of BVS as well as BVS a combined construct against Operational, Strategic and Customer benefits. Strategic and Customer benefits loaded onto a single component during validity and reliability testing and were combined into a single construct to represent both constructs. Operational benefits were defined as improved efficiency, resulting in increased revenues and cost reduction (Duan and Xu, 2012; Nevo and Wade, 2011) while Strategic benefits are defined by improved effectiveness that is likely to improve competitive positioning and enhanced flexibility in responding to market changes (Kim and Baek, 2018; Nevo and Wade, 2011). Strategic benefits were combined with Customer benefits, which is defined as the retention and attracting new of customers (Kim and Baek, 2018). Operational benefits were constructed from three (3) items while the combination of Strategic and Customer benefits constituted six (6). A summary is shown below of the items:

Table 53. Operational and Strategic and Customer Benefits Questionnaire Items

Item	Item Question
Operational Benefits 5	Tests showed that the software improved the quality of operations
Operational Benefits 7	Tests showed that the software improved the reliability of operations
Operational Benefits 9	Tests showed that the software improved the speed of operations
Strategic and Customer Benefits 1	The software we created gives us a competitive advantage
Strategic and Customer Benefits 2	The software helps us to grow market share
Strategic and Customer Benefits 3	The software helps us to improve financial profitability
Strategic and Customer Benefits 4	The software is part of how our company is building long-term future relationships with our customers
Strategic and Customer Benefits 5	The software allows our customers to feel a personal connection with our company

Strategic and Customer Benefits 6	The software represents our company to our customers

The results of the correlation analysis show a strong positive significant relationship between Business Value of Software and Strategic and Customer benefits. All the Business Value of Software constructs showed show a strong positive significant relationship indicating that either of the constructs could be used to improve Strategic and Customer benefits. There was no significant relationship found between Business Value of Software and Operational benefits. However, there is a strong positive significant relationship between Value and Inimitability. The results show partial support for hypothesis five with only Strategic and Customer benefits benefiting from Business Value of Software. Although this is the case, Operational benefits could be improved by single dimensions of Business Value of Software. Thus, hypothesis five is partially supported.

Most importantly, results show that firms able to produce software that is Valuable, Rare, Inimitable, and Non-substitutable/Immobile can experience Strategic and Customer benefits such as improved competitive positioning, enhanced flexibility in responding to market changes and the retention and attraction of new customers. Thus, firms should look to promote software with greater overall business value.

5.1.6. Control Variables

The results indicate that region has a positive effect on the outcome of BVS. Companies in MEA regions generally report higher Business Value of Software. This could imply that companies in MEA regions have a greater likelihood of positive outcomes associated with initiatives aimed at improving the Business Value of Software. Team size, firm age and firm size appear not to influence the ability of a firm to derive value from software.

5.2. Conclusion

This section discussed the results of the data analysis as they relate to the five hypotheses presented in the study. A revised conceptual model is presented (page 88) from the results of the data analysis. Results show all three Innovation Capabilities correlate with Rarity. In addition, Collaboration corelates with Value and is most important to overall BVS. Agility further corelates with Non-substitutability and Immobility. The combined effect of Innovation Capabilities has an overall effect on BVS. Overall, BVS drives Strategic benefits and Customer benefits with all components of BVS correlating to Strategic benefits and Customer benefits. In addition, Value, and Inimitability correlate with Operational benefits. Region as a control was shown to have an effect on BVS.

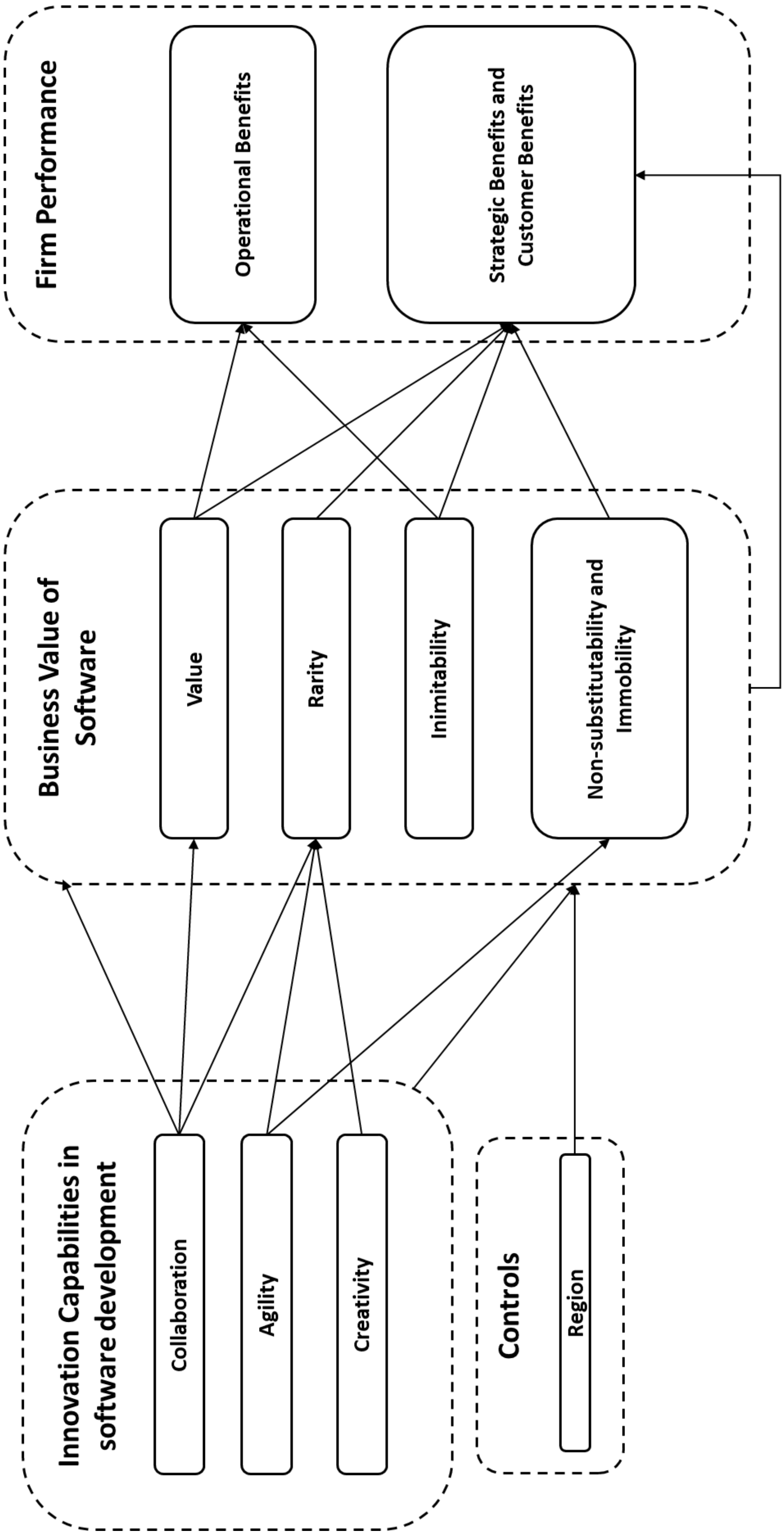

Figure 18. Revised conceptual model with final results

6. CHAPTER 6 – CONCLUSION

The research paper involved the study of Innovation Capabilities on the Business Value of Software. The study was conducted through the administration of a survey where 54 responses were collected. The results, conducted through linear, multiple, and hierarchical regression, of the five hypotheses showed support for hypothesis one, limited support for hypothesis 2 and some support for hypothesis five, but hypotheses three and four were rejected. Control variables for industry, firm size and team size were not significant in predicting the Business Value of Software. However, region was found to have a significant effect on predicting Business Value of Software. This chapter discusses the limitations and contributions of the study and suggestions for future research.

6.1. Limitations

The study employed a snowball approach to data gathering, where participants were identified based on the target audience requirements and ask to pass the survey onto their network who meet the similar profile. While this approach is generally successful in gathering responses, the approach did not produce the results expected in this study. The exact reasons for the low responses cannot be fully identified, however, the reason for low snowballing responses may be due to the specific target audience being senior professionals is the software industry. While there are many software professionals, there are fewer senior software professionals which may have limited the responses able to be gathered from the snowballing approach. While the study produced results that were indicative of relationships, the sample size reduced the statistical power of the study which may have limited the ability to detect significance in the results. As such, more participants may have had a more favourable outcome for the results, such as for hypothesis two (2) where results were promising but could not be confirmed due to lacking statistical significance.

The research model incorporated selected dimensions from previous studies to measure Innovation Capabilities and Business Value of Software, however, these dimensions may not include an exhaustive set of dimensions and other dimensions may be useful in future research.

6.2. Contributions of the Study

6.2.1. Contribution and Implications for Research

Notwithstanding the above limitations, this study has made a number of important contributions. First, the results of the study present a model which may be used by researchers to understand and measure the effects of Innovation Capabilities and how they affect the Business Value of Software. Through a systematic review of literature and by the best understanding of the researcher, the application of the resource-based view of the firm has not been applied to the context of Innovation Capabilities and software development. Thus, the study has presented an approach to understanding Innovation Capabilities, Business Value of Software, and their effects on Firm Performance. In addition, the study operationalised dimensions of Innovation Capabilities which may be incorporated or expanded upon by fellow researchers who may be interested in understanding similar dynamics in software development. This study is among the first to attempt to operationalise dimensions of Innovation Capabilities and test their effects on the Business Value of Software. In addition, the study applied the resource-based view of the firm in the context of software development, applying the properties of a resource to those of software. The outcome has confirmed that the resource-based view of the firm with regards to Business Value of Software and Firm Performance is applicable and can be used in further studies involved in measuring software value. Thus, two dimensions of the study have provided contributions for research; the operationalisation and measurement of Innovation Capabilities on Business Value of Software, and the application of the resource-based view of the firm as a model to measure Business Value of Software on Firm Performance.

6.2.1. Contribution and Implications for Practice

The research into the effects of Innovation Capabilities on the Business Value of Software has presented several outcomes which may be leveraged in practise. Through the operationalisation and studying of the relationship between dimensions of Innovation Capabilities, the Business Value of Software and Firm Performance, organisations may be in a position to understand how these dynamics affect their business and incorporate the findings in improving the Business Value of Software. At a high level, the results have shown a positive relationship between the combination of Innovation Capabilities and the effect on the overall construct of Business Value of Software. These results imply that by focusing on the development of the dimensions of Innovation Capability, especially Collaboration, the outcomes will positively affect the Business Value of Software. In turn, the study showed that Business Value of Software plays a significant role in Strategic and Customer Benefits as a dimension of Firm Performance.

The study found several relationships between individual Innovation Capabilities and the Business Value of Software. Based on these findings some specific recommendations can be made. If an organisation or team is disappointed in their software Value, they should consider improving/increasing the level of team Collaboration. This involves promoting the sharing of information among team members, ensuring that software teams have a shared goal and vision as well as increasing the amount of times teams work together to achieve goals. All dimensions of Innovation Capabilities positively effect Rarity of software. In addition to the previously mentioned Collaboration activities, Rarity can be enhanced by embracing or accommodating changing requirements, working in a way that allows teams to easily adjust, promoting teams to release frequent working versions of their software during development and setting aside time and resources for ideation activities. However, the study indicates that Creativity may have a negative effect on Value. This may be important for an organisation to consider, as focusing on Creativity may positively affect Rarity and when combined, all three dimensions of Innovation Capabilities positively affect the Business Value of Software. However, Creativity in the absence Collaboration and Agility may prove costly in time and resources and not provide a return on investment. An organisation looking to increase the overall Business Value of Software would experience greater results when combining Collaboration, Agility, and Creativity activities. Thus, a company that incorporates various Innovation Capabilities would expect to see additive effects on the Business Value of Software over and above the direct effect of the individual Innovation Capabilities.

The results indicate that Business Value of Software has a positive overall effect on Strategic and Customer benefits dimension of Firm Performance, while only two dimensions support Operational benefits. An organisation is unlikely to improve Operational benefits without focusing on the Value of software, such as the software's usefulness and importance, and its Inimitability through creating software that cannot be matched or replicated by their competition. The results further indicate that all the Business Value of Software dimensions are important for Strategic benefits. Beyond Value and Inimitability, which help with Operational benefits, long term strategic advantage and market growth requires organisations to have software that is Rare, such that is not easily procured in the software marketplace and unique to the organisation, and that the software is Non-substitutable/Immobile, such that the likelihood of their software being acquired or replicated by their competition is reduced. Thus, when seeking Strategic benefits, a firm would achieve the greatest results when its software is developed through Collaboration, Agility, and Creativity to be Non-Substitutable, Rare, and Inimitable.

Controlling for region shows that firms operating in the MEA region are more likely to achieve greater results when improving Innovation Capabilities compared to those in non-MEA regions. This may be an important variable to consider for companies that operate in multiple regions or companies that do not operate in MEA where software may not sufficiently differentiate firms in more developed markets.

6.3. Suggestions for Future Research

The results of the study, while considered successful, have limitations and areas that could be expanded or improved. Completing the study with more participants would improve the integrity of the results and expose more significant relationships between dimensions, thus improving the trustworthiness of the results. Creativity was found, on its own, to be non-significant. Further study of the dimension of Creativity may uncover other approaches to operationalisation of Creativity or other explanations for why, on its own, it might not be as important as an Innovation Capability in all contexts. The controlling variable of region had a positive relationship with Business Value of Software. Further studies could look to understand the relationship with region and Business Value of Software to further understand the relationship. For example, it may be more difficult for firms in more developed regions to enjoy advantages from software alone. More extended conceptualisations, such as the synergies articulated in Nevo and Wade (2011) between IT and non-IT resources, may be required to explain outcomes in those contexts. The choice of software development methodology may have an impact on collaboration and agility. Thus the relationship between software development methodologies and the business value of software, such as comparing the effects of agile methodologies versus traditional software methodologies should be considered in future research.

6.4. Conclusion

The study intended to research a gap in literature between the effects of Innovation Capabilities and the Business Value of Software. Fifty four (54) responses were collected and analysed in the study to address the gap in research. The results concluded that selected Innovation Capabilities have a positive effect on the Business Value of Software, which in turn positively effects the Strategic and Customer benefits of Firm Performance. As a result of the research, researchers and practitioners are able to better understand the dimensions associated with Innovation Capabilities and their effects on the Business Value of Software.

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8. APPENDICES

8.1. Appendix A: Construct Items

Item	Source	Possible measure of…
"Very frequently interacted in an informal way (e.g., irregular or unscheduled meetings)" "…exchanged large amounts of information (e.g. market and competitive analyses)" "…very frequently exchanged resources (e.g. financial means, personnel) or physical work results (e.g. blanks, prototypes)" "To what degree did the team members shared the same vision and goals for this project." "To what degree did your department achieve goals collectively"	Brettel et al. (2011) Kahn (1996) Schweitzer and Gabriel (2012)	Collaboration
"Team members used a creative approach towards problem-solving" "Creativity and innovative approaches of team members were actively encouraged and rewarded" "Time and resources for generating ideas"	Schweitzer and Gabriel (2012)	Creativity
"New product introduction time" "Delivery speed" "Modification flexibility" "Short iterations" "Informal design" "Frequent release of working software" "Prioritised product backlog" "Customers closely collaborate with the development team" "Our organisation encourages fast feedback from customers" "Our businesspeople and developers work closely"	Vickery et al. (2010) Sampietro (2016) Cockburn and Highsmith (2001) (Misra et al., 2009)	Agility
"From the firm's perspective, the implementation of the IT enhances the usefulness of the CSD" "The implementation of the IT increases the importance of the CSD to the firm" "The implementation of the IT makes the CSD more valuable to the firm"	Nevo and Wade (2011)	Value

"Few of the firm's competitors have managed to effectively implement a similar IT into their CSDs" "The implementation of the IT makes the CSD unique in comparison to those of the firm's competitors" "It is unlikely for a competitor of the firm to have a CSD with a similar IT"	Nevo and Wade (2011)	Rarity
"The implementation of the IT created a CSD that few of the firm's competitors can match" "The IT implementation into the CSD cannot be easily replicated by the competition"	Nevo and Wade (2011)	Inimitability
"The firm could replace the current CSD with a self-service automated solution without a drop in service level"	Nevo and Wade (2011)	Non-Substitutability
"We used our existing knowledge to make specific decisions for our latest activity" "We have dedicated much time and effort to ensuring that it would be difficult for another company to acquire the same resources we have" "We constantly strive to ensure that our resources cannot be easily identified by competitors"	Andersén et al. (2016)	Immobility
"The IT implementation into the CSD helps the firm to reduce costs" "The IT implementation into the CSD helps the firm to increase revenue" "Useful information for more effective strategic, operational insights, and decision-making purposes"	Nevo and Wade (2011) Duan and Xu (2012)	Operational Benefits
"The IT implementation into the CSD provides the firm with a competitive advantage" "The IT implementation into the CSD enables the firm to respond more quickly to change" "This mobile app constantly provides fodder for conversation that I have with friends and family"	Nevo and Wade (2011) Kim & Baek (2018)	Strategic Benefits
"I am oriented toward the long-term future of my relationship with this mobile app" "I often feel a personal connection between this brand and me"	Kim & Baek (2018)	Customer Benefits

8.2. Appendix B: Research Instrument

THE EFFECTS OF INNOVATION CAPABILITIES ON THE BUSINESS VALUE OF SOFTWARE

Please answer the following questions with respect to your most recently completed software project. If you have been involved in multiple projects please answer with respect to one of the projects. The survey should take between 10 and 15 minutes to complete.

Participant Information Sheet

Dear Sir / Madam,

My name is Rael Williamson and I am a Masters student in the School of Business Sciences at the University of the Witwatersrand, Johannesburg. As part of my studies, I have to undertake a research project. I am investigating the effects of innovation capabilities on the business value of software under the supervision of Professor Jason Cohen. The aim of this research project is to examine the effects of innovation capabilities in software development on the business value of software.

You are invited to participate in the study given your experience as a software professional. Participation will involve answering a short online questionnaire. This activity will involve a single questionnaire where you will be asked to answer a set of questions about your experience and views on your most recent software project, and should take around 10-15 minutes to complete.

There will be no personal costs to you if you participate in this project, You will not receive any direct benefits from participation but there are no disadvantages or penalties if you do not choose to participate or if you withdraw from the study. You may withdraw at any time or not answer any question if you do not want to. There is no risk or loss should you choose to withdraw. The questionnaire will be completed confidentially and anonymously as I will not be asking for your name or any identifying information. The information you provide will be used only for the purposes of this study and will not be shared with other third parties. The data will be used to complete the research report and for any subsequent publications. It will be stored securely and will not be disclosed to any third parties outside of this research team.

If you have any questions during or afterwards about this research, feel free to contact me on the details listed below. The study results will be written up as a research report. If you wish to receive a summary of this report, I will be happy to send it to you. The data collected from this research project will be stored in a password protected computer and will be kept for 1 year. If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email Charmaine.khumalo@wits.ac.za

Yours sincerely,
Rael Williamson

Researcher:
Rael Williamson, 435337@students.wits.ac.za

Supervisor:
Professor Jason Cohen, jason.cohen@wits.ac.za, 011 717 8164

Section 1: Project Background

Please answer the following questions with respect to your most recently completed software project. If you have been involved in multiple projects please answer with respect to one of the projects.

1. Please select which title best describes your role in the organisation?

Mark only one oval.

- Application Development Manager\Lead
- Software Development Manager\Lead
- Software Engineering Manager\Lead
- IT Manager\Lead
- Project Manager/Scrum Master
- Senior Application Developer
- Senior Software Developer
- Senior Software Engineer
- Other: ____________________

2. Please indicate in which city you work?

____

3. Please indicate the size of your software development team (number of permanent team members)

____

4. Please indicate the industry for which the software was developed

____

5. Please indicate the size of the organisation for which this software was developed, in terms of number of employees

____

6. How old is the organisation , in years?

Check all that apply.

- [ ] Less than 5 years
- [ ] 5 - 10 years
- [ ] 10 - 20 years
- [ ] 20 - 50 years
- [ ] More than 50 years

7. Would you view the organisation as having an intent to use this software for innovation of its product or service offering

Mark only one oval.

- ( ) Yes
- ( ) No

8. Would you consider the software developed to be internally focused (operational/enterprise) or externally focused (customer facing application)?

Mark only one oval.

- ( ) Internal
- ( ) External
- ( ) Internal and External
- ( ) I am not sure
- ( ) Other: ____________

Section 2: Innovation Capabilities

Please answer the following questions with respect to your most recently completed software project. If you have been involved in multiple projects please answer with respect to one of the projects.

9. Our team members interacted in an informal way (e.g., irregular or unscheduled meetings)

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

10. Our team members worked together on an ad-hoc basis

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

11. We promoted sharing of information amongst team members

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

12. We used informal methods (e.g. teams channels) where team members could share information

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

13. We used formal methods (e.g. documentation repositories) where team members could share information

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

14. We promoted sharing and exchanging of resources and work results between team members (e.g. blanks, prototypes)

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

15. Our team shared the same vision and goals for projects

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

16. We worked together as a team to achieve the project goals

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

17. We applied creative approaches towards problem solving (e.g. design thinking, hackathons, new technologies)

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

18. We actively encourage creative and innovative approaches

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

19. Tangible (eg. cash incentives, bonus, prizes and other such rewards with financial value) rewards were used to encourage creative and innovative approaches

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

20. Intangible (eg. Praise, thanks, public acknowledgment/recognition) rewards were used to encourage creative and innovative approaches

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

21. Our team generated creative solutions

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

22. Time was allocated to team members for generating new/unique ideas

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

23. Resources were allocated to teams for generating ideas

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

24. The team created novel and useful ideas on task-related issues

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

25. The team created knowledge that had not existed before the team was formed

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

26. We had few problems accepting changing requirements

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

27. We were open to changing requirements

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

28. We took an approach that allowed us to easily adjust to unexpected changes/events

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

29. We were able to easily overcome issues during software development

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

30. We produced the software in a short period of time

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

31. We used short development iterations

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

32. We initially used rough design specifications for software products

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

33. We frequently released working versions of software during development

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

34. We used working software as our measure of progress

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

35. We chose to prioritise items from a product backlog

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

36. We frequently collaborated with our customers

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

37. We requested frequent feedback from our customers

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

38. We worked closely with businesspeople

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

39. We relied on face to face conversations

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

Section 3: Business Value of Software

Please answer the following questions with respect to your most recently completed software project. If you have been involved in multiple projects please answer with respect to one of the projects.

40. The software we developed is useful to our users

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

41. Users told us that the software we developed is useful

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

42. The software we developed is important to the users

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

43. Users told us that the software we developed is important

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

44. The software we developed is valuable to our users

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

45. Users told us that the software we developed is valuable

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

46. Our competitors have not been able to implement similar software

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

47. The software makes the organisation unique when compared to our competitors

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

48. Competitors are unlikely to have similar software

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

49. The software has given the organisation a competitive advantage that competitors can't match

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

50. The software's implementation into the organisation cannot be easily replicated by competitors

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

51. Competitors would find it very difficult to match the software

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

52. No competitor could replicate the software

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

53. Competitors would struggle to be successful without our software

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

54. The software cannot be replaced with off the shelf products

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

55. The organisation cannot easily replace the software with another solution

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

56. There is no substitute for the software we developed

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

57. The software is built on existing team knowledge

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

58. The software is difficult to acquire or replicate by observing its functionality

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

59. The software cannot be easily identified by our competitors

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

60. The software is difficult to acquire because it is specific to our organisation

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

Section 4: Organisation Performance

Please answer the following questions with respect to your most recently completed software project. If you have been involved in multiple projects please answer with respect to one of the projects.

61. The software we built helps reduce costs for the organisation

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

62. The software we built drives increased revenue for the organisation

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

63. The software we built helps to improve management's decision-making effectiveness

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

64. The software we built improves quality of operations

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

65. Tests showed that the software improved the quality of operations

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

66. The software we built improves reliability of operations

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

67. Tests showed that the software improved the reliability of operations

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

68. The software we built improves speed of operations

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

69. Tests showed that the software improved the speed of operations

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

70. The software we created gives us a competitive advantage

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

71. The software we built helps the business respond more quickly to change

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

72. The software helps us to grow market share

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

73. The software helps us to improve financial profitability

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

74. The software is part of how our company is building long-term future relationships with our customers

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

75. The software allows our customers to feel a personal connection with our company

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

76. The software represents our company to our customers

Mark only one oval.

	1	2	3	4	5	6	7	
Strongly Disagree	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

Thank you for your participation

If you have any questions during or afterwards about this research, feel free to contact me on the details listed below. The study results will be written up as a research report. If you wish to receive a summary of this report, I will be happy to send it to you.

Researcher:
Rael Williamson, 435337@students.wits.ac.za

8.3. Appendix C: Ethics Protocol Approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF BUSINESS SCIENCES ETHICS COMMITTEE
CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: CBUSE/1784**
PROJECT TITLE	The Effects of Innovation Capabilities On the Business Value of Software
INVESTIGATOR	Mr Rael Williamson
SCHOOL/DEPARTMENT OF INVESTIGATOR	School of Business Sciences
DATE CONSIDERED	30 November 2020
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	MINIMAL RISK
EXPIRY DATE	31 December 2022

ISSUE DATE OF CERTIFICATE 7 December 2020 **CHAIRPERSON** ____________________
(Neetu Ramsaroop)

cc: Supervisor: Prof Jason Cohen

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

____
Signature **Date** _____/_____/_____

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

8.4. Appendix D: Missing Data Statistics

Statistics		
	N	
	Valid	Missing
informal_interation_collaboration	56	0
worked_together_collaboration	56	0
sharing_information_collaboration	56	0
informal_sharing_collaboration	56	0
formal_sharing_collaboration	56	0
sharing_work_results_collaboration	56	0
shared_vision_collaboration	56	0
achieved_collective_goals_collaboration	56	0
creative_problem_solving_creativitiy	56	0
creative_approaches_creativity	56	0
tangible_rewards_creativity	56	0
intangible_rewards_creativity	56	0

creative_solutions_creativity	56	0
idea_generation_time_creativity	56	0
idea_generation_resources_creativity	56	0
novel_useful_ideas_on_task_related_issues_creativity	56	0
knowledge_creation_creativity	56	0
accepting_changes_agility	56	0
changing_requirements_agility	56	0
adjust_unexpected_events_agility	56	0
overcome_issues_agility	56	0
short_production_time_agility	56	0
short_development_iterations_agility	56	0
rough_design_specifications_agility	56	0
frequent_working_releases_agility	56	0

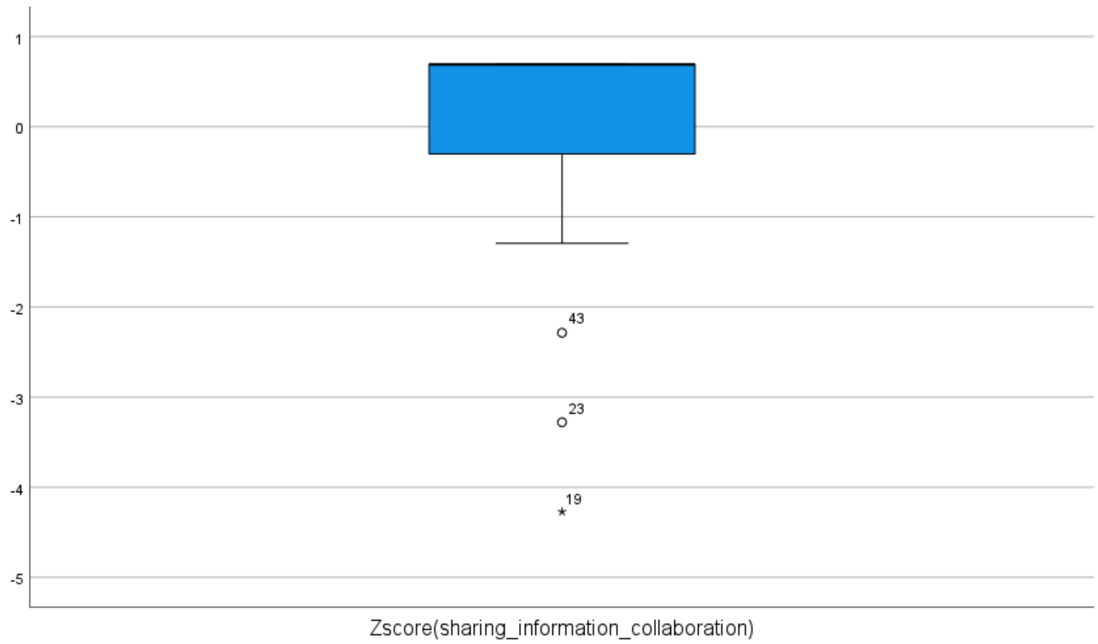
working_software_measure_of_perormance_agility	56	0
backlog_prioritisation_agility	56	0
collaborated_customers_agility	56	0
frequent_feedback_customers_agility	56	0
worked_closely_business_people_agility	56	0
face_to_face_conversations_converations	56	0
useful_to_users_value	56	0
confirmed_useful_to_users_value	56	0
important_to_users_value	56	0
confirmed_important_to_users_value	56	0
valuable_to_users_value	56	0
confirmed_valuable_to_users	56	0
competitors_not_enable_to_implement_similar_software_rarity	56	0

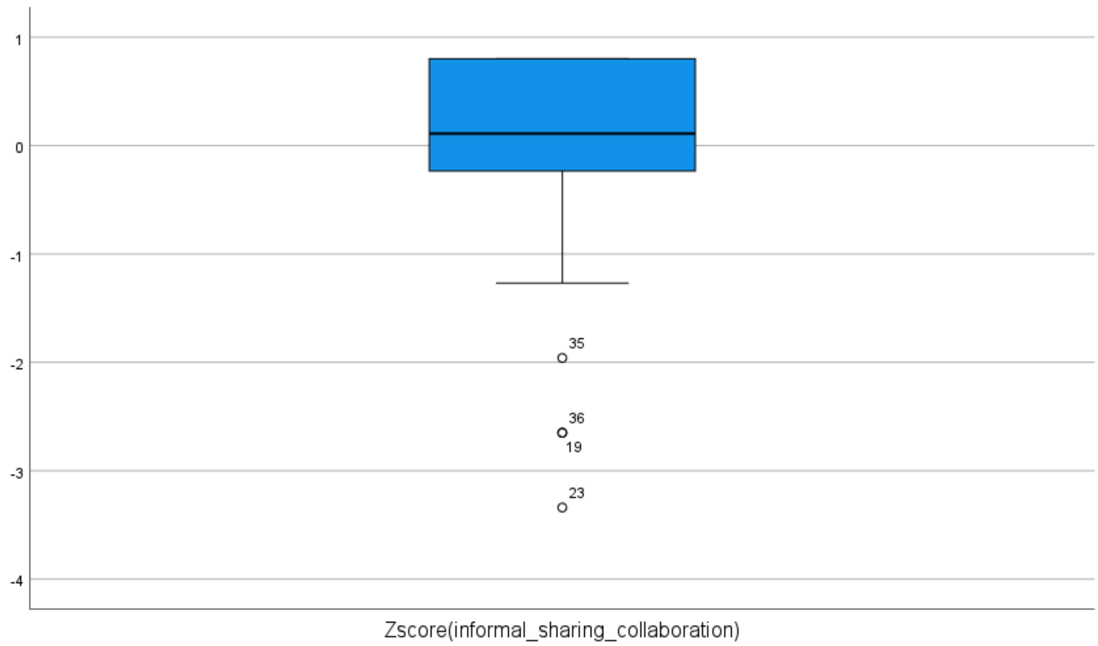
unique_compared_to_competitors_rarity	56	0
competitors_unlikely_have_similar_software_rarity	56	0
competitive_advantage_inimitability	55	1
cannot_be_replicated_implementation_inimitability	56	0
difficult_to_match_inimitability	56	0
difficult_to_replicate_inimitability	56	0
successful_without_software_inimitability	56	0
off_the_shelf_products_non_substitutability	56	0
cannot_easily_replace_non_substitutability	56	0
no_substitute_non_substitutability	56	0
built_on_team_knowledge_immobility	56	0

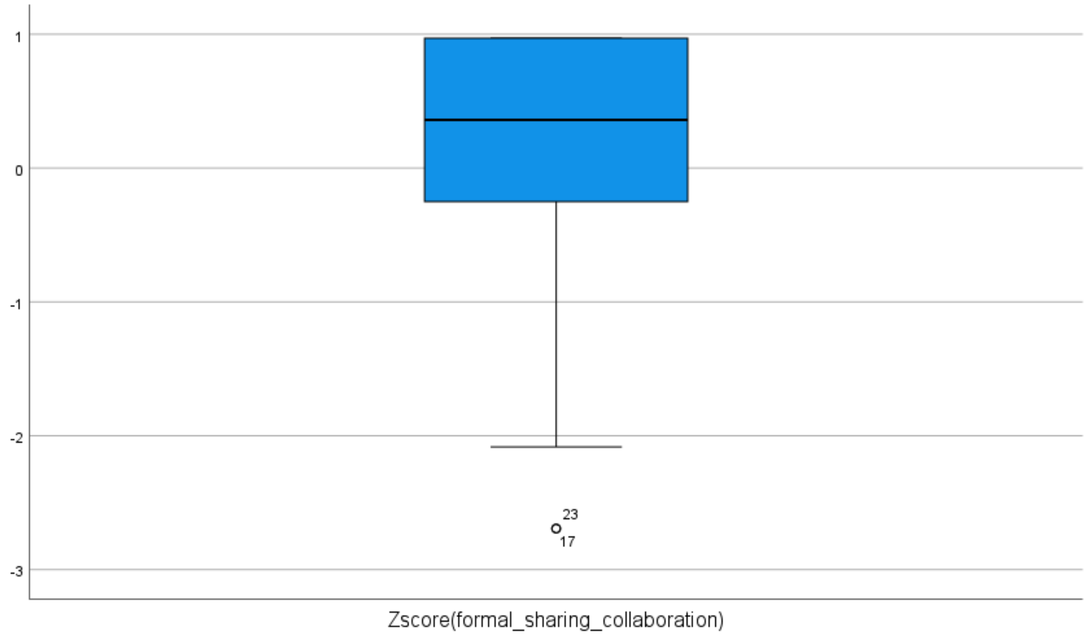
difficult_to_replicate_from_observation_immobility	55	1
cannot_be_easily_identified_immobility	56	0
specific_to_organisation_immobility	55	1
helps_reduce_costs_operational	56	0
drives_increased_revenue_operational	56	0
improve_management_decision_making_operational	56	0
improves_quality_operations_operational	56	0
tested_improves_quality_operations_operational	56	0
improves_reliability_operations_operational	56	0
tested_improves_reliability_operations_operational	56	0
improves_speed_operations_operational	56	0

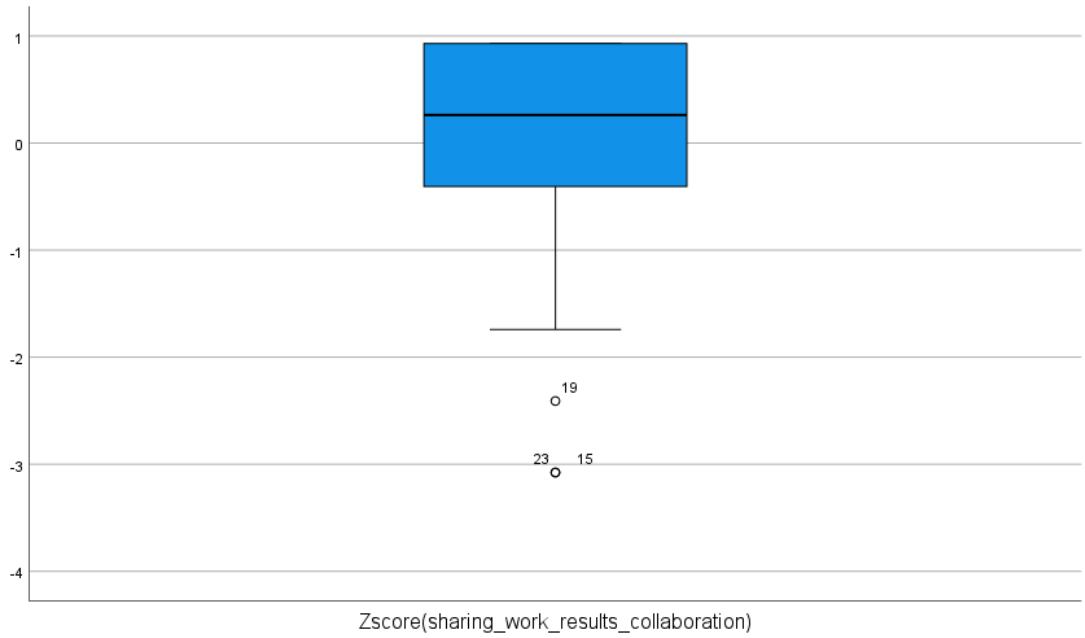
tested_improves_speed_operations_operational	56	0
competitive_advantage_strategic	56	0
respond_quickly_to_change_strategic	55	1
grow_market_share_strategic	56	0
improve_financial_profitability_strategic	56	0
long_term_relationships_customer	56	0
personal_connection_customer	56	0
represents_company_to_customers_customer	56	0

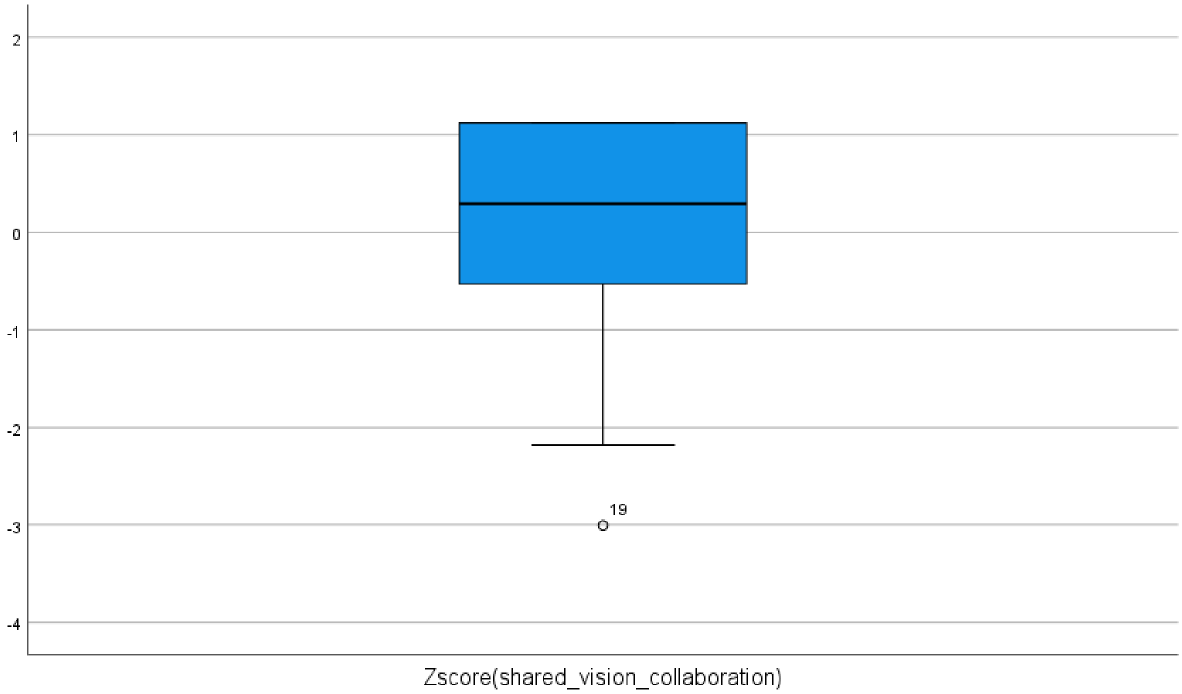
8.5. Appendix E: Outlier Analysis



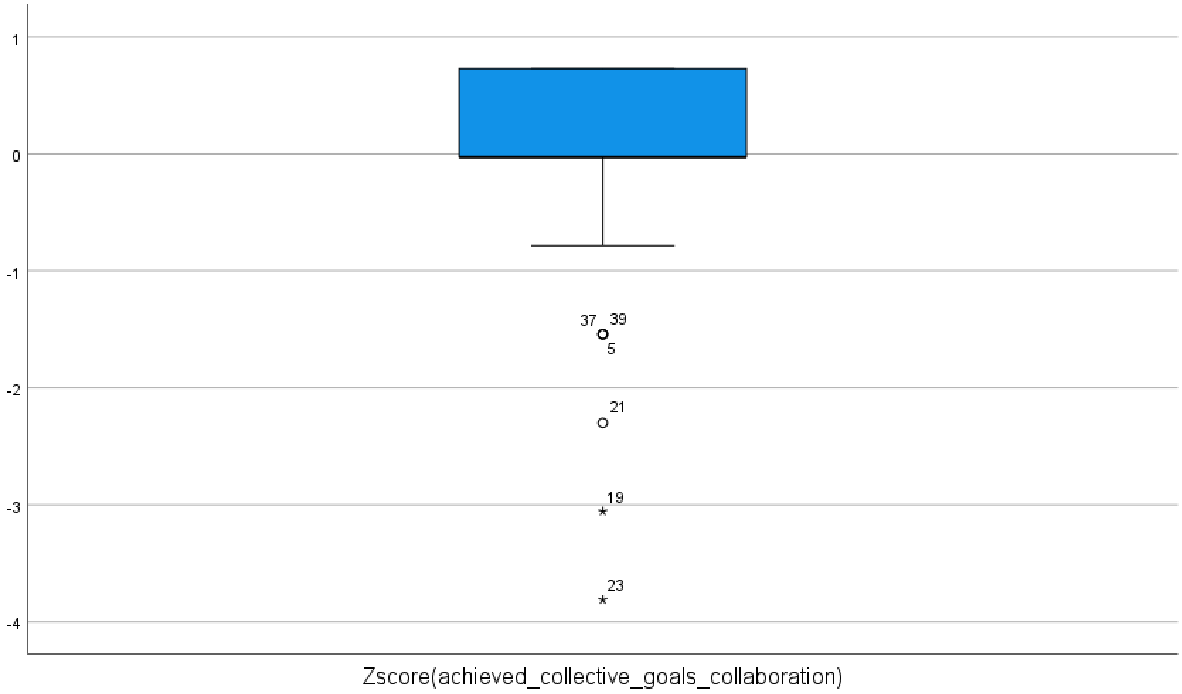



1
0
-1
-2
-3
23
17
Zscore(formal_sharing_collaboration)

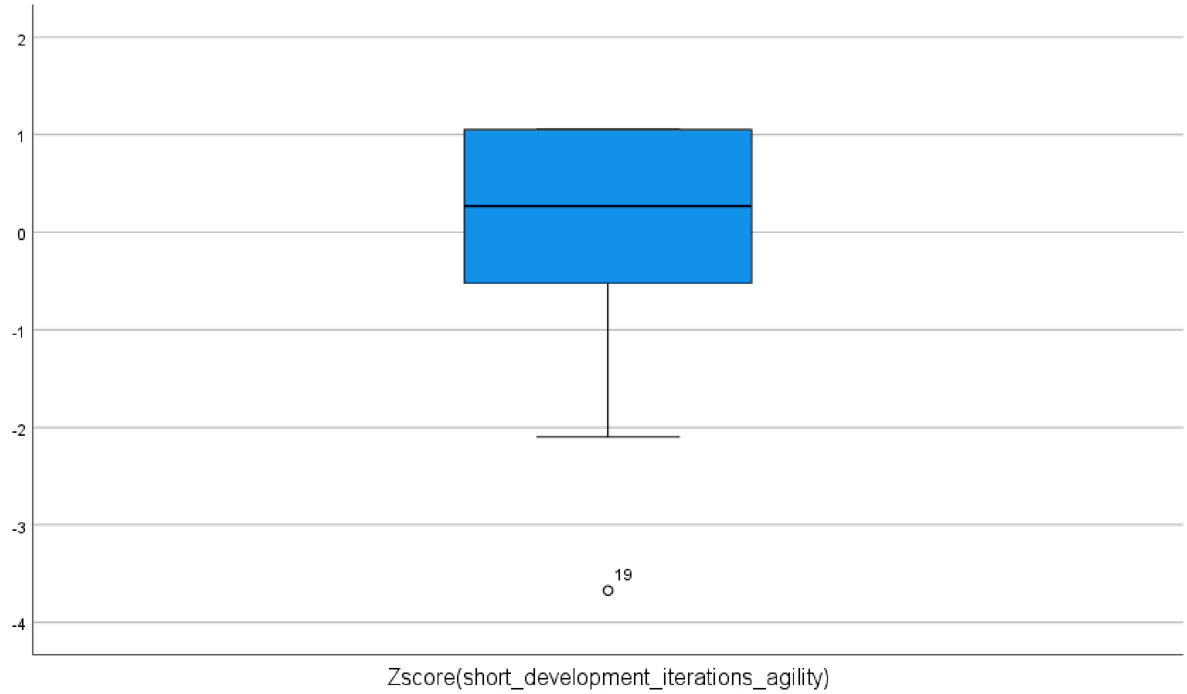

1
0
-1
-2
-3
-4
19
23
15
Zscore(sharing_work_results_collaboration)



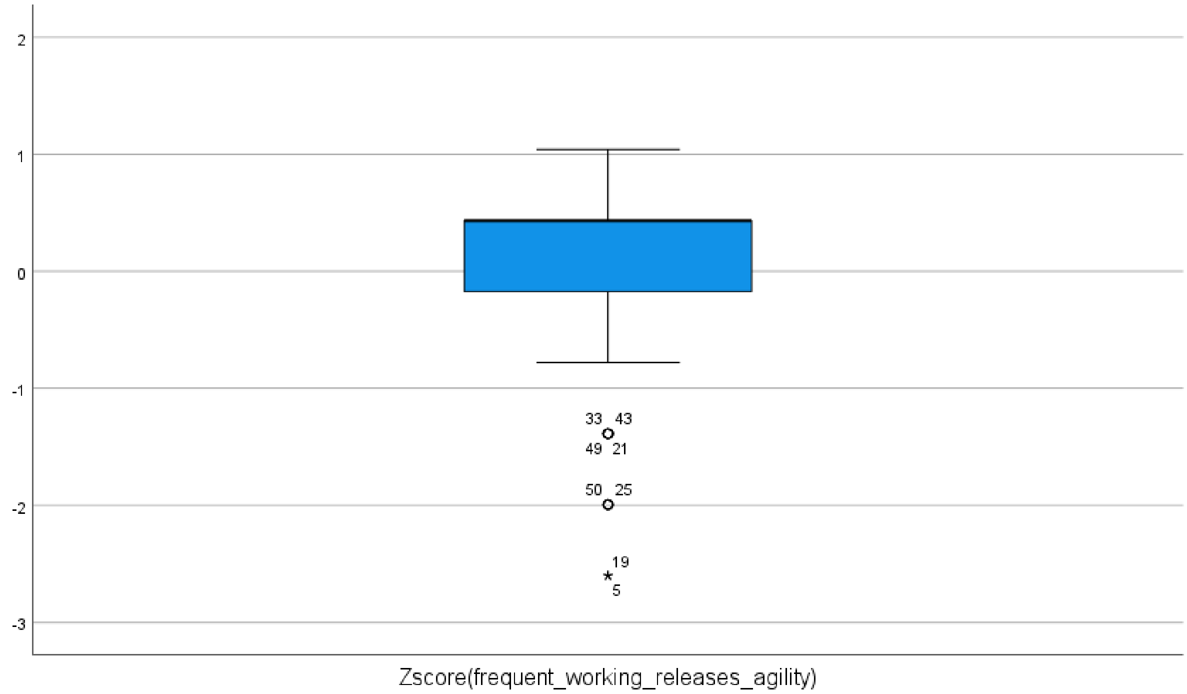
2
1
0
-1
-2
-3
-4
19
Zscore(shared_vision_collaboration)



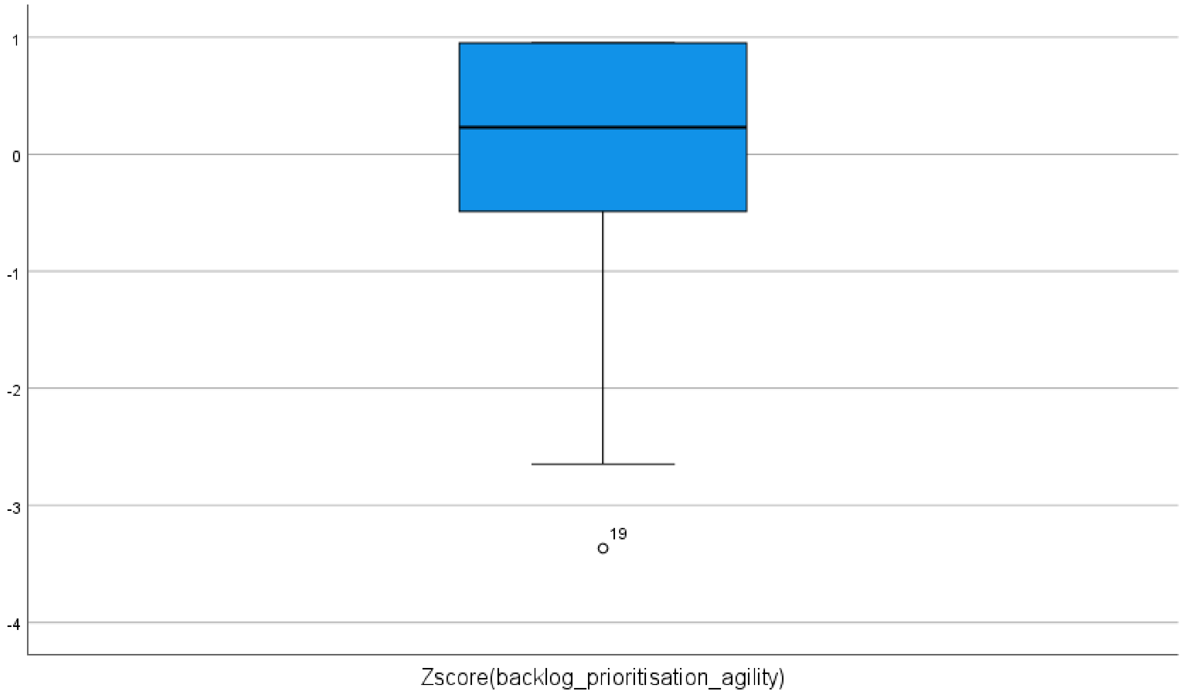
1
0
-1
-2
-3
-4
37
39
5
21
19
23
Zscore(achieved_collective_goals_collaboration)



2
1
0
-1
-2
-3
-4
19
Zscore(short_development_iterations_agility)



2
1
0
-1
-2
-3
33 43
49 21
50 25
19
5
Zscore(frequent_working_releases_agility)



8.6. Appendix F: Tests of Assumptions

Collinearity

Multicollinearity may occur when two or more independent variables in a multiple regression analysis are highly correlated. The presence of multilinearity results in unstable regression estimates for independent variables. Thus, when performing multiple regression analysis, as performed in this study, it is important to check that independent variables are not highly correlated. A test of the tolerance scores was performed where tolerance scores should be close to 1 and VIF close to 0 but at least below 5. The results below indicate tolerance scores close to 1 and VIF below 5. Thus, we are satisfied that the collinearity of the independent variables is not problematic.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-11.132	3.417		-3.258	.002		
	CompCollab	1.243	.587	.309	2.117	.039	.757	1.321
	CompCreativity	.060	.319	.029	.188	.852	.667	1.498
	CompAgility	.596	.430	.201	1.385	.172	.764	1.309

a. Dependent Variable: CompositeBVS

Figure 19. Coefficients of Business Value of Software and Innovation Capabilities

Assumption of Linear Relationships

Standard multiple regression analysis follows a linear model and cannot be fitted to data that is nonlinear. Thus, any violations of this assumption can be tested by examining the scatterplot of standardised residuals and standardised predicted values (ZRESID vs ZPRED). The resulting scatterplot should be spherical, or block shaped. If the residuals follow a curved shape, nonlinearities should be considered. Figure 20 shows no sign of a curved shape and rather that of a block shape, thus a linear relationship is present.

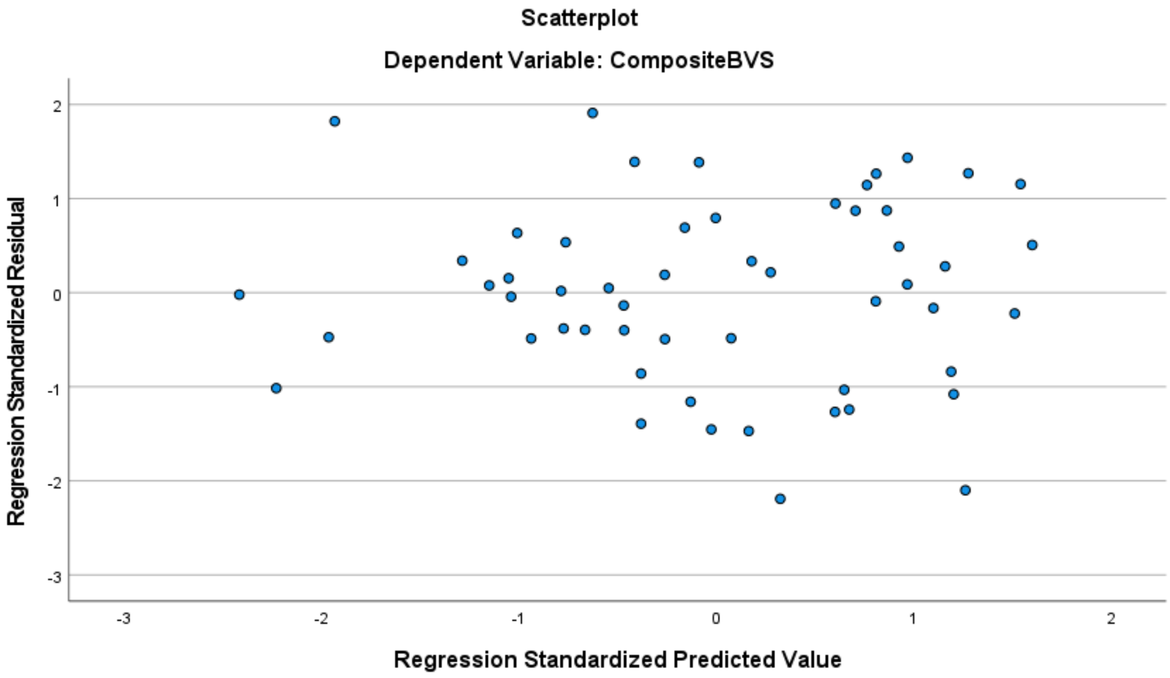


Figure 20. Normality of the Residual Distribution of Business Value of Software and Innovation Capabilities

Heteroscedasticity

Heteroscedasticity (assumption of constant error variance) is checked by examining figure 20. If the plot fans in (or out), it is a sign of heteroscedasticity. Figure 20 shows does not exhibit a fan shape and thus does not violate heteroscedasticity.

Normality of the Residual Distribution

The normal P-P plot of regression standardised residual is used to determine normality of residual distribution. The points in the plot should hug the line or rollercoaster around it. Figure 21 suggests the residuals are approximately normally distributed.

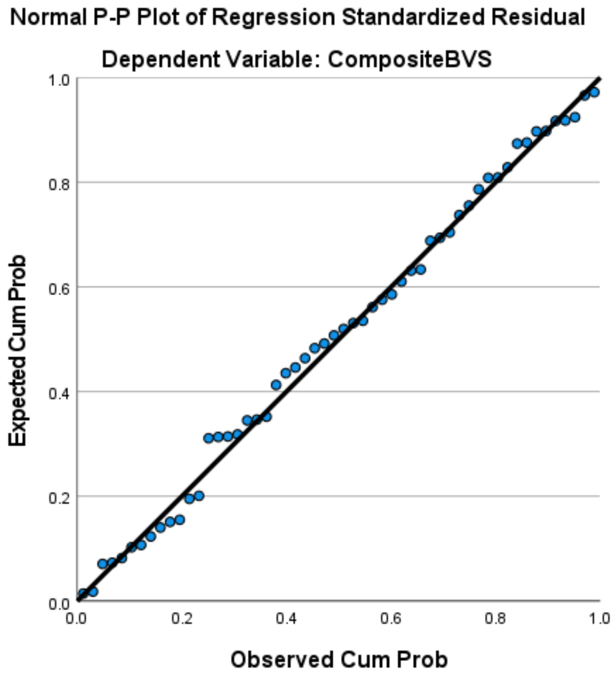


Figure 21. Normality of the Residual Distribution of Business Value of Software and Innovation Capabilities

8.7. Appendix E: Development Focus One-Way ANOVA

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
CompCollab	0	21	6.0476	.70935	.15479	5.7247	6.3705	4.33	7.00
	1	11	6.1515	.87386	.26348	5.5644	6.7386	4.33	7.00
	2	22	6.1818	.78832	.16807	5.8323	6.5313	5.00	7.00
	Total	54	6.1235	.76423	.10400	5.9149	6.3321	4.33	7.00
CompCreativity	0	21	4.1905	1.63153	.35603	3.4478	4.9331	1.00	7.00
	1	11	4.3636	1.36182	.41060	3.4488	5.2785	1.67	7.00
	2	22	4.9394	1.38639	.29558	4.3247	5.5541	2.00	7.00
	Total	54	4.5309	1.49565	.20353	4.1226	4.9391	1.00	7.00
CompAgility	0	21	5.3810	1.06085	.23150	4.8981	5.8638	3.00	7.00
	1	11	5.3333	1.13529	.34230	4.5706	6.0960	3.33	7.00
	2	22	5.5758	1.00360	.21397	5.1308	6.0207	3.00	7.00
	Total	54	5.4506	1.03838	.14131	5.1672	5.7340	3.00	7.00
CompValue	0	21	5.7540	1.28519	.28045	5.1690	6.3390	3.17	7.00
	1	11	6.0000	.97183	.29302	5.3471	6.6529	3.50	7.00
	2	22	6.0076	.89454	.19072	5.6110	6.4042	4.33	7.00
	Total	54	5.9074	1.06481	.14490	5.6168	6.1980	3.17	7.00
CompRarity	0	21	3.7460	1.72532	.37650	2.9607	4.5314	1.00	7.00
	1	11	4.5758	1.33409	.40224	3.6795	5.4720	2.33	6.67
	2	22	4.2273	1.70709	.36395	3.4704	4.9842	2.00	7.00
	Total	54	4.1111	1.64833	.22431	3.6612	4.5610	1.00	7.00
CompInimit	0	21	2.9365	1.60769	.35083	2.2047	3.6683	1.00	6.33
	1	11	3.7576	1.61995	.48843	2.6693	4.8459	2.00	7.00
	2	22	3.3182	1.36656	.29135	2.7123	3.9241	1.00	6.00
	Total	54	3.2593	1.51812	.20659	2.8449	3.6736	1.00	7.00
CompImmoNonSub	0	21	4.0381	1.44030	.31430	3.3825	4.6937	1.20	7.00
	1	11	4.8436	1.19405	.36002	4.0415	5.6458	3.40	6.80
	2	22	4.2127	1.56429	.33351	3.5192	4.9063	1.20	7.00
	Total	54	4.2733	1.45339	.19778	3.8766	4.6700	1.20	7.00

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
CompCollab	Between Groups	.204	2	.102	.169	.845
	Within Groups	30.750	51	.603		
	Total	30.955	53			
CompCreativity	Between Groups	6.412	2	3.206	1.458	.242
	Within Groups	112.147	51	2.199		
	Total	118.560	53			
CompAgility	Between Groups	.598	2	.299	.270	.765
	Within Groups	56.548	51	1.109		
	Total	57.146	53			
CompValue	Between Groups	.809	2	.405	.348	.708
	Within Groups	59.283	51	1.162		
	Total	60.093	53			
CompRarity	Between Groups	5.471	2	2.735	1.007	.372
	Within Groups	138.529	51	2.716		
	Total	144.000	53			
CompInimit	Between Groups	4.995	2	2.498	1.087	.345
	Within Groups	117.153	51	2.297		
	Total	122.148	53			
CompImmoNonSub	Between Groups	4.821	2	2.410	1.147	.326
	Within Groups	107.134	51	2.101		
	Total	111.954	53			

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) control	(J) control	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
CompCollab	0	1	-.10390	.28901	.931	-.8016	.5938
		2	-.13420	.23689	.838	-.7061	.4377
	1	0	.10390	.28901	.931	-.5938	.8016
		2	-.03030	.28674	.994	-.7225	.6619
	2	0	.13420	.23689	.838	-.4377	.7061
		1	.03030	.28674	.994	-.6619	.7225
CompCreativity	0	1	-.17316	.55192	.947	-1.5055	1.1592
		2	-.74892	.45240	.232	-1.8410	.3432
	1	0	.17316	.55192	.947	-1.1592	1.5055
		2	-.57576	.54759	.548	-1.8976	.7461
	2	0	.74892	.45240	.232	-.3432	1.8410
		1	.57576	.54759	.548	-.7461	1.8976
CompAgility	0	1	.04762	.39192	.992	-.8985	.9937
		2	-.19481	.32125	.817	-.9703	.5807
	1	0	-.04762	.39192	.992	-.9937	.8985
		2	-.24242	.38884	.808	-1.1811	.6962
	2	0	.19481	.32125	.817	-.5807	.9703
		1	.24242	.38884	.808	-.6962	1.1811
CompValue	0	1	-.24603	.40128	.814	-1.2147	.7227
		2	-.25361	.32892	.722	-1.0476	.5404
	1	0	.24603	.40128	.814	-.7227	1.2147
		2	-.00758	.39813	1.000	-.9687	.9535
	2	0	.25361	.32892	.722	-.5404	1.0476
		1	.00758	.39813	1.000	-.9535	.9687
CompRarity	0	1	-.82973	.61342	.373	-2.3105	.6510
		2	-.48124	.50280	.607	-1.6950	.7325
	1	0	.82973	.61342	.373	-.6510	2.3105
		2	.34848	.60860	.835	-1.1207	1.8176
	2	0	.48124	.50280	.607	-.7325	1.6950
		1	-.34848	.60860	.835	-1.8176	1.1207
CompInimit	0	1	-.82107	.56411	.321	-2.1828	.5407
		2	-.38167	.46239	.689	-1.4979	.7345
	1	0	.82107	.56411	.321	-.5407	2.1828
		2	.43939	.55968	.714	-.9117	1.7905
	2	0	.38167	.46239	.689	-.7345	1.4979
		1	-.43939	.55968	.714	-1.7905	.9117
CompImmoNonSub	0	1	-.80554	.53945	.303	-2.1078	.4967
		2	-.17463	.44217	.918	-1.2420	.8928
	1	0	.80554	.53945	.303	-.4967	2.1078
		2	.63091	.53521	.471	-.6611	1.9229
	2	0	.17463	.44217	.918	-.8928	1.2420
		1	-.63091	.53521	.471	-1.9229	.6611