Factors That Contribute Significantly to Scrum Adoption as Perceived by Scrum Practitioners Working Within South African Organisations

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DECLARATION

I declare that **Factors That Contribute Significantly to Scrum Adoption as Perceived by Scrum Practitioners Working Within South African Organisations** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the thesis/dissertation to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

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ABSTRACT

Scrum is the most adopted and under-researched Agile methodology. The research conducted on Scrum adoption is mainly qualitative. Therefore, there was a need for a quantitative study to investigate Scrum adoption challenges.

The general objective of this study was to investigate the factors that have a significant relationship with Scrum adoption as perceived by Scrum practitioners working within South African organisations. To achieve this objective a narrative review to synthesise the existing challenges was conducted, followed by the use of these challenges in the development of a conceptual framework. After that, a survey questionnaire was used to test and evaluate the developed framework.

The research findings indicate that relative advantage, complexity, and sprint management are factors that have a significant linear relationship with Scrum adoption. The findings are generalisable to the population, and the author recommends that organisations review the findings during their adoption phase of Scrum.

Keywords: Adoption Challenges, Agile Methodologies, Diffusion of Innovation, Multiple Linear Regression, Narrative Review, Quantitative Research, Scrum, Scrum Practitioner, Software Engineering, South African Organisation.

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
ASD	Adaptive Software Development
CF	Conceptual Framework
CSIR	Council for Scientific and Industrial Research
DOI	Diffusion of Innovation
DSDM	Dynamic Systems Development Method
EFA	Exploratory Factor Analysis
FDD	Feature-Driven Development
IEEE	Institute of Electrical and Electronics Engineers
IJEST	International Journal of Environmental Science and Technology
IS	Information Systems
ISD	Information Systems Development
ISV	Independent Software Vendor
IT	Information Technology
JCSE	Johannesburg Centre for Software Engineering
KISS	Keep it Simple, Stupid
KMO	Kaiser Meyer Olkin
LASD	Lean and Agile Software Development
LSD	Lean Software Development
MLR	Multiple Linear Regression
OB	Organisational Behaviour

PAF	Principal Axis Factoring
PCI	Perceived Characteristics of Innovating
RAD	Rapid Application Development
RUP	Rational Unified Process
SA	South African
SACCF	Scrum Adoption Challenges Conceptual Framework
SACDM	Scrum Adoption Challenges Detection Model
SDLC	Software Development Life Cycle
SDM	Software Development Methodology
SE	Software Engineering
SEMAT	Software Engineering Method and Theory
SPSS	Statistical Package for Social Sciences
TA	Technology Acceptance
TAM	Technology Acceptance Model
TMS	Top Management Support
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UNISA	University of South Africa
UTAUT	Unified Theory of Acceptance and Use of Technology
XP	Extreme Programming

PUBLICATIONS FROM THE DISSERTATION

Hanslo, R. & Mnkandla, E. 2018. Scrum Adoption Challenges Detection Model: SACDM. In Federated Conference on Computer Science and Information Systems (FedCSIS). Poznan, Poland: IEEE: 949–957.

CHAPTER 1: NATURE OF THE STUDY

Chapter 1 is structured as follows:

1.1 - Introduction

1.2 - Problem Statement

1.3 - Research Objectives

1.4 - Research Hypotheses

1.5 - Definition of Key Terms

1.6 - The Research Journey

1.7 - Limitations of the Study

1.8 - Scope of the Study

1.9 - Significance of the Study

1.10 - Ethical Considerations

1.11 - Outline of the Study

1.12 - Chapter Summary

1.1 Introduction

"Software development has become one of the world's most important practices. The software we produce today is rapidly becoming the embodiment of much of the world's intellectual property. Simply put, our modern world depends on software" (Leffingwell 2011: 3).

Before the widespread use of Agile processes, a more systematic and predictive approach for developing software was used, with its inception in the 1950s and 1960s (Leffingwell 2011: 5). A Waterfall Process Model is a plan-based approach, whereby the process flows from top to bottom linearly (Pressman 2010: 39). Figure 1.1 depicts the Waterfall Model.

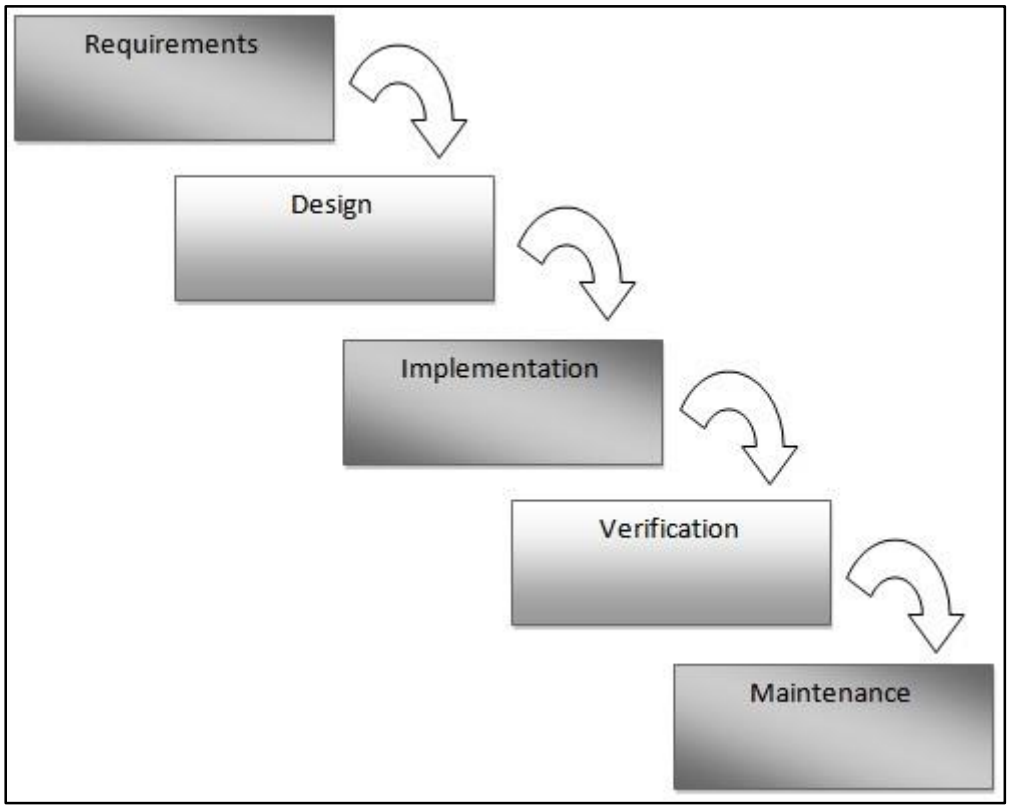


Figure 1.1: Simplified Waterfall Model (Source: www.waterfall-model.com).

Scrum was developed in the early 1990s by Ken Schwaber and Jeff Sutherland (Pressman 2005: 117). Scrum is currently the most widely adopted Agile methodology, based on the VersionOne survey done in 2017. A citation by Leffingwell (2011: 14) on the VersionOne 2009 survey affirms the consistency by displaying a 74% uptake of Scrum and Scrum variants. The reason for its high adoption rates could be its simplicity, as it is lightweight and easy to master.

Agile adoption has its challenges; however, what is certain is the fact that successful adoption improves numerous aspects of the business operation such as project visibility, manage change

priorities, better aligned Information Technology (IT) and Business, increased productivity, and enhanced software quality just to mention a few (VersionOne 2017: 9). As stated by Rogers (2003: 26), "A technological innovation usually has at least some degree of benefit for its potential adopters".

What is evident from the finite amount of reviewed literature is that, while there are common problems and challenges identified, there are no known empirical quantitative studies conducted on the Scrum adoption challenges experienced by individuals within South African (SA) organisations.

A descriptive and explanatory case study done by Noruwana and Tanner (2012: 41) on Agile processes with emphasis on Scrum, alludes that there is a knowledge base to unearth on adoption challenges in the SA context. While there are challenges and issues, changing technologies have and will continue to play a significant role in the success of companies, and many industries (Sultan & Chan 2000: 106).

The author, therefore, felt that it was necessary to do a quantitative research study to investigate the SA Scrum adoption challenges experienced in practice. The alternate research hypotheses wanted to disprove the null hypotheses, by providing research results to confirm the existence of a relationship between Scrum challenges and the adoption of Scrum.

Multiple theories, models and frameworks such as Diffusion of Innovation (DOI), Technology Acceptance Model (TAM), Perceived Characteristics of Innovations, and the Theory of Planned Action have been used to better understand the adoption and implementation of methodologies in software development (Vijayasarathy & Turk 2012: 138).

This study looks at the Scrum adoption challenges experienced through the lens of the DOI theoretical model, implementing a Conceptual Framework (CF) using a custom version of DOI. The CF is divided into four constructs identified as individual factors, team factors, organisation factors, and technology factors, combines to form a holistic representation of the individual's beliefs, the individual's relation to people, how they perceive the organisation they work for, and their perception of the methodology being used (Chan & Thong 2007: 4). Each construct contains

independent variables that were used to determine which factor has a significant relationship with Scrum adoption as perceived by the individual, and who is a Scrum practitioner working within a SA organisation.

This research provides an opportunity to identify and evaluate what the broader Scrum adoption challenges are within SA organisations, as well as providing literature and findings that could improve on the existing adoption challenges knowledge base.

1.2 Problem Statement

Ambler (2012: internet), and Du Toit (2013: internet) states that in the region of only 60% to 70% of software projects adopting Agile methodologies experience success, leaving 30% to 40% of projects with challenges or failures. The statistics might indicate uncertainty on the effectiveness of adopting an Agile methodology such as Scrum by individuals.

While research was done on adoption challenges of Agile methodologies within the SA context, little research has been on adoption challenges of the Scrum Agile methodology. Of the limited research done, the research was mainly qualitative with emphasis on case studies. The case study phenomenon on the adoption of Agile methodologies is a common reoccurrence within the existing literature (Chan & Thong 2007: 6), as well as the lack of research, focused on the individual's intentions to adopt a Software Development Methodology (SDM) (Hardgrave et al. 2003: 124).

There is a need for an empirical study involving the use of a quantitative approach to examine individuals' perceptions of Scrum and its adoption challenges (Sultan & Chan 2000: 106, 109). The author is of the opinion that the lack of quantitative studies on Scrum and Agile adoption within the SA context prevents the author and fellow researchers from being able to perform predictive statistical analysis on the challenges that influences adoption. Another reason for the need for a quantitative study is to allow the researcher to be able to generalise within the population based on the sample.

This research, therefore, applied quantitative methods to examine the relationships among the major factors that contribute to the adoption of Scrum as perceived by Scrum practitioners within SA organisations.

1.3 Research Objectives

1.3.1 General Objective

The general objective of this research was to investigate the factors that have a significant linear relationship with Scrum adoption as perceived by Scrum practitioners working within SA organisations.

1.3.2 Specific Objectives

a) To provide a generalised model based on an empirically constructed understanding of the factors that are important to the adoption of Scrum within organisations.
b) To consolidate the Scrum and Agile adoption challenges of existing literature, using a narrative review.
c) To provide research literature that adds to the greater body of knowledge on Scrum adoption challenges.

1.4 Research Hypotheses

This study collected and analysed data to test whether the following alternative hypotheses could be accepted:

a) **H_1 - Escalation of Commitment:** There is a significant linear relationship between escalation of commitment and Scrum adoption.
b) **H_2 - Experience:** There is a significant linear relationship between experience and Scrum adoption.
c) **H_3 - Over-Engineering:** There is a significant linear relationship between over-engineering and Scrum adoption.
d) **H_4 - Communication:** There is a significant linear relationship between communication and Scrum adoption.

e) **H_5 - Teamwork:** There is a significant linear relationship between teamwork and Scrum adoption.
f) **H_6 - Specialisation:** There is a significant linear relationship between specialisation and Scrum adoption.
g) **H_7 - Sprint Management:** There is a significant linear relationship between sprint management and Scrum adoption.
h) **H_8 - Change Resistance:** There is a significant linear relationship between change resistance and Scrum adoption.
i) **H_9 - Training:** There is a significant linear relationship between training and Scrum adoption.
j) **H_{10} - Recognition:** There is a significant linear relationship between recognition and Scrum adoption.
k) **H_{11} - Quality:** There is a significant linear relationship between quality and Scrum adoption.
l) **H_{12} - Resources:** There is a significant linear relationship between resources and Scrum adoption.
m) **H_{13} - Collaboration:** There is a significant linear relationship between collaboration and Scrum adoption.
n) **H_{14} - Management Support:** There is a significant linear relationship between management support and Scrum adoption.
o) **H_{15} - Organisational Culture:** There is a significant linear relationship between organisational culture and Scrum adoption.
p) **H_{16} - Organisational Structure:** There is a significant linear relationship between organisational structure and Scrum adoption.
q) **H_{17} - Relative Advantage:** There is a significant linear relationship between relative advantage and Scrum adoption.
r) **H_{18} - Complexity:** There is a significant linear relationship between complexity and Scrum adoption.
s) **H_{19} - Compatibility:** There is a significant linear relationship between compatibility and Scrum adoption.

1.5 Definition of Key Terms

This research study uses the following key terms as defined below:

- **Adoption Challenges**

The challenges faced by software development organisations when choosing and following an Agile methodology (Tanner & Khalane 2013: 1).

- **Agile Methodologies**

The development of software using the process of iterative increments, allowing for changes during the development process with a competent, collaborative team that places a high priority on communication (Mnkandla 2010: 30).

- **Scrum**

Agile methodology with emphasis on project management structure, and communication between all stakeholders including clients, and business representatives. Regularly setting sprint time limits for software completion, reviewing changes, and applying retrospection before working on the next product backlog requirements (Schwaber & Sutherland 2011: 3-15).

- **Software Engineering**

The application of a sound, systematic approach to software development which produces quality software systems that meet the client's requirement and lowers unnecessary overhead in the process (Pressman 2005: 53).

- **Software Organisation**

Any company, firm or organisation that has a division, team or individual responsible for developing new or extending existing software, for the benefit of the software organisation or the client they service.

- **Scrum Practitioner**

Any individual that actively uses Scrum for project and task completion.

- **Waterfall Model**

A Software Engineering (SE) process model which follows a systematic, linear approach to software development, whereby changes in customer requirements outside of the requirements gathering step of communication is challenging to include, and complete successfully (Pressman 2010: 39).

1.6 The Research Journey

The author faced many challenges throughout the research process, as most of the research studies carried out on Scrum and Agile adoption challenges was primarily using qualitative methods, such as case studies and interviews (Chan & Thong 2007: 6). Within SA, the exacerbated problem of the lack of Scrum and Agile adoption studies in general was mentioned in the literature review. Therefore, it dawned upon the author that to conduct an empirical study on Scrum adoption factors as perceived by Scrum practitioners working within SA organisations, the first step to achieve the primary research objective was to consolidate known Scrum and Agile adoption challenges. After that, the author could proceed with a quantitative research design to determine the factors that had a significant relationship with Scrum adoption. As a result, the author operationalised the Agile and Scrum adoption challenges experienced both globally and within SA. The narrative review conducted was vital for the extraction and syntheses of the data**.**

Having researched several Scrum and Agile adoption studies, the author realised that there was a need for a formalised Scrum Adoption Challenges Conceptual Framework (SACCF). Therefore, the author decided that the next step to empirically identify which Scrum adoption challenges have a significant linear relationship and correlation towards Scrum adoption was to construct a model which could be tested and evaluated. The first iteration of the model which has also been published as the Scrum Adoption Challenges Detection Model (SACDM) provided a holistic approach to identifying the challenges that contribute towards Scrum adoption**.** The CF is based on the Diffusion of Innovation (DOI) theory, which investigates how an innovation is adopted or rejected by individuals and organisations based on their perceptions of the innovation (Hardgrave

et al. 2003: 127). The DOI theory in itself was insufficient to be used as the SACCF, as the Scrum methodology is a social phenomenon which focuses on people instead of processes, as mentioned in the literature by Dönmez and Grote (2011: 326). Therefore, the author adapted the approach by Sultan and Chan (2000: 113), which looked at the innovation from the individual, group, company, and technology perspective. The development of the SACCF allowed the author to comprehend better the factors which form part of Scrum adoption.

The SACCF played an essential role in the construction of the survey questionnaire. The questions within the survey questionnaire have been designed based on the challenges derived from the narrative review. The challenges, therefore, are the independent variables, and Scrum adoption is the dependent variable. Since the CF factors derive from the narrative review's syntheses of adoption challenges, the author was thus able to perform a survey study to determine the challenges which have a significant relationship with Scrum adoption. The SACCF can now be thoroughly evaluated and validated.

Having performed all the groundwork to describe the adoption challenges of the Scrum and Agile methodologies, the author was able to develop the first iteration of the SACCF. However, after designing the survey questionnaire, it became apparent that the method for the model testing and evaluation needed to change. The significant change was shifting the statistical analysis to be conducted on the research results from logistic regression to Multiple Linear Regression (MLR). Section 6.2 of Chapter 6 which discusses this change in detail, led to the second iteration of the CF.

The second iteration of the SACCF was ready to be evaluated and validated using the developed survey questionnaire. The survey questionnaire which uses the operationalised independent variables was able to assess which factors contribute toward Scrum adoption. Therefore, due to the exploratory nature of this research study, the conceptual model went through a third and final iteration. The author used the statistical analysis results derived from the survey data to re-evaluate and validate the final iteration of the SACCF. It was discovered that the CF was able to identify which Scrum adoption challenges have a statistically significant relationship with Scrum adoption.

The journey from the consolidation of the Scrum and Agile adoption challenges, to the development of the SACCF, and finally the testing and evaluation of the SACCF using an online survey questionnaire was a long and tedious journey. The research journey is illustrated in Figure 1.2 to provide the reader with a holistic view of the steps taken.

Ultimately, this journey has developed the author's expertise on the Scrum adoption topic, which resulted in the author publishing and reviewing academic papers within the research field.

1.7 Limitations of the Study

There is no restriction to the geolocation of the responses within SA. However, the majority of SA's organisations and Scrum practitioners are in the provinces of Gauteng and the Western Cape. Another limitation of the study is the lack of a systematic review in the extraction and synthesis of the existing Scrum and Agile adoption challenges, resulting in the narrative review's data being unreproducible. This study investigates Scrum adoption from the perspective of the individual Scrum practitioner perceptions, which further limits the findings influence on the organisation's or team's decision to adopt Scrum. The last limitation is in the small population sample size, which decreases the generalisability of the research outcomes.

1.8 Scope of the Study

What is excluded from the research are adoption challenges of other Agile SDM's, including non-agile methodologies. No research is done outside the borders of the SA software organisation, as interests are specific to the adoption challenges within the SA borders. Within the SA borders, there will be no data collection from many of the nine provinces, as this will not be feasible and practical. The data collection is mainly derived from the Gauteng and Western Cape provinces.

Implementation challenges are excluded from the research, including these challenges is beyond the scope of the study. The qualitative methodology was not used even though the respondents' opinions are recorded; the reason for this decision is because the questionnaire responses did not focus on the meaning of responses.

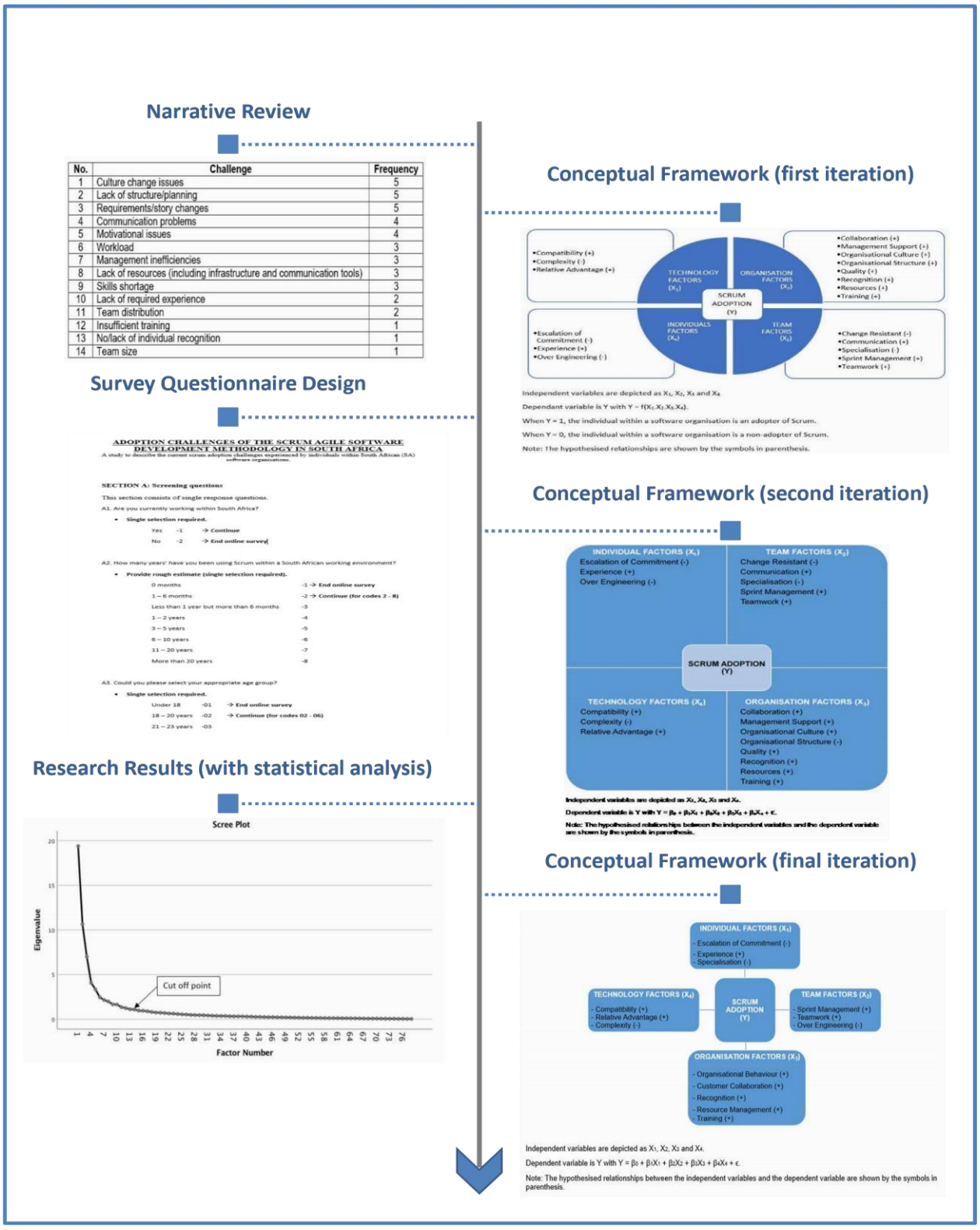


Figure 1.2: Scrum Adoption Research Journey.

A mixed-method approach was not implemented. While the narrative review method is used to select relevant literature on Scrum and Agile adoption challenges for extraction and synthesis purposes, the output thereof is not the primary objective of this study.

1.9 Significance of the Study

The study aims to make the following research contributions on the challenges of Scrum adoption:

- Synthesise existing knowledge of the challenges facing Agile and Scrum adoption, broadening our understanding of the topic.
- Identify the variables that influence Scrum and Agile adoption based on the existing literature.
- Develop a CF using a custom model of the DOI theoretical model, which is used to test and evaluate Scrum adoption.
- Use constructs at the individual, team, organisation, and technology level to identify factors that are significant predictors of Scrum adoption.
- Based on the empirical findings provide suggestions for future research.

1.10 Ethical Considerations

Before the researcher could proceed with data collection, the University of South Africa (UNISA) ethics committee gave the ethical clearance in line with the UNISA research ethics policy. The ethics clearance included informed consent from respondents over the age of 18. Respondents' confidentiality was guaranteed, and personal information was not required. Data was analysed at the group-level and not the individual level to de-identify participants. Appendix G includes the ethical clearance certificate.

1.11 Outline of the Study

This chapter has laid down the motivation and background for this research, where the problem statement, research hypotheses, research objectives, research design, the definition of key terms,

the author's research journey, limitations of the study, scope and delimitations, significance of the study and ethical considerations were stated.

Chapter 2 encompasses the first half of the literature review which discusses the challenges experienced during the adoption phase of Scrum and other Agile methodologies. The challenges are extracted and synthesised. This chapter includes a brief discussion on the success and benefits of Scrum and Agile adoption.

Chapter 3 focuses on the CF, which is the second half of the literature review, describing the theory behind the derived model, its dependent and independent variables, and the structure of the model.

Chapter 4 defines the research methodology, describing the research design, population sample, measuring instruments, data collection and statistical analysis.

Chapter 5 is where the results of the analysis are displayed.

Chapter 6 is the critical evaluation of the research contributions, discussing the development of the CF, and testing and evaluating the CF with an online survey questionnaire. After that, the discussion of the research findings provides opinions on the limitations and main findings of the research.

Chapter 7 closes by providing recommendations for future research which could allow more research studies to improve on this dissertation.

1.12 Chapter Summary

Agile methods are well established within the SE community, and Scrum is at the forefront of adoption and implementation. However, organisations are continuously experiencing challenges and issues during the adoption and implementation of the Scrum framework. What those challenges are, are identified in the global community. However further literature can identify the Scrum adoption challenges experienced by Scrum practitioners working within SA organisations.

Therefore, this study aims to expand the current knowledge base, providing research findings on the factors that have a significant linear relationship with Scrum adoption as perceived by Scrum practitioners working within SA organisations.

This chapter presented an overview of the study. An introduction into the study phenomena "Scrum adoption challenges" was established. The next chapter presents a literature review on SDM's, the state of Agile, the definition of Scrum, and the challenges related to Agile and Scrum adoption.

CHAPTER 2: LITERATURE REVIEW - THE AGILE AND SCRUM CHALLENGES

Chapter 2 is structured as follows:

2.1 - Introduction

2.2 - Software Development Methodologies

2.3 - The State of Agile

2.4 - Agile Adoption Challenges

2.5 - Scrum Defined

2.6 - Scrum Adoption Challenges

2.7 - Chapter Summary

2.1 Introduction

The previous chapter focused on the nature of the study and the composition thereof. This chapter presents the current knowledge base of Agile, Scrum and their respective challenges.

A description of the Software Development Methodology (SDM) adoption is that it is a more significant challenge in changed behaviour processes as opposed to tool adoption. Because of the radical behavioural change required, it is regarded more as a mandatory rather than a voluntary innovation. The introduction of new methodologies causes problems for individuals and organisations due to the complexities of methodology adoption, affecting the success and adoption thereof (Mohan & Ahlemann 2013: 832). Even when an organisation has been implementing a traditional SDM for years, adopting Agile methodologies poses new challenges such as software developer resistance, management style, and systems development process (Chan & Thong 2007:

2). Adoption challenges experienced within an organisation should focus their attention at the individual adoption level and not at the organisational adoption level, as the adoption at the individual level has a tremendous impact on the implementation process (Riemenschneider et al. 2002: 1141-1142).

The technological transition was studied since the early 1940s, and the Diffusion of Innovation (DOI) model is a widely adopted theoretical model (Bayer & Melone 1989: 161). Chan and Thong (2007: 5) inform that popular theory used for Information Technology (IT) tool adoption are DOI and Technology Acceptance Model (TAM). These models were sufficiently used for SDM acceptance. This sentiment is echoed by Mohan and Ahlemann (2013: 834), which also states that studies should regard the adoption of methodologies as actual use and not merely intended to use. A software innovation adoption problem mentioned by Rogers (2003: 26) states that the difficulty in observing and tracing "idea-only" innovations result in a slower rate of adoption.

2.2 Software Development Methodologies

Migrating from non-Agile to Agile methodologies poses many challenges, some of these challenges include changes in management style, communication methods, and process changes within organisations. (Chan & Thong 2009: 804).

Before we elaborate on the Agile challenges within the existing literature, the following subsections consist of a few Agile methodologies. These Agile methodologies provide a contextual background for Scrum.

2.2.1 Adaptive Software Development

Adaptive Software Development (ASD) is the creation of Jim Highsmith. ASD provides a technique to increase the success rate of developing complete, customer approved complex software and systems (Pressman 2005: 114).

The cornerstone of the methodology is collaboration and team self-organisation. This is evident in ASD's adaptive life cycle. The three phases of the life cycle are speculation, collaboration and learning.

2.2.2 Dynamic Systems Development Method

The Dynamic Systems Development Method (DSDM) is an Agile software development approach that does not focus primarily on system writing but has a more abstract software development focus (Koch 2005: 239). DSDM is considered an incremental method often compared to the Rapid Application Development (RAD) model. RAD place emphasises on a short development cycle (Pressman 2005: 81).

DSDM follows the 80% rule, where 80% of the system is developed in 20% of the time, generating only the work required for each increment to be able to proceed to the next increment. The DSDM include steps for feasibility, business study, functional model iteration, and implementation.

2.2.3 Extreme Programming

Extreme Programming (XP) has been a widely adopted Agile software development method, first publicised by Kent Beck (Pressman 2005: 110). Key practices of XP include the following:

- A team of five to ten programmers work at one location with customer representation on-site.
- Development occurs in frequent builds or iterations, which may or may not be releasable, and delivers incremental functionality.
- Requirements are specified as user stories, each a chunk of new functionality the user requires.
- Programmers work in pairs, follow strict coding standards, and do their unit testing.
- Customers participate in acceptance testing.
- Requirements, architecture, and design emerge over the course of the project.

XP is prescriptive in scope and customers are often readily available on-site for communication and collaboration purposes. The learning outcomes by paired programmers are invaluable, as the

one developer that is not programming guides the one programming and this results in higher software quality in a shorter time interval (Leffingwell 2011: 14-15).

2.2.4 Feature-Driven Development

Originally conceived by Peter Coad and his colleagues, Feature-Driven Development (FDD) is an Agile method for object-oriented Software Engineering (SE) (Pressman 2005: 120). “A feature is a small, client-valued function expressed in the form: <action><result> <object> with the appropriate prepositions between the action, result, or object” (Palmer & Felsing 2002: 41).

FDD places greater emphasis on project management than most of the other Agile methodologies, with ad hoc project management becoming inadequate as the project grows in size. FDD defines six milestones during the design and build of a feature to improve the likelihood of success of scheduled software increments (Pressman 2005: 121). The milestones for each feature are the following:

- Domain walkthrough.
- Design.
- Design inspection.
- Code.
- Code inspection.
- Promote to build.

2.2.5 Lean Software Development

Lean Software Development (LSD) is not an Agile methodology but rather a set of tools and principles that make the software projects leaner (Koch 2005: 253). LSD draws its origins from the vehicle manufacturing industry, where productivity is measured by maximum reduction in unnecessary resource use, rather than increase throughput. Koch (2005: 253) explains that LSD is characterised by seven lean principles. LSD's principles are further expanded into 22 lean software development tools.

This section described the variance and similarities between a few of the Agile methodologies used within practice. The next section discusses the adoption of Agile SDM's.

2.3 The State of Agile

2.3.1 Introduction

This subsection will be demonstrating the growth and adoption of Agile methodologies chronologically, including the growth and adoption of Scrum, within the past two decades.

The term "Agile Method" has been coined as recently as February 2001, even though there was the existence of some of these Agile methods (Koch 2005: 3). There were many reasons for the inception of the Agile method; one of the reasons was the need for methods that could respond quickly to change.

For this reason, the "Agile Manifesto" was created, by leading developers of the time. Although the Agile Manifesto gives a complete listing of the agreement, the following four statements give a good idea of what Agile is all about (Beck et al. 2001: internet):

- Individuals and interactions over processes and tools.
- Working software over comprehensive documentation.
- Customer collaboration over contract negotiation.
- Responding to change over following a plan.

The goal of Agile is to remove impediments to a successful software project. How Agile goes about making the success a reality depends on the type of Agile method implemented. Regardless of the type of Agile method implemented, the common goal between these Agile methods is to produce quality software products in the shortest possible time with the least number of impediments as possible (Mnkandla & Dwolatzky 2007: 14). Communication, skilled individuals, continuous learning, and teamwork are essential aspects of any Agile method (Noruwana & Tanner 2012: 42).

2.3.2 Adoption of Agile Methodologies

Agile methods picked up in popularity from the early 2000s, due to organisations requiring software at a higher speed and better quality. Agile methods make promises of achieving better quality software at higher productivity levels. As the years of Agile methods awareness and adoption increased, the implementation of traditional approaches dropped (De O. Melo & Kon 2011: 322).

A survey was conducted on Agile adoption as early as 2004 by Dogs and Klimmer, as described by Kurapati et al. (2012: 18). The results taken from 84 responses placed Scrum fourth in the adoption ranking, at 7.2%. The most adopted Agile methodology was Extreme Programming (XP) (38.6%) followed by Feature Driven Design (FDD) (14.55%) and Rational Unified Process (RUP) (11.9%).

Another international Agile adoption survey conducted by Ambler in 2008 as mentioned by Akhtar et al. (2010: 460), indicates that 69% of organisations are practising an Agile methodology. What is important to note is that Scrum has been revealed to be the most rapidly growing methodology of the study. Thereafter there seems to be a trend chronologically in the research conducted in Agile method popularity from XP being the most popular (Kurapati et al. 2012: 16), to Scrum slowly building momentum as one of the most widely used and popular Agile methodologies, usually in conjunction with XP (Akhtar et al. 2010: 458; Hoda et al. 2011a: 75).

From the research studies dated from 2011 onwards, usage trends change over to Scrum being the most widely adopted and practised Agile method (Cocco et al. 2011: 117; Overhage et al. 2011: 1). After that, it shows signs of domination with mention of Scrum being the most popular by far (Anderson et al. 2012: 127), with a study by Kapitsaki and Christou (2014: 104) indicating that Scrum has become the usual way organisations build software. Scrum is often used as the methodology of choice when an organisation decides to run a pilot test on Agile software development.

Figure 2.1 displays a line chart of the upward trend of Scrum's usage growth as an Agile methodology, chronologically, over the years dated back from 2006 when VersionOne (a technology company specialising in Agile lifecycle management software) initiated the survey

study. The percentages in Figure 2.1 is not a sum out of 100, due to some organisations implementing multiple methodologies simultaneously.

When compared to the affirmations of the other surveys there is a connection in that while Scrum usage increases, the XP usage dwindles. Due to the practices of XP (see Section 2.2), it is often used with Scrum in organisations to create a hybrid between Scrum and XP, as seen in Figure 2.1.

The Agile growth has seen tremendous uptake across the globe, where 83% of individuals within the 7th Annual State of Agile Development Survey (VersionOne 2013: 8) suggesting that they are planning to implement Agile development in future projects. A considerable increase from the 59% suggestion from individuals in the 6th Annual State of Agile Survey (VersionOne 2012: 5). Similarly, the percentage of respondents who said that their organisations were practising Agile development has gone from 84% in the 7th State of Agile Development Survey (VersionOne 2013: 3) to 94% in the 11th Annual State of Agile Report (VersionOne 2017: 7).

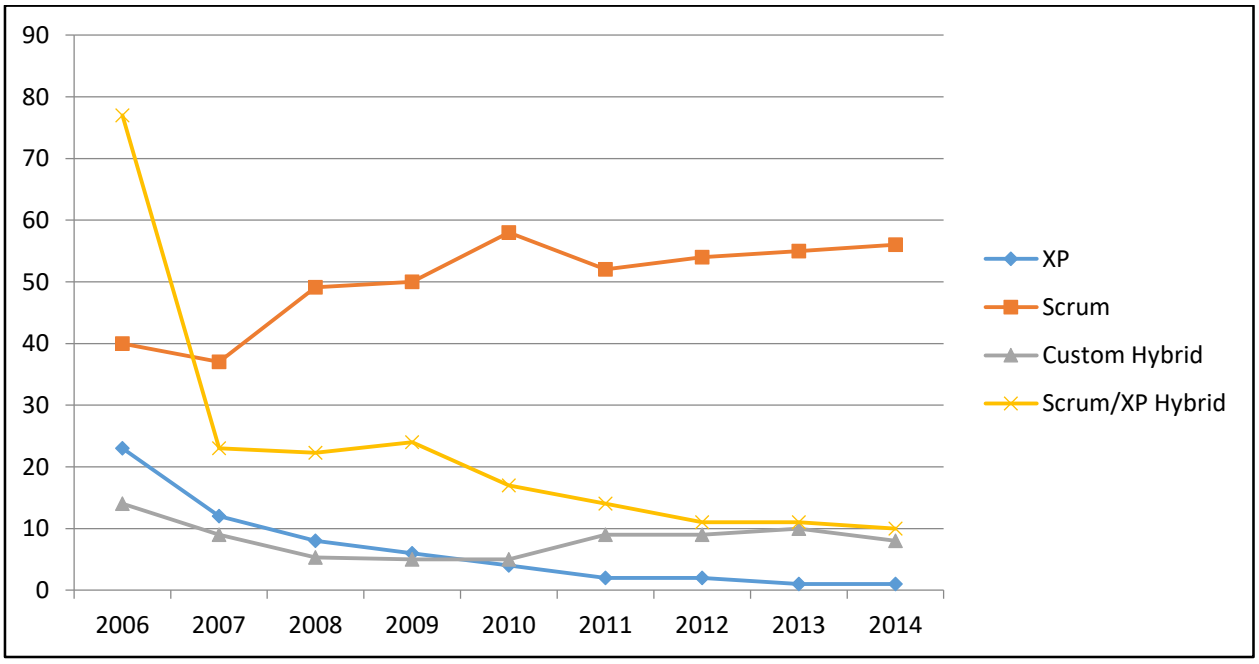


Figure 2.1: Scrum Usage Growth Percentage (Source: www.versionone.com).

In the year 2017 Scrum and Scrum variants recorded 76% of the Agile methodologies use, with pure Scrum being just over half of the total usage with 58%. The findings mentioned in a study by

Hardgrave et al. (2003: 143), suggests that some organisations custom-tailor off-the-shelf methodologies to match current work practices and organisational mandate. The adopters want to be more actively involved in the customisation of the methodology to best suit the team during the innovation diffusion (Rogers 2003: 27).

It is not uncommon for developers to abandon the adoption of a methodology because of other's perceptions thereof. Xu and Quaddus (2012: 20) stress the importance of individual characteristics in explaining the adoption and diffusion of an innovation. The individual's perception might explain the hybrid percentages in Figure 2.1, where companies combine good Agile practices from various Agile methods (Senapathi et al. 2011: 134). ScrumBut, which is a similar connotation, will be discussed later in this chapter.

Other noticeable percentages are those of DSDM with less than 1%, and Agile Unified Process with less than 1%. Surprisingly XP makes up less than 1% of the agile methodologies used. LSD displays 2% implementation and Kanban which interestingly for one of the younger SDM's has 5% of the total usage.

Table 2.1 describes the Agile methodology usage from 2006 to 2014 in percentage. The ranking is applied to the table's limited listing of Agile methodologies in Table 2.2, giving a more explicit indication of usage popularity and consistency during the period.

This section described the trends of Agile Methodologies within the global context through the inclusion of survey, and other research study results. Although there are many Agile methodologies, including and explaining them was not part of the scope of this study. SDM's such as XP, DSDM, and LSD were included to illustrate the growth of Scrum compared to other Agile methodologies.

The State of Agile section depicted Scrum as the dominant Agile methodology of preference, based on the statistics. The prevalence of the Scrum began as early as 2007 (see Table 2.2). A decade has passed from the year 2007, but Scrum which is the most used Agile methodology is still under-researched within the SA context.

Table 2.1: Agile Methodology Usage Percentage (Source: www.versionone.com).

Agile Method	2006	2007	2008	2009	2010	2011	2012	2013	2014
XP	23	12	8	6	4	2	2	1	1
DSDM	8	5	1.4	n/a	n/a	1	1	1	1
Scrum	40	37	49.1	50	58	52	54	55	56
Custom Hybrid	14	9	5.3	5	5	9	9	10	8
Scrum/XP Hybrid	77	23	22.3	24	17	14	11	11	10
LSD	n/a	n/a	1.9	3	2	2	2	3	2
Kanban	n/a	n/a	n/a	n/a	n/a	3	4	5	5
Agile Unified Process	n/a	n/a	2.2	n/a	n/a	1	1	1	1
Scrumban	n/a	n/a	n/a	n/a	3	3	7	7	6

Table 2.2: Agile Methodology Usage Rank (Source: www.versionone.com).

Agile Method	2006	2007	2008	2009	2010	2011	2012	2013	2014
XP	3	3	3	3	4	5	6	7	7
DSDM	5	5	7	n/a	n/a	6	7	7	7
Scrum	2	1	1	1	1	1	1	1	1
Custom Hybrid	4	4	4	4	3	3	3	3	3
Scrum/XP Hybrid	1	2	2	2	2	2	2	2	2
LSD	n/a	n/a	6	5	6	5	6	6	6
Kanban	n/a	n/a	n/a	n/a	n/a	4	5	5	5
Agile Unified Process	n/a	n/a	5	n/a	n/a	6	7	7	7
Scrumban	n/a	n/a	n/a	n/a	5	4	4	4	4

When perusing Scrum research literature within the SA context, the research methodology is primarily qualitative, as mentioned earlier in this chapter. The inclusion of the State of Agile section is to allude the reader to how significant a role Scrum plays within the Agile methodology environment and the importance of understanding the adoption challenges within SA as perceived by Scrum practitioners.

To empirically study the Scrum adoption challenges it is, therefore, necessary to apply a quantitative approach to better understand the adoption challenges that could limit the success of Scrum adoption outcomes.

The next section describes the Agile adoption challenges.

2.4 Agile Adoption Challenges

2.4.1 Introduction

Agile software development is the de facto standards for today's organisations developing software. In a recent survey conducted by VersionOne (2017: 2) as mentioned earlier in this chapter, 94% of all organisations surveyed currently practice Agile methods. What makes Agile so appealing is the fact that people in the field understand that, as much as one would like to think they are in control of the software development process at the start of a project, hindsight suggests that it is challenging to set fixed control structures up front.

Blankenship et al. (2011: 2) sum it up nicely when they say "Real-world software projects change, not every requirement can be gathered up front, things get missed, and the business is always learning and figuring out better ways to do things. We want the software to outlive the business requirements; not the business requirements outliving the software".

One of the components that make Agile so widely popular amongst IT personnel is that the decision making has shifted from a management to a predominantly team role, decentralising the decision-making process where it once was centralised (Stray et al. 2012: 153-154). This way of doing things challenge conventional management ideas, which expect project decisions to come in a top-down hierarchical structure with team members abiding by the decisions made by management (Hoda et al. 2011a: 83).

It has been documented on numerous occasions in previous research studies that adopting the Agile methodology mind-set requires change, and that change comes with its challenges (Hoda et al. 2011a: 84; Marchenko & Abrahamsson 2008: 17; Senapathi et al. 2011).

What follows in the next subsection is a brief description of the benefits of adopting Agile methods. Subsection 2.4.3 discusses the challenges faced when organisations adopt Agile. The two subsections mentioned above should provide organisations with a base from which they can better understand the challenges faced by Scrum and how it correlates to Agile.

2.4.2 Benefits of Agile Adoption

The benefits of Agile adoption and implementation give one a good idea as to why the Agile transformation within organisations has been so huge within the past few years. From literature thus far, despite there being many benefits and successes of Agile adoption, there are also many inconsistencies and isolated cases in the benefits encountered.

The isolated cases mentioned above, include benefits such as continuous improvement (Bjarnason & Regnell 2012: 177), stress and workload reduction (Kurapati et al. 2012: 28), cost reduction, maintainable and extensible code (Kapitsaki & Christou 2014: 105).

A group of benefits identified as having a standard connection is the work environment. According to the consolidated findings taken from Dingsøyr et al. (2006: 5,10), Hoda et al. (2011a), and Santos and Goldman (2011: 324), the work environment of an organisation that adopted Agile displays attributes of creativity, informal structure, openness, and organisational learning.

The benefits with the highest frequency count come as no surprise. As alluded to earlier in the study by Mnkandla and Dwolatzky (2007: 14), the goal is to produce quality software in the shortest possible time. From the limited data gathered, quality (Dingsøyr et al. 2006: 5; Giblin et al. 2010: 59; Kapitsaki & Christou 2014: 105; Korhonen 2010: 99; VersionOne 2017: 8), work performance (Dingsøyr et al. 2006: 5; Kapitsaki & Christou 2014: 105; Roche & Vasquez-McCall 2009: 141; VersionOne 2015: 8), self-organisation (Hoda et al. 2011a: 74; VersionOne 2015: 8), and customer collaboration (Kapitsaki & Christou 2014: 105) were frequently cited as Agile adoption benefits. Table 2.3 lists the Agile adoption benefits from the highest frequency to the least.

Table 2.3: Agile Adoption Benefits with Frequency.

No.	Benefit	Frequency
1	Quality	5
2	Work performance	4
3	Customer collaboration	2
4	Self-organising teams	2

2.4.3 Challenges encountered during Agile Adoption

"Quality is never an accident; it is always the result of intelligent effort". - John Ruskin

Considering the quote, one needs to ask the question; what is quality in terms of software development?

According to Mnkandla and Dwolatzky (2007: 2) quality is compatibility, correctness, ease, efficiency, extendibility, integrity, portability, reusability, robustness and verifiability.

Therefore, it is the goal of any software development organisation to provide the client with the 'correct' required product at the highest possible quality within the requested timeframe (Nathan-regis & Balaji 2012: 23).

Currently, even though it has been forty years since the principles of Agile methodologies was used, a crisis within the medium to large software system development environment persists (Dwolatzky 2012: 1).

So, what are the challenges with regards to adoption of Agile methodologies? What causes them to have these persistent challenges? What are these challenges in Scrum referring too?

Noruwana and Tanner (2012: 43-44) state that the reason for the difficulty in adopting Agile methodologies is because there is no structured approach. Lack of a structured approach is due to stakeholders not knowing the best solution to be adopted to solve the problem (Noruwana & Tanner 2012: 54). Other literature reviews suggest, the transition from traditional to Agile methodologies

should be gradual and should not be done radically (Ihme 2013: 270; Mnkandla & Dwolatzky 2004: 237).

The existing challenges faced during Agile adoption and implementation are not as straightforward as one might think. The reason for this might be that not all organisations follow the same set of standards or principles while adopting a methodology of choice, as mentioned earlier. Another reason might be that currently these challenges are investigated on an organisational level instead of the individual level, and what is challenging for one practitioner might not be for another. The research methodologies used might also contribute to the variation in challenges experienced, e.g. a quantitative survey design and a qualitative case study will generate different research results.

There are numerous Agile challenges identified in the reviewed literature. Of them, the most uncommon of the listings are challenges such as retrospective inadequacy (Bjarnason & Regnell 2012: 178), and an increase in stress and workload (Kim & Ryoo 2012: 481). It was anticipated that an increase in stress would be mentioned frequently; however, this is not the case. Increase in stress is one of the least identified Agile challenges; see Table 2.4. One unusual Agile adoption challenge mentioned in a case study by Hajjdiab and Taleb (2011: 32-33) specified that "too much documentation" became a burden as team members still operated in the old way of doing things, namely the traditional method. In the case study mentioned above, the eight unique adoption challenges experienced in the organisation are:

- Missing the Agile master role.
- The overzealous teams.
- The absence of a pilot project.
- Scrum implementation.
- Current work pressure.
- Upper management concerns.
- Governmental bureaucratic system.
- Documentation requirements.

The above results will thus not be included in Table 2.4 as it does not add significantly to the overall goal of consolidation of adoption challenges. It is specific to the case study, but it was worth mentioning.

Table 2.4: Agile Adoption Challenges with Frequency.

No.	Agile Challenge	Frequency
1	Lack of knowledge/training/learning	7
2	Organisational culture	5
3	Lack of communication	5
4	Lack of documentation	4
5	Escalating commitment	2
6	Lack of senior support	2
7	Budget and schedule constraint	2
8	Ineffective teamwork	2
9	Work specialisation	2
10	Skills deficiency	2
11	Resistance to change	2
12	Hard to scale	2
13	Retrospective inadequacy	1
14	Increase stress and workload	1

Table 2.4 derives from the literature provided by 17 individual sources, namely; Stray et al. (2012: 154-155), Bjarnason and Regnell (2012: 178), Irrazabal et al. (2011: 172), Hoda et al. (2011: 77), Dorairaj et al. (2011: 102,106,109), Senapathi et al. (2011: 142), Stray et al. (2011: 146,152,157), Asnawi et al. (2011: 194), Ressin et al. (2011, 320), Santos and Goldman (2011: 324), Fægri (2010: 29,34), Hoda et al. (2010: 73), Marchenko and Abrahamsson (2008: 17), Kim and Ryoo (2012: 481), Kapitsaki and Christou (2014: 105), Ihme (2013: 258,262), and VersionOne (2017: 12).

The frequency table depicts the top three challenges encountered during the adoption phase as:

- Lack of knowledge/training/learning.
- Organisational culture.

- Lack of communication.

It is not surprising to find these three issues at the top of the table, as these challenges show up quite often in survey responses as well, see VersionOne.com. One entry that came in fourth is lack of documentation. Lack of documentation is a surprising inclusion, but not an invalid entry as such. The author believes that documentation, if not done overzealously, contributes substantially toward the cohesiveness and structure of a project. Skill deficiency as depicted in the table, contributes towards the challenges encountered. The author's expectation that skill deficiency is one of the most critical Agile adoption challenges, is unconfirmed in the review. A research study on the motivation of IT professionals mentioned that the improvement of skills directly contributes towards turnover, motivation and satisfaction (Hardgrave et al. 2003: 136).

It is important to emphasise that most of the research methodologies used in the reviewed research studies thus far to describe the Agile adoption challenges are mainly qualitative, with semi-structured interviews and case studies being the predominant methods. Very few studies are conducted using quantitative survey designs that allow for a more generalised set of variables. The lack of empirical studies conducted on the adoption of Agile methodologies is confirmed in the research by Chan and Thong (2007: 5).

VersionOne.com provides the Annual State of Agile Survey, for the past 13 years dating back to 2006. The 12th annual survey ran in 2017. The advantages of this study is that it is a global survey. The demographics of the 11th annual survey in 2016 included North America (50%), Europe (28%), Asia (10%), South America (5%), Oceania (4%) and Africa (2%), (VersionOne 2017: 5). The annual survey spans across multiple industries within the global software development community (VersionOne 2015: 3), such as Independent Software Vendor (ISV) companies, healthcare, government, telecom, financial services, and public services (VersionOne 2015: 5).

What follows next is a chronological breakdown of the Agile adoption challenges by percentage (see Table 2.5), and ranking (see Table 2.6). The responses are extracted from the VersionOne Annual State of Agile Survey during the years 2006 to 2014. The survey has broken up the challenges into two separate subsections, namely what the organisation's most significant concerns

regarding the adoption of Agile development are, and what the barriers to further adoption of Agile in existing organisations are.

Therefore, the barriers of adoption were considered, and concerns with respect to its relation to the significance of this literature review are discussed. The Agile challenges have been numbered for legibility in Table 2.5 and Table 2.6. The numbering is, therefore, response coding with a footnote for the description thereof.

The VersionOne 2009 survey results have been omitted from the review because it has no percentage data. The most frequent challenges in the response data across the surveys are clear. Those that stand out are:

- Not enough personnel with the necessary skills or Agile experience.
- General organisational resistance to change.
- Customer collaboration.
- Management support.
- Project complexity/size.
- Ability to change organisational culture.
- Budget constraints/time to transition.
- Pre-existing rigid/Waterfall framework.

The top three issues encountered on average across the eight years of survey results are the ability to change organisational culture, general organisational resistance to change, and not enough personnel with the necessary skills or Agile experience.

What is immediately evident is that there are common challenges in the VersionOne survey data when compared to the qualitative data evaluated in Table 2.4. Common high frequencies again are lack of experience/skills, lack of customer collaboration, and organisational culture change. Other challenges such as organisational resistance to change, lack of documentation, and management support do not share the same sentiment.

Table 2.5: Agile Adoption Challenges Percentage (Source: www.versionone.com).

Agile Challenge	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	n/a	25	45	n/a	51	52	52	53	44
2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	22
3	n/a	n/a	17	n/a	25	27	22	23	14
4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	15
5	15	21	22	n/a	29	26	26	25	23
6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	13
7	20	36	44	n/a	40	39	41	42	34
8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	24
9	14	24	32	n/a	34	34	31	30	29
10	21	34	42	n/a	40	40	33	33	35
11	n/a	n/a	24	n/a	29	28	28	26	12
12	n/a	n/a	n/a	n/a	n/a	n/a	35	35	32
13	12	n/a	23	n/a	31	30	26	28	n/a
14	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	11
None	n/a	n/a	n/a	n/a	12	12	13	13	16

n/a=no data available
Agile challenge number with the definition:
1=Ability to change organisational culture.
2=Concerns about a loss of management control.
3=Confidence in the ability to scale Agile.
4=Confidence in methods for scaling Agile.
5=Customer collaboration.
6=Development team support.
7=General organisational resistance to change.
8=Management concerns about lack of upfront planning.
9=Management support.
10=Not enough personnel with the necessary skills or Agile experience.
11=Budget constraints/transition time.
12=Pre-existing rigid/Waterfall framework.
13=Project complexity/size.
14=Regulatory compliance.

Table 2.6: Agile Adoption Challenges Rank (Source: www.versionone.com).

Agile Challenge	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	n/a	3	1	n/a	1	1	1	1	1
2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	8
3	n/a	n/a	8	n/a	6	7	8	9	11
4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10
5	3	5	7	n/a	5	8	7	8	7
6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	12
7	2	1	2	n/a	2	3	2	2	3
8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6
9	4	4	4	n/a	3	4	5	5	5
10	1	2	3	n/a	2	2	4	4	2
11	n/a	n/a	5	n/a	5	6	6	7	13
12	n/a	n/a	n/a	n/a	n/a	n/a	3	3	4
13	5	n/a	6	n/a	4	5	7	6	n/a
14	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	14
None	n/a	n/a	n/a	n/a	7	9	9	10	9

n/a=no data available
Agile challenge number with the definition:
1=Ability to change organisational culture.
2=Concerns about a loss of management control.
3=Confidence in the ability to scale Agile.
4=Confidence in methods for scaling Agile.
5=Customer collaboration.
6=Development team support.
7=General organisational resistance to change.
8=Management concerns about lack of upfront planning.
9=Management support.
10=Not enough personnel with the necessary skills or Agile experience.
11=Budget constraints/transition time.
12=Pre-existing rigid/Waterfall framework.
13=Project complexity/size.
14=Regulatory compliance.

The reason for this discrepancy could be due to the research methodology approach used as mentioned previously, namely qualitative versus quantitative. If taken from the DOI theory perspective discussed in Subsection 3.3.2 of Chapter 3, organisational resistance to change makes

sense. The DOI theory investigation shows that the adoption of an innovation is a very social process. The investigation further mentions that most individuals' decisions on innovation evaluation and adoption is subjective instead of an objective evaluation process (Rogers 2003: 28). Known as the subjective norm, the intention to adopt a methodology depends on the manager's as well as the co-worker's opinion of the methodology regardless of the compatibility and usefulness (Riemenschneider et al. 2002: 1143). Whereas Yi et al. (2006: 398) states that studies suggest that compatibility does play a vital role in technology adoption outcomes, in addition to perceived usefulness and perceived ease of use. Riemenschneider et al., cited in Vijayasarathy and Turk (2012: 138) concluded by stating that significant predictors to adoption are an organisational mandate, team fit and subjective norm.

The top five challenges per annum experienced by respondents in percentage, except for 2009, will be discussed next. In 2006, the top five Agile adoption challenges encountered were lack of skills or Agile experience (21%), resistance to change (20%), customer collaboration (15%), management support (14%) and project complexity/size (12%).

The adoption challenges of 2007 were very similar to those of 2006, with resistance to change (36%), lack of skills or Agile experience (34%), ability to change the organisational culture (25%), management support (24%) and customer collaboration (21%). The ability to change organisational culture replaces customer collaboration as the third challenge.

In 2008 the ability to change organisational culture is at the forefront of Agile challenges experienced with 45% (this challenge remains the biggest across the subsequent years), followed by resistance to change (44%), lack of skills or Agile experience (42%), management support (32%), and budget and transition time (24%).

The years 2010 and 2011 are almost identical except resistance to change, and the lack of skills and Agile experience swopping positions. The year 2010 included challenges such as the ability to change the organisational culture (51%), resistance to change (40%), lack of skills or Agile experience (40%), management support (34%), and project complexity (31%). During 2011 the top five challenges were the ability to change the organisational culture (52%), lack of skills and

Agile experience (40%), resistance to change (39%), management support (34%), and project complexity (30%).

In 2012, project complexity dropped out of the top five challenges with the inclusion of the pre-existing rigid Waterfall framework challenge. The challenge of a pre-existing rigid Waterfall framework continues during 2013 and 2014. The 2012 survey recorded challenges such as: ability to change the organisational culture (52%), resistance to change (41%), rigid/Waterfall framework (35%), lack of skills/agile experience (33%), and management support (31%). The year 2013 included the ability to change the organisational culture (53%), resistance to change (42%), rigid Waterfall framework (35%), lack of skills and Agile experience (33%), and management support (30%).

The last year of the comparison (2014), had challenges such as the ability to change the organisational culture (44%), lack of skills and Agile experience (35%), resistance to change (34%), rigid Waterfall framework (32%), and management support (29%).

When comparing the longitudinal survey results of the years 2006 to 2014 against VersionOne's 2017 survey results, the trend is almost identical. The top five challenges are organisational culture (63%), lack of skills and Agile experience (47%), lack of management support (45%), resistance to change (43%), and the lack of a business/customer/product owner (41%).

As the purpose of this research study was not to regurgitate existing survey results, due to scope limitations, the author, therefore, did not include each year's figures. The figures, percentages, and rankings were used as an indication of the longitudinal consistency of the challenges encountered within the existing literature.

The next section briefly defines Scrum, allowing the reader to gain a better understanding of the Agile methodology. After that, in Section 2.6 the author investigates the Scrum and Agile adoption challenges faced within the SA context.

2.5 Scrum Defined

Scrum is a term that originates from a 1986 study by Takeuchi and Nonaka, which mentions that the best results for projects historically, is when teams are small and cross-functional (Marchesi et al. 2007: 241). Scrum was developed in the early 1990s by Jeff Sutherland and Ken Schwaber (Pressman 2005: 117). The Scrum guide (Schwaber & Sutherland 2011: 3) states the following about Scrum: "A framework within which people can address complex adaptive problems, while productively and creatively delivering products of the highest possible value. Scrum is:

- Lightweight
- Simple to understand
- Extremely difficult to master."

Scrum is not much of a software development method, but more of a project management method (Asnawi et al. 2011: 198; Irrazabal et al. 2011: 171; Marchenko & Abrahamsson 2008: 15), which focuses on people instead of processes (Dönmez & Grote 2011: 326). Scrum is so flexible and abstract in its definition and implementation that it is used outside of the Software Engineering (SE) practice (Leffingwell 2011: 15).

Scrum is a value-driven method (as opposed to the plan-driven approach of the Waterfall Method) which is iterative and incremental development (Anderson et al. 2012: 123). The Scrum value-driven method continuously reassess the problem while making small software feature increments in short time blocks within small teams (Blankenship et al. 2011: 15). The Scrum process as depicted in Figure 2.2, displays some of the Scrum artifacts, Scrum activities, and Scrum roles involved in the Scrum process.

Below is a listing of the items within each of the three components of artifacts, activities, and roles that make up the Scrum process:

The six Scrum artifacts are:

Product Backlog – The list of product items requested by the customer; for whom the software development team needs to complete. The managing of the product backlog is the responsibility of the product owner (Heikkila et al. 2013: 86).

User Stories – A user story is the increment of value to the customer written on a card. The product backlog is a collection of user stories (Blankenship et al. 2011: 17; Heikkila et al. 2013: 86). See Heikkila et al. (2013: 88) for a detailed explanation of how product requirements are broken down into smaller and more manageable user stories and tasks, from the features and epics.

Backlog Sizing – The size generation of the product backlog.

Sprint Backlog – The amount of work that needs to be completed by the development team within the current sprint (the sprint is usually 30 days in length). The sprint backlog is a subset of the product backlog (Blankenship et al. 2011: 19).

Burndown Chart – Displays how the remaining work of the sprint task completion is progressing in graphical format.

Acceptance Criteria – Seen as a secondary artifact, which provides the developer with steps to follow before a story is considered done. The acceptance criteria are created with the assistance of the product owner.

Scrum roles can be broken up into five categories as listed below:

Scrum Master – The person that fills this position is responsible for making sure the entire Scrum process team are kept abreast and adheres to the Scrum practices. This position is seen as the Scrum mentor and stands in the middle of the development team and the customer. The Scrum master provides the development team with the administrative support of Scrum, although a member of the development team often fills this position (Bianco 2011: 182).

Product Owner – The product owner is responsible for the product backlog and making sure the development team fulfils the requirements of the customer (Heikkila et al. 2013: 86).

Customer – The organisation or individual for whom the product is developed.

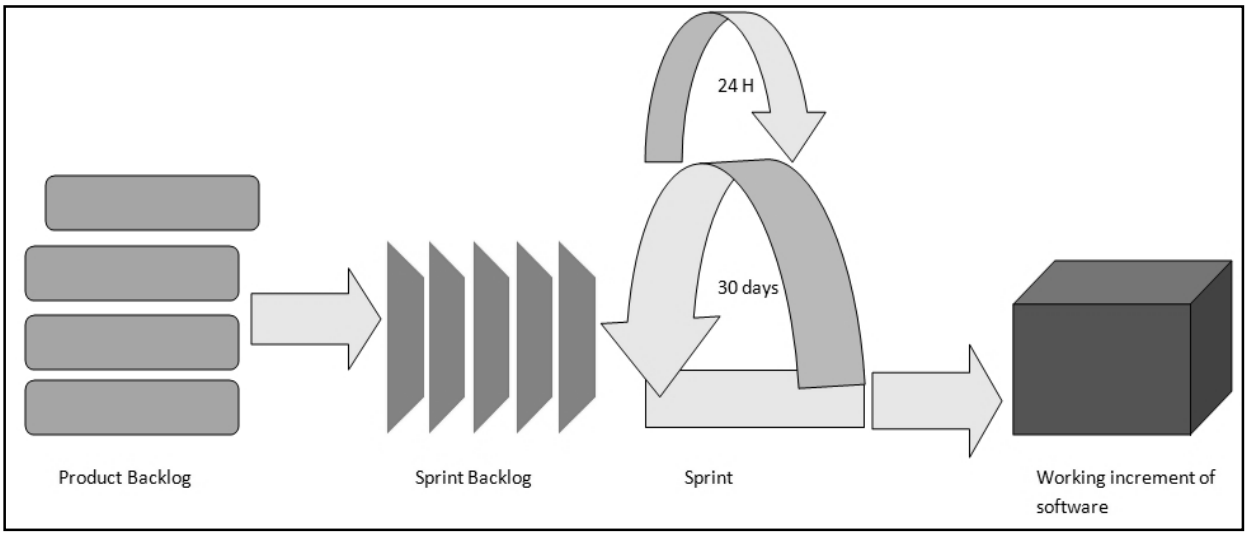


Figure 2.2: The Scrum Process (Source: www.Scrumalliance.org).

Development Team – Usually a group of 5 to 9 members (although subgroups of these numbers may exist in large organisations with multi projects) from various professions such as developers, testers, business analysts, designers, and DevOps engineers (Holzmann & Panizel 2013: 70). The team is responsible for making sure that the product backlog shrinks in size as the number of sprints increases.

Other Stakeholders – These are individuals such as the project managers, directors, and sponsors who do not actively contribute towards the Scrum process. Often customers are included as other stakeholders (Blankenship et al. 2011: 23).

The four activities that most Scrum teams and Scrum organisations deploy are sprint planning, daily stand-ups (Scrums), sprint reviews and sprint retrospectives. However, other activities are not mentioned here, as well as activities that are specific to an organisation and Scrum team.

Sprint Planning – This is the major four-hour long meeting which includes many of the Scrum roles. The length of the meeting might vary based on organisational preferences. Those roles that must be present are the Scrum master, product owner and development team. The meeting will determine which stories to include into the next sprint and which to exclude. The sprint usually

lasts for 30 days. However, this can be amended to suit the organisation. What is included or excluded in the Sprint is decided between the product owner and the development team, with greater influence coming from the latter.

Daily Stand-ups (Scrums) – The Scrum is a brief fifteen-minute meeting for the development team and the Scrum master. The daily stand-up time of commencement during the day is irrelevant; however, it usually takes place first thing in the morning. What is discussed by each member of the development team are (Bianco 2011: 182):

- What have you done since yesterday?
- What are you planning to do today?
- What obstacles are preventing you from achieving your goal?

Sprint Review – The review happens at the end of the sprint. The review is the opportunity for the development team to present the work of the completed sprint to the customer and other stakeholders. The completed sprint is presented in the form of a demo, and the customer provides feedback.

Sprint Retrospectives – Retrospectives is a time-boxed meeting for the development team and the Scrum master, to discuss how the last sprint went and if there are any ways in which they can improve any drawbacks they may have encountered.

This section provided a background on Scrum. The author included the definition of Scrum because of its significance in the development of the generalised model as mentioned in the specific objectives of Chapter 1. The quantitative analysis performed on the developed custom model depends on variables such as relative advantage, complexity, compatibility, sprint management, and teamwork. These variables are dependent on the Scrum practitioner's use and understanding of Scrum as the technology being investigated.

Therefore, for the reader to better understand how the Scrum methodology contributes towards adoption challenges, its definition had to be contextualised. The next section elaborates on the Scrum adoption challenges experienced within the global and SA context.

2.6 Scrum Adoption Challenges

2.6.1 Introduction

Scrum is the most widely adopted Agile methodology as alluded to earlier. When considering Scrum's usage with other methodologies the adoption percentage increases even more. It is often not followed as prescribed in the textbooks but used as a hybrid solution with other methodologies depending on the organisational preference (Ihme 2013: 267; Kapitsaki & Christou 2014: 103; Kurapati et al. 2012: 16-17). As Senapathi et al. (2011: 134) eloquently put it, "Most organisations do not strictly adhere to any particular Agile method but use a tailored approach by combining some good Agile practices from different Agile methods that best suit their contextual requirements".

Does this pose as a sign of weakness about Scrum as an Agile methodology? Does it lack in certain areas? For example, the project management aspect has been continuously mentioned as being a strong point, but does it lack a more fluid way of allowing team members to complete the project requirements? According to Asnawi et al. (2011: 200), by eliminating the time-boxed approach and incorporating Kanban, this solves their challenge.

A qualitative, semi-structured, thematic interview approach case study, done by Ihme (2013: 259) adds an interesting spin to the existing literature. It states, referencing studies conducted by Boehm as well as Fernandez and Fernandez, respectively, that a hybrid project management approach, using traditional as well as the Agile approach might be more beneficial to certain large organisations. A suggestion that Scrum can be used with the Waterfall approach, and still provide the results that companies are looking for goes to show that there are no limitations to making software development a sustainable success, which at the end of the day is the only factor that matters.

ScrumBut is the definition of a hybrid or custom approach to using Scrum when there are signs of weakness in the unmodified Scrum methodology. Heikkila et al. (2013: 85) say that advocates of Scrum usually refer to the ScrumBut definition during instances of issues encountered during an

unmodified Scrum, and the necessity to hide any dysfunctions for which changes are required. An example taken from Scrum.org (2015: internet) is as follows:

"(We use Scrum, but) (having a Daily Scrum every day is too much overhead,) (so we only have one per week)".

A problem identified by Tanner and Khalane (2013: 2) is the lack of adequate clarity on quality management, borrowing practices from other Agile methodologies. The study suggests that Scrum needs the inclusion of practices from other methodologies (Tanner & Khalane 2013: 3).

Other literature studies perused states that the research on the organisational culture of Scrum teams, which is one of the highest mentions based on the Agile adoptions challenges frequency count, are limited (Hoda et al. 2011a: 84). A few of the suggestions to make the transition to Scrum easier, and making the environment more conducive to adopting Scrum is:

- Removing the command and control approach to project management (Akhtar et al. 2010: 460).
- Removing any communication barriers (Holzmann & Panizel 2013: 70).
- Giving large organisations more time to adopt the Agile methodology mind-set (Korhonen 2010: 90-91).
- Introduce Scrum to team members with less experience within an environment where no previous constraining structures exist (Dönmez & Grote 2011: 327).

According to Akif and Majeed (2012: 1), a common challenge identified amongst distributed Scrum teams is proximity issues. Scrum largely depends on stakeholders having regular face to face Scrum meetings. Other adoption challenges identified for distributed teams are product owner role changes, shared Scrum visual element challenges, and information share challenges.

The study by Akif and Majeed (2012: 2-3) collected data through two research design methods, namely a survey and face to face interviews. The data source was two companies with a total of 20 employees. These employees included the development team, Scrum masters, project managers

and the quality assurance team. Akif and Majeed (2012) conclude that the major issues identified as affecting Scrum implementation are:

- Quality items pile up.
- Module integration issues.
- Code quality issues due to short deadlines.
- Disruption in teamwork.
- Mature versus immature Scrum, with mature Scrum having fewer issues.
- Sprint duration, with a shorter sprint affecting the team negatively.
- Lack of Scrum training.
- Release process management.
- Bad backlog management structure.
- No technical practices.
- Multiple teams which force organisations to employ a "Scrum of Scrums" method, which does not work well.
- Too much communication.

Adoption challenges of Agile and Scrum are relatively similar amongst the two literature sources by Hajjdiab and Taleb (2011: 32-33) which is a case study, and VersionOne (2013: 6-7) which is a survey. Although all the findings between the two studies are not identical, the few that match are:

- Skillset deficiencies of developer team personnel.
- Lack of experience with Agile methods.
- Insufficient training provision.
- Communication problems during the initial adoption phase.
- Lack of development team motivation to follow and adopt Agile.
- Cultural change resistance.

The benefits of Scrum adoption followed by a review of the challenges of Scrum and Agile adoption within SA are discussed next.

2.6.2 The Benefits of Scrum Adoption

What are the benefits of Scrum adoption? Are there any similarities to the Agile adoption benefits described in Table 2.3?

A description of the benefits experienced by two individual case studies is discussed. The one case study is an action research project conducted in Norway, and the other a grounded theory study conducted in Pakistan.

The action research study conducted by Dingsøyr et al. (2006: 6-7), describe the following as benefits given by the respondents during the interviews:

- Improved work environment.
- Improved time to market.
- Improved software quality (with lowered software defects).
- Increased motivation in development projects.
- Improved problem-solving.
- Improved teamwork.

The grounded theory research study conducted by Akhtar et al. (2010: 461), provides the following benefits specific to the IT industry within Pakistan:

- Teams are more collaborative displaying increased teamwork.
- Increase in development team self-determination.
- Transform project work anytime to current and most recent requirements.
- Improved management of product releases and user story completion.
- Increased flexibility due to Scrum.
- Reduced risk of requirements unpredictability, through improved communication.

A full tabulation of the benefits summarised from ten research papers are described in Table 2.7, extracted and synthesised from Akhtar et al. (2010), Atlas (2009: 136-139), Dingsøyr et al. (2006: 6-7), Green (2012: 172-176), Holzmann and Panizel (2013: 73), Kapitsaki and Christou (2014:

106), Lavazza et al. (2010: 150), Marchesi et al. (2007: 243-244), Overhage et al. (2011: 6), and Santos et al. (2011: 302).

Table 2.7: Scrum Adoption Benefits with Frequency.

No.	Benefit	Frequency
1	Quality (decrease in software defects)	6
2	Improved teamwork	6
3	Improved time to market	3
4	Improved work environment	3
5	Self-determination	3
6	Increased motivation	3
7	Better project management	2
8	Effective problem solving	1
9	Small teams	1
10	Better knowledge transfer	1
11	Market perception	1

2.6.3 Adoption Challenges from a South African perspective

Before elaborating on the challenges encountered during Scrum and Agile adoption within the SA context, a brief description of the issues experienced during Scrum adoption within the global context are disclosed. The purpose is to provide a flow of context from the more general to the more specific.

The global Scrum adoption challenges in Table 2.8 are taken from eight literature studies with the earliest publication year being 2008 (Asnawi et al. 2011: 199-200; Fægri 2010: 34; Heikkila et al. 2013: 85; Kapitsaki & Christou 2014: 105; Marchenko & Abrahamsson 2008: 16; Overhage et al. 2011: 6; Santos et al. 2011: 292; Stray et al. 2011: 146-147). The literature is relatively recent and therefore relevant for this research study. One of the very peculiar challenges comes from the mixed mode study by Heikkila et al. (2013: 85), which indicated that cross-functional generalist teams were not plausible in the environment. The finding by the mixed mode study is contradictory to the Scrum philosophy of well-balanced teams consisting of individuals with overlapping skills.

Top management support (TMS) has been found to significantly affect the user's perception of an IT technology, as well as the organisation's IT adoption, and diffusion respectively (Dong 2008: 204; Dong et al. 2009: 55). Therefore, the inclusion of the lack of TMS is expected, considering the impact management support has on IT adoption (Hardgrave & Johnson 2003: 324). However, although TMS is essential for the adoption and diffusion of a methodology, it cannot save a project that is failing, and too much support might hinder the adoption and diffusion success (Dong 2008: 205).

In the next section, the challenges encountered by organisations during the adoption of Scrum and Agile methodologies within SA is described. The first subsection provides an example of the types of challenges experienced by a SA case study after that provision is made for a frequency count of the significant Agile and Scrum adoption problems experienced, providing more insight into the similarities across organisations.

Table 2.8: Global Scrum Adoption Challenges with Frequency.

No.	Challenges	Frequency
1	Teamwork/communication issues	2
2	Lack of knowledge/skills	2
3	Organisational culture/mind-set	2
4	High management overhead	2
5	Lack of quality	1
6	Requirements creep	1
7	Over-engineered solutions	1
8	Long time to market	1
9	Low user satisfaction	1
10	Over-optimistic task estimates	1
11	Lack of documentation	1
12	Too many meetings	1
13	Lack of top management support	1
14	Project team size	1
15	Cross-functional generalist teams	1

Again, the major adoption challenge is culture and people related, with mention that there is no structured approach for adopting Agile methods. When companies do adopt Scrum, they only adopt those parts that address organisation related problems (Noruwana & Tanner 2012: 55).

A few of the challenges to adopting the Scrum Agile method, revealed by the Noruwana and Tanner (2012) case study are:

- Culture change difficulties.
- Lack of a structured approach.
- Assigning of new roles to development team members.
- Cultural change issues.
- Developers opposed to team-related pair-ups (pair programming, the practice of XP).
- Resistance to team evaluation, with preference for individual recognition.

Although these challenges experienced are specific to the case study, the author was able to check for any commonalities in adoption challenges experienced amongst the studies. As a result, the author noticed a familiar pattern of adoption challenges.

The frequency count of Table 2.9 is from the literature provided by six SA sources, namely: Du Toit (2013: internet), Mnkandla and Dwolatzky (2004: 245), Noruwana and Tanner (2012: 44-54), Tanner and Khalane (2013: 2), Tanner and Mackinnon (2013), and Tanner and Wallace (2012: 3, 11).

Table 2.9: SA Scrum and Agile Adoption Challenges with Frequency.

No.	Challenge	Frequency
1	Culture change issues	5
2	Lack of structure/planning	5
3	Requirements/story changes	5
4	Communication problems	4
5	Motivational issues	4

No.	Challenge	Frequency
6	Workload	3
7	Management inefficiencies	3
8	Lack of resources (including infrastructure and communication tools)	3
9	Skills shortage	3
10	Lack of required experience	2
11	Team distribution	2
12	Insufficient training	1
13	No/lack of individual recognition	1
14	Team size	1

The frequency table identifies the top five challenges encountered during the adoption phase, as:

- Cultural change issues.
- Lack of structure/planning.
- Requirements/story changes.
- Communication problems.
- Motivational issues.

It is possible that management inefficiencies can merge with lack of structure/planning, and lack of resources with emphasis on communication tools can merge with communication problems. However, this might limit the opportunity to identify factors of significance during the research survey. Therefore, it will be more beneficial to keep it separate as mentioned above. It should be made clear that the discussion on communication problems include clients, and not just the Scrum teams and the organisation they represent. Especially in Scrum, clients are expected to be more collaborative, knowledgeable and representative, and committed toward the projects (Chan & Thong 2009: 804). The importance of the customer's active involvement in the development process is crucial to the success of Agile development and the higher the involvement of customers during the development process the higher the chance of success (Chan & Thong 2007: 7).

Mohan and Ahlemann (2013: 836) state that the use of Information Systems Development (ISD) methodologies is determined by the rationale and hierarchy of the organisational culture. Often the needs, beliefs, and values of the user of the methodology are not considered, which is like the subjective norm situation, whereby the developer's views are not always the determinant to the Agile methodology adoption decision. As Hardgrave et al. (2003: 123) put it; "Developer's intentions are directly influenced by their perceptions of usefulness, social pressure, compatibility and organisational mandate". Chan and Thong (2009: 805) indicate that prior SDM studies focused on the developer views on the SDM such as perceived ease of use and perceived usefulness, however failing to realise the importance of management (e.g. management style) and people-related (e.g. competency levels) challenges.

Due to the nature of software development being a social phenomenon, and Agile being at the forefront of this complex human interaction activity (Tanner & Wallace 2012: 3-4), there was the expectation that noise and disturbance by team members would be identified as one of the problems encountered. However, surprisingly this is not the case, and the study by Eccles et al. (2010: 10) states, on the contrary, employees welcome it.

During the SA Software Engineering Method and Theory (SEMAT) 2012 conference, Dwolatzky (2012: 1) gave a brief description of the SE issues in existence. The summarised issues are:

- Exaggerated zeal.
- The lack of a globally adopted and accepted theoretical basis.
- The considerable number of methodologies and its variations not being that different.
- Lack of experimental research knowledge.
- The separation between academic research and industry practice.

These findings are like the findings of the other Agile methodology literature. For example, Mnkandla and Dwolatzky (2007: 12) state that "All agile methodologies have striking similarities amongst their processes because they are based on the four agile values and 12 principles". Providing a similarity analysis between three prominent Agile practices of XP, Lean Software Development (LSD), and Scrum, Mnkandla and Dwolatzky (2007: 17) emphasised that similarities are often not necessarily deduced by practitioners of SE.

A suggestion by Du Toit (2013: internet) during the Agile Africa 2013 conference is to mix and match Agile methodology practices. He states that there is no single methodology for all circumstances. This ideology repeats in the study by Noruwana and Tanner (2012: 44) that said: "Organisations need to choose software development methods that suit their culture instead of changing their culture to accommodate the methodology". On the positive side, SA organisations regularly adopt a hybrid type Agile methodology as advised above. They select aspects that they feel will address the challenges encountered within their organisation (Noruwana & Tanner 2012: 56).

With Scrum being the most successful Agile methodology currently adopted and implemented as mentioned earlier in this chapter, the potential benefits of using Scrum as the sole project management methodology for all SE projects must not be overlooked. Where it lacks in technicality, it can make up for by adding practices of other Agile methodologies, such as XP (Mnkandla & Dwolatzky 2007: 14).

Effective adoption of Scrum and Agile methodologies by individuals, organisations, and teams within organisations should be a concern. If management has a clear understanding of what the adoption challenges faced by individuals within organisations are, this could allow management to be better prepared to foster the successful adoption of new methodologies (Sultan & Chan 2000: 106).

Because the Scrum Agile methodology is implemented within Scrum teams as mentioned earlier in the Scrum definition section, the factors that have a significant relationship with Scrum adoption should include the input of various independent variables. Consideration must be given to management and people-related challenges, not just those factors related to the individual perception of using the new technology. Therefore, other factors that can contribute towards Scrum adoption may include team-related challenges (e.g. TMS), as well as organisational problems (e.g. organisational culture). The other factor to consider that contributes toward adoption is the technology investigated, which in this study is Scrum.

This section identified the existing Scrum adoption challenges from a global and SA context. It described the pre-existing Scrum adoption challenges experienced both locally and internationally.

A narrative review of existing literature allowed the author to extract and synthesise the adoption challenges in the form of frequency tables. The consolidated challenges are used in the Conceptual Framework (CF) as the independent variables.

Determining what factors have a significant linear relationship with Scrum adoption as perceived by Scrum practitioners working within SA organisations is the primary objective of this study. From the investigation of the literature review, the author began to see the importance of a multi-factor approach in determining which Scrum challenges influence Scrum adoption. The common constructs based on the challenges identified in the narrative review were individual factors, team factors, organisational factors, and technology factors. The operationalisation of the constructs mentioned above is a discussion in Chapter 4.

2.7 Chapter Summary

Organisations do not make structural changes for the sake of change, but they make changes when they see the benefit in making the transition (Hoda et al. 2011a: 84). Scrum is the de facto Agile methodology recommended by customers globally (Akhtar et al. 2010: 459).

What was unearthed from conducting this literature review is worth further investigation. A few Scrum adoption challenges experienced within the SA context have now been extracted and synthesised in this literature review. The three challenges consistently referenced as one of the most significant contributors toward challenges experienced during Scrum and Agile adoption from a global and SA context are:

- Organisational culture.
- Lack of knowledge/skills.
- Management problems such as overhead and support.

Overhage et al. (2011: 3-4) informs the reader that Scrum is the most under-researched Agile methodology even though it is the most utilised. Descriptive, explorative, and qualitative studies are currently the most commonly used research methodologies with emphasis on case studies for

Agile and Scrum adoption studies. Therefore, the qualitative findings cannot be generalised to the larger population because of its concentration on small teams or individual organisations (Marchenko & Abrahamsson 2008: 15). Kurapati et al. (2012: 16) state that the focus of previous research on case studies led to a large research gap within the software industry's Agile methodology usage.

Numerous theoretical models were developed and used for Information Systems (IS) literature. These models have been used to study the phenomenon of organisational and individual adoption of IT methodologies and technologies (Kishore & McLean 2007: 756). The next chapter will discuss the CF while elaborating on the factors developed from the Agile and Scrum adoption challenges synthesised in this chapter. The factors are part of the CF based on the DOI theory.

CHAPTER 3: THE CONCEPTUAL FRAMEWORK

Chapter 3 is structured as follows:

3.1 - Introduction

3.2 - Background

3.3 - The Theoretical Models

3.4 - Identifying the Dependent and Independent Variables

3.5 - The Structure of the Conceptual Framework

3.6 - Chapter Summary

3.1 Introduction

The preceding chapter presented the literature review on Agile and Scrum adoption challenges. The Scrum Agile Software Development Methodology (SDM) brings many benefits to Scrum practitioners. However, as discovered, Scrum also presents many challenges. This chapter presents the reader with the Conceptual Framework (CF) which is constructed to demonstrate the various factors that are predicted to have a significant relationship with Scrum adoption. The author developed a custom model from the Agile and Scrum adoption challenges derived from the narrative review. The theoretical lens for the CF was the Diffusion of Innovation (DOI) theory.

The CF chapter divides into smaller sections. The next section provides a background into the CF's level of investigation. After that, the theoretical model section discusses the models considered, and the model chosen for the study. Section 3.4 identifies and explains the concepts

and variables used in the study while Section 3.5 discusses the CF structure. Figure 3.1 depicts the research process, with the CF starting from the last three blocks in the diagram.

3.2 Background

"There is a consensus in the literature that beliefs affect attitudes, which in turn, affect intentions, which in turn, affect adoption and use." (Jeyaraj & Sabherwal 2008: 207). This sentiment of attitudes, perceptions, user intentions and other behavioural traits contributing to the individual's adoption of technologies are mentioned in Yi et al. (2006: 399). Furthermore, the concurrence is uttered by several of the Technology Acceptance (TA) theoretical models such as the theory of planned behaviour, Technology Acceptance Model (TAM), and the Theory of Reasoned Action (TRA). Therefore, if the behavioural aspects of individuals play a contributing role towards their adoption decisions, then it would make sense to include these variables as part of the study's input during the construction of the CF.

Previous literature studies suggest that much emphases were placed on characteristics at the organisation level or eliciting data from groups within the organisations (Hardgrave et al. 2003: 126; Mohan & Ahlemann 2013: 832; Riemenschneider et al. 2002: 1141; Sultan & Chan 2000: 108). Other studies focused primarily on characteristics of management, especially the Top Management Support (TMS) (Sultan & Chan 2000: 107). Even when research focused on the acceptance or diffusion of innovation at the group and organisational level, they are inevitably composed of individuals. Sultan and Chan (2000: 108) explain that to understand the complexity of patterns of diffusion within organisations, one needs to appreciate that the mixture of factors that affect adoption often depends on the decisions of the individual (Sultan & Chan 2000: 114). Hardgrave and Johnson (2003: 323) go on further to say that even when the adoption of an Information Systems Development (ISD) process occurs at the organisational level, this does not conclude that there has been a consensus of acceptance by the individuals within the organisation.

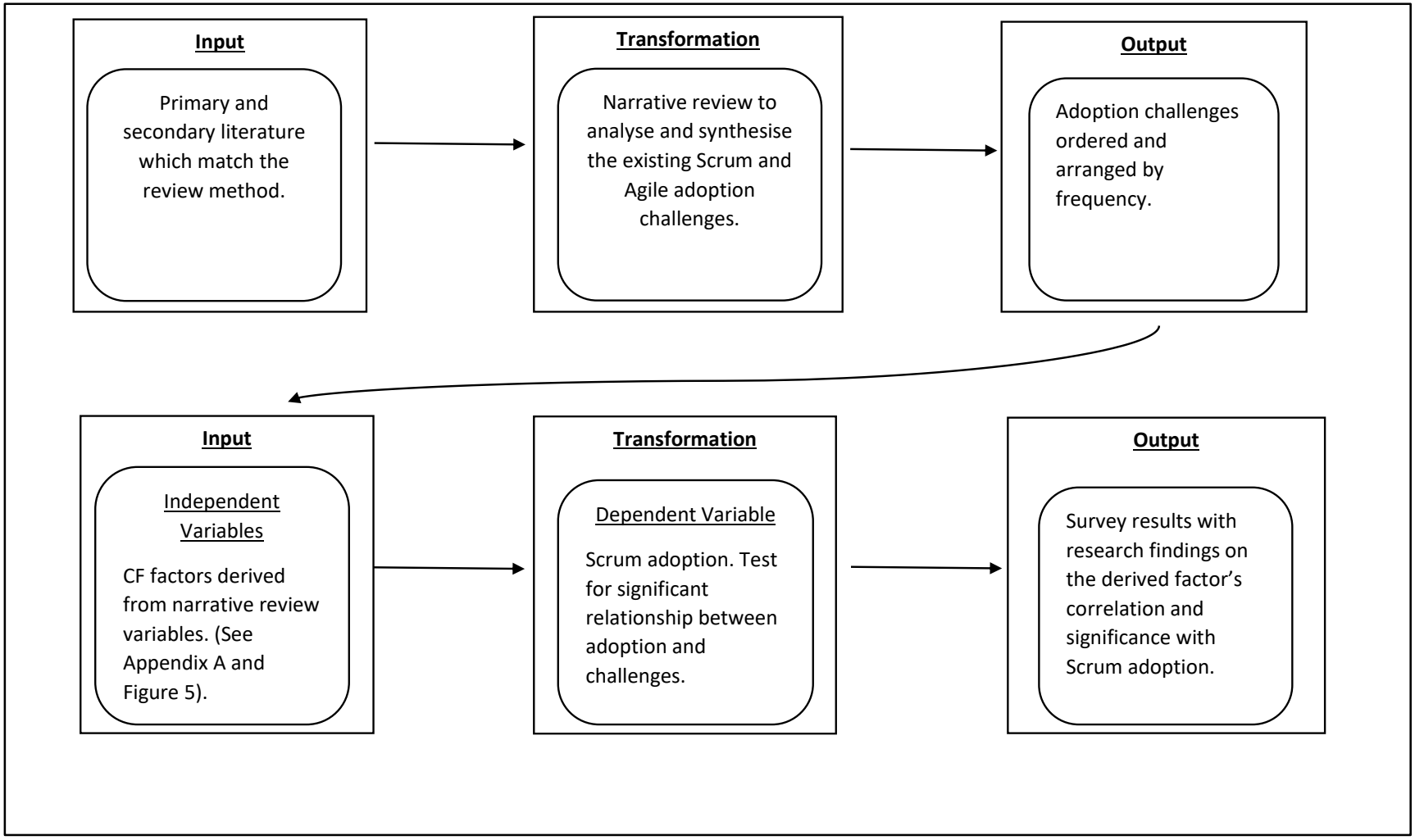


Figure 3.1: Research Process Diagram.

The individuals might resist the organisation's decision to adopt. Therefore, it needs to be a mutual decision between the two entities. The individual's full-scale approval might also result in the organisation standardising the process based on the popularity amongst the individuals.

In this study, the author, therefore, focused on the adoption of methodologies at the individual level, as very few studies have explicitly examined it at this level (Hardgrave et al. 2003: 135).

Now that the author has defined the level of investigation, the next step is to determine which theoretical models would be a suitable fit for this study. A study by Jeyaraj and Sabherwal (2008: 207) focused on the adoption of Information Systems (IS) innovation by individuals. It listed the various theoretical models that is used in the context of the individual adoption of IS and Information Technology (IT) innovations. These theoretical models, as mentioned by Jeyaraj and Sabherwal (2008) are; 'the Theory of Reasoned Action (TRA) (Fishbein & Ajzen 1975), DOI for individuals (Rogers 1983), TAM (Davis 1989), Theory of Planned Behaviour (TPB) (Ajzen 1991), Perceived Characteristics of Innovating (PCI) (Moore & Benbasat 1991), Model of PC Utilization (Thompson, Higgins, & Howell 1991), Motivational Model (Davis, Bagozzi, & Warshaw 1992), Social Cognitive Theory (Compeau & Higgins 1995), Task-Technology Fit (Goodhue & Thompson 1995), and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003).'

Because the author was interested in the adoption at the individual level, characteristics of the technology such as relative advantage, perceived compatibility, and complexity are not the only or most significant contributions in differentiating challenges of significance (Chan & Thong 2007: 6). The adoption of methodologies by organisations, using organisations as the unit of analysis was also not the focus of this study. The author does, however, recognise the contribution technology, and organisational factors that play a role in obtaining a more holistic view of Scrum adoption (Sultan & Chan 2000: 108), especially given that research on methodologies are more complex than research on tools, as human behaviour plays a more prominent role, which contributes to the complexity. Therefore, the author still includes these factors as part of the CF, which will be elaborated on in Subsection 3.3.3.

Fichman in Mohan and Ahlemann (2013: 832) mentions that what actions individual adopters take is very important as a determinant of the implementation of IS methodologies by organisations. However, research and organisations still tend to focus on organisational intentions of adoption, which is unfortunate.

What the statements mentioned above indicate is that, to understand the challenges to Scrum and Agile adoption the perceptions of individuals need to be extracted, providing a more explicit indication of the significance the challenges have on Scrum adoption. For example, in a study conducted by Rogers (2003: 27), five qualities were considered as the essential characteristics of innovation in explaining the rate of adoption. The essential characteristics of the innovation is in its complexity, trialability, relative advantage, compatibility, and observability. The characteristics of the innovation are as perceived by the individual. The five qualities also display signs of malleability, i.e. having the ability to change in its role of importance, dependent on the individual's stage of adoption.

As an example, Hardgrave et al. (2003: 137) suggest that during the implementation of a new or altered methodology, the compatibility quality may play an essential role in how much the innovation affects the individual's work practices. Not all these qualities display an equal impact on adoption behaviour. Compatibility, relative advantage and complexity have been identified, based on innovation studies, as displaying a relatively consistent relationship with adoption behaviour (Kishore & McLean 2007: 756). For this reason, the author has included only compatibility, relative advantage and complexity as part of the CF's technology factors (see Figure 3.2).

3.3 The Theoretical Models

3.3.1 Introduction

Various theories have been used in previous studies related to SDM's, Agile methodologies, and IT adoption, respectively. These include previous studies by 'Sultan and Chan, Roberts and Hughes, Cho and Kim, Ceschi et al., Nerur et al., and Cockburn and Highsmith' to name a few

(Chan & Thong 2009: 809). Within the previous studies, theories that are used are depicted in Table 3.1, adapted from Jeyaraj et al. (2006: 3).

Table 3.1: Models used during Organisational and Individual IT Adoption Research (Source: Jeyaraj et al. (2006)).

No.	Theory	Used in individual adoption studies	Used in organisational adoption studies
1	Diffusion/Implementation Model		X
2	Diffusion of Innovation Theory[1]	X	X
3	Perceived Characteristics of Innovations	X	
4	Social Cognitive Theory	X	
5	Technology Acceptance Model	X	
6	Technology Acceptance Model II	X	
7	Theory of Planned Behaviour	X	
8	Theory of Reasoned Action	X	
9	Tri-Core Model		X
10	Unified Theory of Acceptance and Use of Technology	X	

1=used in this research study.

What is immediately evident in Table 3.1 is the use of the DOI theory in both individual and organisational adoption studies which makes the DOI theory ideal for this study. As a result, the author has identified through the narrative review the independent variables that are classified under the individual, and organisational constructs, see Section 3.4, and Section 3.5 respectively. As Chan and Thong (2009: 804), and Mohan and Ahlemann (2013: 837) explain, previous studies make use of technology adoption models, such as Technology Adoption Model (TAM), and they tend to focus on the technical aspects of the IT adoption. However, the author focused on several constructs which include technological, individual, team, and organisational factors. All these factors play a critical role in understanding the adoption of SDM's, and therefore the DOI model was used for the research study.

3.3.2 DOI Model Defined

"Diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas." (Rogers 2003: 21). The new ideas go through several stages before they get used, i.e. from idea to diffusion, followed by adoption or rejection, and therefore, create social change. Diffusion thus includes the spontaneous and planned growth of new ideas (Rogers 2003: 22). The innovations that develop from these new ideas are either adopted or rejected by potential users based on how they feel toward the innovation (Hardgrave et al. 2003: 127).

Diffusion as a process has four main elements, namely: innovation, communication channels, time, and the social system. The elements mentioned above are used in every diffusion campaign, diffusion program, and diffusion research study (Rogers 2003: 25). Innovations have their characteristics, and as a result, the characteristics contribute to the varying rates in adoption. The five characteristics of innovation with a brief definition are:

- **Compatibility** – The degree to which the perception of the innovation is consistent with the past experiences, existing values, beliefs, and needs of potential adopters.
- **Complexity** – The level of difficulty to understand and use the innovation, i.e. the less complicated the innovation, the faster the rate of adoption.
- **Observability** – The level of ease with which to see the results of an innovation, i.e. the easier it is for individuals to see the results of an innovation, the more likely they are to consider adopting it.
- **Relative Advantage** – The degree to which the perception of the innovation is higher than the idea it supersedes. The rate of adoption increases with a higher perception.
- **Trialability** – The degree to which an innovation may be experimented with, within a test environment before being fully utilised, i.e. trialability lowers the level of uncertainty, which in turn, increases the adoption rate.

Any innovation that has these five qualities will generally have a greater chance of adoption, and of these five qualities, the two that contributes the most toward explaining the rate of adoption are compatibility and relative advantage (Rogers 2003: 27).

The communication channel element defines how the message gets transferred from one individual to another. Because diffusion is a social process and the adoption decision process of individuals is usually subjective and not objective, the opinions of others with similar attributes as the individual, known as homophily, are important determinants to whether the individual considers adopting the innovation (Rogers 2003: 28).

The time element according to Rogers (2003: 29) is concerned with how long the individual takes from knowledge of the innovation to either adopting or rejecting it. The element can be broken down into three sections, namely:

- **The Innovation-Decision Process** – Broken up into five sub-processes. The knowledge, persuasion, decision, implementation and confirmation sub-processes.
- **Innovativeness and Adopter Categories** – How early the individual or group adopt the innovation compared to others, consisting of the five categories of innovators, early adopters, early majority, late majority, and the laggards.
- **The Rate of Adoption** – The speed at which the adoption occurs by members of the social system.

The social system is the last element, which is defined as individuals, organisations, informal groups, and subsystems, which are members or units of the social system. The social system members work together as a collective in problem-solving activities to achieve a common goal (Rogers 2003: 31).

3.3.3 The Custom Model

While DOI as a theoretical model covers both the individual and organisational aspects of IT adoption studies, it is not enough though for complex methodologies within Agile, such as Scrum (Sultan & Chan 2000: 108). To only focus on the individual's perception of the technology, and not on the dynamics and challenges within the organisation and team would not be ideal. Therefore, Scrum adoption would require a modification of the DOI theory to incorporate a multi-variable measure for adoption (Sultan & Chan 2000: 108).

According to Chau and Tam (1997: 3), diffusion variables are not sufficient enough as a predictor of complicated organisational innovation adoption, as the independent and control variables it provides might be of limitation. Bayer and Melone (1989: 164) provide a few failures of DOI due to its limitations. Two of the failures are firstly the lack of theoretical justification for the five adopter categories without sufficient empirical support for the classifications used, and secondly, not taking the interaction between various social systems into account.

Because the Scrum methodology as mentioned in the literature review is a social phenomenon with a strong emphasis on project management, it is vital that the author develops a model that includes behavioural aspects to it, which, unfortunately, has not received much attention by previous IS adoption studies (Jeyaraj & Sabherwal 2008: 206). As Chan and Thong (2009: 804) so eloquently put it, "There is an urgent need to conduct a critical review of the existing literature to develop a CF for Agile methodologies acceptance."

The author required a broader consideration of the fact that the author was not merely dealing with tools or simple methods, but complex methodologies, and as such, needed to consider cognitive and automatic user behaviour, e.g. habits and emotions (Mohan & Ahlemann 2013: 836). Therefore, the author has included the individual, team, organisational and the technological factors for a more balanced and comprehensive understanding towards Scrum adoption challenges. The inclusion of a broad number of factors is what Chan and Thong (2009: 804, 812) suggested.

The author used the idea of Senapathi et al. (2011: 134-135), who developed a CF based on a synthesis of past research on DOI, Agile implementation, and IS implementation literature. Their group of five factors are Agile innovation, organisational, sociological, team, and technological factors. The five factors were adopted from Agile, Extreme Programming (XP), DOI, IS frameworks, and literature.

With a similar approach, this research study's CF is a synthesis of research composed of the DOI theoretical model, Agile adoption, Scrum adoption, SDM adoption, and IS innovation literature. The custom model's constructs are discussed in Section 3.4.

To summarise, the custom model allowed the author to gain a better understanding of the human behaviour behind Scrum adoption, which gave the author an opportunity to develop constructs to be incorporated into the model. This deviation from the highly validated theoretical models used for existing IT innovation studies was welcomed because of the lack of originality and innovativeness encountered within the field (Mohan & Ahlemann 2013: 837). As an example, Chan and Thong (2007: 13) suggested that the factors (e.g. perceived compatibility, perceived usefulness) used within the TAM and DOI theoretical models are too general and abstract to provide practical insights into methodologies such as Scrum, XP, and Kanban.

3.4 Identifying the Dependent and Independent Variables

3.4.1 Introduction

As mentioned earlier in this chapter, the custom model has DOI as the theoretical base, however, the author tailored the model to match the context of the application, i.e. Scrum adoption challenges (Sultan & Chan 2000: 107). The author did not use all the DOI characteristics of innovation in the study; the three included due to being consistently relevant in innovation studies are compatibility, complexity and relative advantage (Hardgrave et al. 2003: 127).

The sources for the independent variables were carefully perused and relevant literature was earmarked for further investigation. These pre-selected literature sources were filtered based on the content provided, i.e. Do the literature sources contain challenges and issues experienced during Scrum and Agile adoption? Alternatively, is the literature describing adoption challenges on irrelevant SDM's?

The narrative review method produced the adoption challenges which were selected and grouped to be later used as the factors of the model. The assignment of the independent variables to one of the four CF constructs of individual factors, team factors, organisation factors, and technology factors was the prerogative of the author. Therefore, the independent variables were tailored towards the specificity of the innovation (Chau & Tam 1997: 3; Sultan & Chan 2000: 109).

3.4.2 Constructing the Conceptual Framework Factors

Table 3.2 displays the mapping of the narrative review's extracted and synthesised challenges to the 19 CF factors. The literature is differentiated geographically between SA and global (non-SA). The challenges derive from Agile, Scrum, SDM, and IS innovation literature. Table 3.2 includes the identified challenge chapter and the page number reference located within this dissertation.

Because Scrum is under-researched, and the research methodology used is primarily qualitative in nature (Noruwana & Tanner 2012: 41; Overhage et al. 2011: 3-4), the author resorted to including Agile adoption challenges for the construction of the factors. The reason to include Agile adoption challenges was to make sure that the CF was comprehensive enough to be tested and evaluated. The author was aware of the lack of adoption challenges derived from existing Scrum adoption literature.

The reader should be aware that not all the adoption challenges have been included during the mapping process. Challenges excluded includes regulatory compliance, and project complexity and size. The author excluded challenges on the basis that it was specific to an individual study, not showing any commonality within the literature or the identified problem is not a result of innovation adoption, thereby making it a challenge in itself, e.g. project complexity.

The following subsections define the constructed factors.

Table 3.2: Mapping of the Innovation Adoption Variables and Adoption Challenges to the 19 Conceptual Framework Factors.

Factor	Challenge	Location	Literature	Chapter	Page
Escalation of Commitment	➢ Escalating commitment	Global	Agile adoption	2	28
	➢ Escalation of commitment	Global	SDM adoption	3	66
Experience	➢ Skills deficiency	Global	Agile adoption	2	28
	➢ Not enough personnel with the necessary skills or Agile experience	Global	Agile adoption	2	30
	➢ Skillset deficiencies of developer team personnel	Global	Agile adoption	2	41
	➢ Lack of experience with Agile methods	Global	Agile adoption	2	41
	➢ Lack of knowledge/skills	Global	Scrum adoption	2	44
	➢ Skills shortage	SA	Scrum and Agile adoption	2	46
	➢ Lack of required experience	SA	Scrum and Agile adoption	2	46
Over-Engineering	➢ Over-engineered solutions	Global	Scrum adoption	2	44
Communication	➢ Lack of communication	Global	Agile adoption	2	28
	➢ Communication problems during the initial adoption phase	Global	Agile adoption	2	41
	➢ Communication problems	SA	Scrum and Agile adoption	2	46
Teamwork	➢ Lack of senior support	Global	Agile adoption	2	28
	➢ Ineffective teamwork	Global	Agile adoption	2	28
	➢ Development team support	Global	Agile adoption	2	31

Factor	Challenge	Location	Literature	Chapter	Page
	➢ Teamwork/communication issues	Global	Scrum adoption	2	44
	➢ Team distribution	SA	Scrum and Agile adoption	2	46
Specialisation	➢ Work specialisation	Global	Agile adoption	2	28
	➢ Cross-functional generalist teams	Global	Scrum adoption	2	44
Sprint Management	➢ Requirements creep	Global	Scrum adoption	2	44
	➢ Over-optimistic task estimates	Global	Scrum adoption	2	44
	➢ Too many meetings	Global	Scrum adoption	2	44
	➢ Retrospective inadequacy	Global	Agile adoption	2	28
	➢ Project team size	Global	Scrum adoption	2	44
	➢ Lack of structure/planning	SA	Scrum and Agile adoption	2	46
	➢ Requirements/story changes	SA	Scrum and Agile adoption	2	46
	➢ Management inefficiencies	SA	Scrum and Agile adoption	2	46
	➢ Workload	SA	Scrum and Agile adoption	2	46
	➢ Team size	SA	Scrum and Agile adoption	2	46
Change Resistance	➢ Resistance to change	Global	Agile adoption	2	28
	➢ Pre-existing rigid/Waterfall framework	Global	Agile adoption	2	30
	➢ Cultural change resistance	Global	Agile adoption	2	41
	➢ Lack of development team motivation to follow and adopt Agile	Global	Agile adoption	2	41
	➢ Motivational issues	SA	Scrum and Agile adoption	2	46

Factor	Challenge	Location	Literature	Chapter	Page
Training	➢ Lack of knowledge/training/learning	Global	Agile adoption	2	28
	➢ Insufficient training provision	Global	Agile adoption	2	41
	➢ Insufficient training	SA	Scrum and Agile adoption	2	46
Recognition	➢ No/lack of individual recognition	SA	Scrum and Agile adoption	2	46
Quality	➢ Lack of quality	Global	Scrum adoption	2	44
	➢ Low user satisfaction	Global	Scrum adoption	2	44
Resources	➢ Lack of documentation	Global	Agile adoption	2	28
	➢ Budget and schedule constraint	Global	Agile adoption	2	28
	➢ High management overhead	Global	Scrum adoption	2	44
	➢ Budget constraints/time to transition	Global	Agile adoption	2	30
	➢ Lack of documentation	Global	Scrum adoption	2	44
	➢ Lack of resources (including infrastructure and communication tools)	SA	Scrum and Agile adoption	2	46
Collaboration	➢ Customer collaboration	Global	Agile adoption	2	30
	➢ Lack of a business/customer/product owner	Global	Agile adoption	2	34
Management Support	➢ Management support	Global	Agile adoption	2	30
	➢ Concerns about a loss of management control	Global	Agile adoption	2	31
	➢ Management concerns about lack of upfront planning	Global	Agile adoption	2	31
	➢ Lack of top management support	Global	Scrum adoption	2	44

Factor	Challenge	Location	Literature	Chapter	Page
	➢ Top management support	Global	IS innovation	2	44
Organisational Culture	➢ Organisational culture	Global	Agile adoption	2	28
	➢ General organisational resistance to change	Global	Agile adoption	2	30
	➢ Ability to change organisational culture	Global	Agile adoption	2	30
	➢ Organisational culture/mind-set	Global	Scrum adoption	2	44
	➢ Culture change difficulties	SA	Scrum adoption	2	45
	➢ Cultural change issues	SA	Scrum and Agile adoption	2	46
Organisational Structure	➢ Top-down hierarchical structure	Global	SDM adoption	2	24
	➢ Informal structure work environment	Global	SDM and Agile adoption	2	25
	➢ Organisational structure	Global	IS innovation	3	71
Relative Advantage	➢ Increase stress and workload	Global	Agile adoption	2	28
	➢ Long time to market	Global	Scrum adoption	2	44
	➢ DOI theory characteristic	n/a	DOI theory	3	57
Complexity	➢ Hard to scale	Global	Agile adoption	2	28
	➢ DOI theory characteristic	n/a	DOI theory	3	57
Compatibility	➢ Confidence in the ability to scale Agile	Global	Agile adoption	2	31
	➢ Confidence in methods for scaling Agile	Global	Agile adoption	2	31
	➢ DOI theory characteristic	n/a	DOI theory	3	57

n/a=not applicable

3.4.3 Individual Factors

The first set of variables are concerned with the individual's challenges.

a) Escalation of Commitment

In the software industry context, escalation of commitment is defined as continuously assigning resources to projects that indicate signs of failure. Statistics of 30% to 40% of software projects that experience an escalation of commitment have been recorded (Stray et al. 2012: 153). The author has included escalation of commitment to the individual factors construct because individual developers within Scrum teams have often caused this problem. The individual tends to persist with a task even though it is not adding value to the project. The sooner the Scrum team notice this problem, usually in daily stand-ups, the higher the chance of limiting resource wastage.

H_1: There is a significant linear relationship between escalation of commitment and Scrum adoption.

b) Experience

While experience is being knowledgeable and skilled on an event or subject, it also refers to the project team member having mastery of multiple skill sets, such as programming languages and management skills. Acquiring the mastery of multiple skill sets is achieved by working on various tasks, projects, and teams over some time (Chan & Thong 2009: 809). Experience is also a contributor to the performance of programmers (Brooks 1980: 209).

H_2: There is a significant linear relationship between experience and Scrum adoption.

c) Over-Engineering

Over-engineering or over-engineered solutions can be summarised as software that has more features or functionality added to it than required from the client. Reasons that could lead to software being over-engineered are lack of communication with stakeholders, bad planning, and limited domain knowledge by the Scrum team (Santos et al. 2011: 292). This variable has been included as an individual factor because the individual developer within the development team is usually responsible for completing a sprint backlog item. The development team is part of the sprint planning meeting, and if anything related to the

backlog item is unclear to the developer during the sprint, he or she may liaise with the Scrum team to clear any confusion. The author, therefore, thinks that over-engineering affects Scrum adoption negatively.

H_3: There is a significant linear relationship between over-engineering and Scrum adoption.

3.4.4 Team Factors

The second set of variables are concerned with the individual's perception of team-related challenges.

a) Communication

Communication is the act of exchanging information from one individual or group to another using a standard system of behaviour (Chan & Thong 2009: 809). Communication within the Scrum team is constantly required. Communication is required during sprint planning while working on project related tasks, during the demonstration, and during the release of product updates. Communication is therefore hypothesised to have a significant relationship with Scrum adoption.

H_4: There is a significant linear relationship between communication and Scrum adoption.

b) Teamwork

Teamwork is the process whereby individuals work together as a team to complete tasks, and to achieve a common goal or objective (Chan & Thong 2009: 809). However, teamwork within Agile development methodologies is a reoccurring problem. Activities which have been documented as essential to increase team, as well as organisational performance, are recognising other's achievements, responding constructively to team member opinions, assisting and supporting others, and showing greater leniency toward team members (Stray et al. 2011: 146).

H_5: There is a significant linear relationship between teamwork and Scrum adoption.

c) Specialisation

The term specialisation refers to the process of having a high degree of knowledge and skills within a domain of interest, which as a result improves the individual's proficiency and expertise within his or her role. Agile software development teams prioritise the idea of self-

organising teams in which team members share overlapping skills. The overlapping of skills improves team flexibility. The problem with work specialisation within a Scrum team is that it does not make provision for interchangeable roles (Fægri 2010: 28-29).

H_6: There is a significant linear relationship between specialisation and Scrum adoption.

d) Sprint Management

Sprint Management is defined as a time-boxed activity that monitors and manages the progress of a sprint. Events that prevent optimal sprint cycles includes scope creep, lack of timeous feedback, lack of planning, and lack of team cohesion (Tanner & Khalane 2013: 2, 4; Tanner & Mackinnon 2013). Sprint management done well is hypothesised to have a strong significant relationship with Scrum adoption.

H_7: There is a significant linear relationship between sprint management and Scrum adoption.

e) Change Resistance

Resistance to change within the context of the work environment is a process whereby employees see change as disruptive and intrusive (Strebel 1996: 86). With Agile process introduction, developers tend to display signs of cautious optimism, scepticism, and enthusiasm with the problem of some developers not welcoming the change, resisting it without much thought put into it (Cohn & Ford 2003: 74). Change resistance is therefore hypothesised to have a negative correlation with Scrum adoption.

H_8: There is a significant linear relationship between change resistance and Scrum adoption.

3.4.5 Organisation Factors

The third set of variables deals with the individual's perception of related organisational challenges.

a) Training

Training is the acquisition of skills and knowledge through teaching and learning which improves the competency areas of the individual or group. The training within this research study applies to employees going for training to achieve the goals and objectives of the

organisation they represent (Chan & Thong 2009: 809). Training is hypothesised to have a positive correlation with Scrum adoption.

H_9: There is a significant linear relationship between training and Scrum adoption.

b) Recognition

Recognition from a business point of view is matching remuneration, rewards, and benefits with the productivity levels of the workers (Bishop 1987: 43). The study by Noruwana and Tanner (2012: 43) identified that individuals were unhappy with the lack of recognition for their contributions within the team. The reason was that team level recognition does not distinguish between team member productivity levels. Therefore, recognition is hypothesised to improve the likelihood of adoption.

H_{10}: There is a significant linear relationship between recognition and Scrum adoption.

c) Quality

The quality referred to is that of software quality, and how its correctness contributes toward software projects meeting the business requirements, and user expectations. There have been many attempts to improve the quality of software project throughput, yet many software projects continue to fail (Tanner & Khalane 2013: 1).

H_{11}: There is a significant linear relationship between quality and Scrum adoption.

d) Resources

Resources in the context of this study refer to any asset or service, whether it is staff, materials, or money that allows the organisation to operate sufficiently in producing products and services requested by clients. An exploratory case study conducted by Noruwana and Tanner (2012: 52-53) on a SA company identified lack of Agile experience, limitation in skillsets, and team members with too many responsibilities, as examples of lack of labour resources. Lack of resources is hypothesised to harm adoption.

H_{12}: There is a significant linear relationship between resources and Scrum adoption.

e) Collaboration

Included in the Agile Manifesto is the statement "Customer collaboration over contract negotiation". What this suggests is that individuals, teams, and organisations need to work closely together with clients to achieve a common goal instead of spending most of their effort on securing the contract. Research indicates that many organisations and customers within Agile environments do not abide by this principle. Some of the challenges faced by the lack of collaboration are Agile teams being overly committed, loss of business and productivity, products and user requirements not aligning, and inadequate feedback mechanisms (Hoda et al. 2011b: 525-526, 532). Sufficient collaboration is therefore hypothesised to have a significant relationship with Scrum adoption.

H_{13}: There is a significant linear relationship between collaboration and Scrum adoption.

f) Management Support

Management support allows organisations to look at innovation adoption from a positive perspective, and this creates a conducive environment for innovativeness (Chan & Thong 2009: 809). Two findings that are of interest for this study are firstly management that penalises employees for mistakes made does not encourage innovativeness, and secondly, management support has a direct effect on the adoption of innovation (Sultan & Chan 2000: 111-112). Scrum adoption is therefore hypothesised to show a positive correlation to management support.

H_{14}: There is a significant linear relationship between management support and Scrum adoption.

g) Organisational Culture

E.H. Schein (1990), as quoted by Chan and Thong (2009: 809) defines organisational culture as "a pattern of basic assumptions invented, discovered or developed by a given group as it learns to cope with its problems of external adaptation and integration that has worked well enough to be considered valid and, therefore, is to be taught to new members as the correct way to perceive, think, and feel in relation to those problems". An organisational culture that promotes innovative and independent thinking is hypothesised to have a strong linear relationship with Scrum adoption.

H_{15}: There is a significant linear relationship between organisational culture and Scrum adoption.

h) Organisational Structure

The organisation structure is a system with defined activities which govern how individuals within roles, and procedures, are coordinated to achieve the goals and objectives of the organisation. Evidence from previous studies indicates that organisations that allow for an open and integrated environment with a less hierarchical structure improve the innovation adoption rates (Sultan & Chan 2000: 110-111). While previous studies have broken up organisational structure into the three components of centralisation, formalisation, and integration, the author, however, decided to keep it as a single variable for reasons of simplicity as well as study requirements.

H_{16}: There is a significant linear relationship between organisational structure and Scrum adoption.

3.4.6 Technology Factors

The fourth set of variables are derived from the DOI theory and are used to measure the individual's perception of the Scrum methodology as an innovation.

a) Relative Advantage

The relative advantage defined in Subsection 3.3.2 of this chapter is the degree by which Scrum has made a positive contribution to the existing conditions of the individual or organisation (Sultan & Chan 2000: 112). Relative advantage is hypothesised to have a significant relationship with Scrum adoption.

H_{17}: There is a significant linear relationship between relative advantage and Scrum adoption.

b) Complexity

Complexity is the degree of difficulty experienced by individuals and organisations when adopting Scrum as an innovation (Sultan & Chan 2000: 112). Complexity is hypothesised to display a negative correlation toward Scrum adoption.

H_{18}: There is a significant linear relationship between complexity and Scrum adoption.

c) Compatibility

Sultan and Chan (2000: 112) explained that the compatibility of innovation might determine the likelihood of individuals either adopting or rejecting the innovation. Therefore, the adoption of Scrum within the context of this study can be determined by its compatibility with individuals working within SA organisations.

H_{19}: There is a significant linear relationship between compatibility and Scrum adoption.

3.5 The Structure of the Conceptual Framework

Figure 3.2 displays the custom model developed from the list of factors on page 62 (Table 3.2). It is crucial for the reader to note that the author has adapted the innovation adoption model from the Sultan and Chan (2000) study. As shown in Figure 3.2, the CF for this study displays the factors that are hypothesised to influence the adoption of the Scrum methodology by Scrum practitioners and the proposed directionality of these relationships.

The CF that has been named the Scrum Adoption Challenges Conceptual Framework (SACCF) was used to identify Scrum challenges which had a significant linear relationship with Scrum adoption. The dependent variable in this study (Y) was the adoption of Scrum. Scrum adoption is dependent on the independent variables discussed in the literature review and included in the four constructs shown in Figure 3.2: (X_1) individual factors; (X_2) team factors; (X_3) organisational factors; and (X_4) technology factors.

3.6 Chapter Summary

This chapter looked at the conceptualised model to identify the constructs and factors that have a significant linear relationship with Scrum adoption, as perceived by Scrum practitioners within SA organisations. The conceptualised model can be used to generalise results to the population (Overhage et al. 2011: 8; Senapathi et al. 2011: 138). This study, therefore, seeks to determine the significance of the four constructs and its factors have on the adoption of Scrum at the individual level.

The next chapter looks at the research methodology used to conduct the research study; some of the sections are research design, population sample, analysis, and reliability and validity.

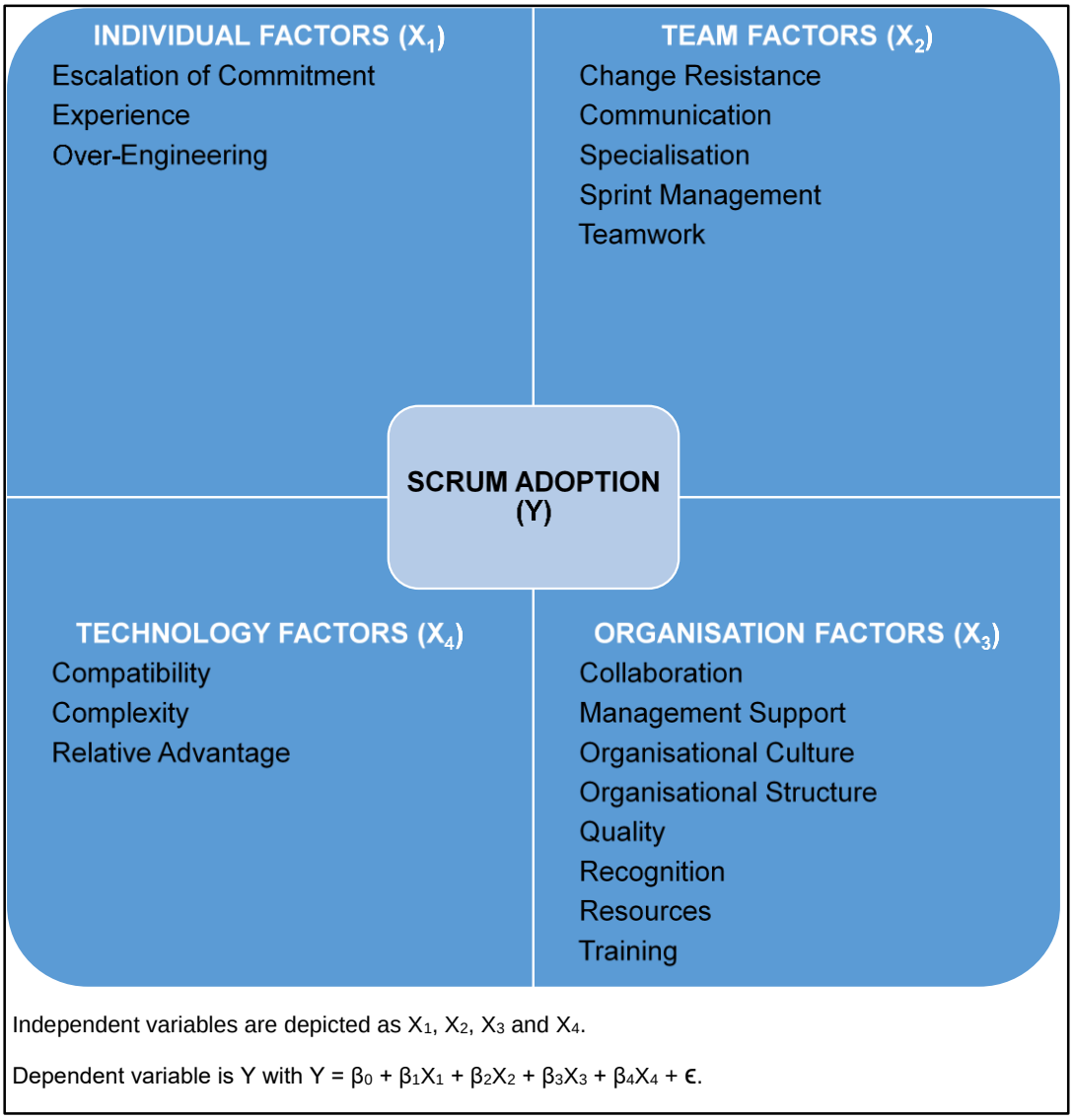


Figure 3.2: Scrum Adoption Challenges Conceptual Framework (SACCF).

CHAPTER 4: RESEARCH METHODOLOGY

Chapter 4 is structured as follows:

4.1 - Introduction

4.2 - Operationalisation of Variables

4.3 - Research Design

4.4 - Population and Sample

4.5 - Measuring Instruments

4.6 - Reliability and Validity

4.7 - Data Collection

4.8 - Data Analysis

4.9 - Chapter Summary

4.1 Introduction

Research methodology is the chapter of the dissertation that makes sense of the entire document. It describes and elaborates on the research methods and research techniques, respectively, providing the logic for the decisions made (Welman et al. 2005: 2).

In the literature review chapter, the author described the challenges experienced during the adoption of Scrum and other Agile methodologies. The top five challenges identified was culture change issues, lack of structure and planning, requirements and story changes, communication problems, and motivational issues. The emphasis was on the Scrum Agile methodology, with SA Scrum practitioners as the population universe. In the Conceptual Framework (CF) chapter, the

author described the structure of the CF that was inspired by the Diffusion of Innovation (DOI) theory, with an adapted version of the constructs as displayed in the adoption of new technology study by Sultan and Chan (2000).

This chapter comprises the methodology implemented during the dissertation. The sections of the chapter consist of the operationalisation of variables, research design, population and sample, followed by the measuring instruments and its reliability and validity, data collection methods, and the data analysis.

4.2 Operationalisation of Variables

Operationalisation of variables was done based on the narrative review of the existing primary and secondary literature sources as discussed in the research design section of this chapter (see Section 4.3).

- **Dependent Variable**: Scrum adoption is the dependent variable in our model. The author, therefore, looked at the average of the three statements in the questionnaire on Scrum adoption to derive the factor score, see Section G in Appendix A.

- **Independent Variables**: All the factors described in the Scrum Adoption Challenges Conceptual Framework (SACCF) are measured on a seven-point Likert-type scale, where one means strongly disagree, and seven means strongly agree. The independent variables were used to generate factor analysis scores. A description of the operationalisation of each variable is in Appendix A.

  To test the hypotheses the author conducted three sets of analysis. Firstly, an Exploratory Factor Analysis (EFA) was done to validate the independent variables and provide the factor scores. After that the factors generated from the first order EFA were used to produce the second order EFA scores. Secondly, the correlation matrix provided the test results of the correlation between the different factors. The final analysis uses Multiple Linear

Regression (MLR) to assess the relationship between the dependent variable and the independent variables.

4.3 Research Design

"Research is a process that involves obtaining scientific knowledge by means of various objective methods and procedures", (Welman et al. 2005: 2). Scientific knowledge is obtained using two types of research methodologies, namely qualitative and quantitative.

When pursuing a research dissertation or thesis, the decision for an appropriate research methodology is based on the population sample chosen and how the data is acquired, analysed and interpreted. Table 4.1 displays a few of the differences between these two methodologies as emphasised by Welman et al. (2005: 8-9).

Table 4.1: Differences between Qualitative and Quantitative Methodologies (Source: Welman et al. (2005)).

No.	Qualitative	Quantitative
1	Subjective data	Objective data
2	Explorative methods	Structured methods
3	Insiders view	Outsider's perspective
4	Emphasis on validity	Focus on reliability
5	Small samples	Large samples
6	Holistic approach	Particularistic approach
7	Methods include case studies, observations, and unstructured in-depth interviews.	Methods include laboratory and field studies, survey designs, and longitudinal designs.

In Chapter 1, the author identified the need for research on factors that contribute towards Scrum adoption within the SA context. The existing research on Scrum adoption is primarily qualitative. The same qualitative research design approach is followed in Agile adoption challenges research. The author experienced challenges during the narrative review due to the lack of coherence between the existing qualitative literature.

The author chose the quantitative methodology because of the value it could add to the Scrum adoption body of knowledge. The quantitative approach allows the author to develop a synthesised set of variables which could be used for Scrum adoption factor generalisation within the population. The quantitative methodology approach also adds further value by allowing researchers to apply predictive and prescriptive analysis techniques to the validated Scrum adoption factors. Based on the additional contributions a quantitative study could add to Scrum and Agile adoption research, the author implemented the quantitative survey in the research design.

A narrative review of the literature on Scrum and Agile adoption was used to identify the independent variables to use in the conceptual model. The narrative review was not used as part of a mixed-method approach to answer research questions and hypotheses using both a qualitative and quantitative research design but was merely used as an enabler to allow the author to acquire the variables to use as factors in the conceptual model. The online survey questionnaire was the primary data gathering method to answer the research hypotheses. Survey questionnaires were provided and arranged for the subjects in the form of online surveys.

The quantitative survey design is discussed further in the following subsection.

4.3.1 The Quantitative Survey Design

According to Welman et al. (2005: 292), based on the definition of Huysamen (1993: 26), states that opinion eliciting is usually done using a survey research design method. Therefore, this research design takes the form of a positivist, quantitative, non-experimental, descriptive, nomothetic, cross-sectional survey design. The survey was self-administered using questionnaires. The sampling method was non-probability, self-selection sampling. The decision for the selection of the research design and sampling method is due to the appropriateness for the kind of research done, namely survey research design. The data was more accessible to obtain as well as more generalisable because of the increased population sample. However, it had a degree of self-selection bias and could have resulted in a non-representative population sample. Questionnaires were provided and arranged for the subjects in the form of online surveys.

The primary objective of this research was to investigate the factors that have a significant relationship with Scrum adoption, as perceived by SA Scrum practitioners. The dissertation, therefore, took the opinions of Scrum practitioners within SA organisations into account.

The data collection methods were in the form of rating scales. Subjects on request completed a fifteen-minute online survey questionnaire, see the questionnaire design in Appendix B. The assurance of a subject's confidentiality was through anonymous communication of questionnaire material. Each subject completed a survey questionnaire which was individually validated and then analysed statistically.

4.4 Population and Sample

4.4.1 Units of Analysis

The population in the research methodology context refers to the activities, cases, events, objects, phenomena, and subjects used for sampling (Brynard & Hanekom 1997).

The sample group (n=207) is from the population universe consisting of Scrum practitioners working within SA organisations. To clarify, Scrum practitioners in the context of this study refers to any professional employed within a SA organisation who is using Scrum while being involved in the Software Development Life Cycle (SDLC). A professional includes developers, testers, management, clients, Scrum masters, and product owners. The SA organisation is an organisation located within South Africa that have individuals and teams that practice Scrum as an Agile methodology.

The respondents Scrum usage duration within the population sample are predominately between three to five years. The respondent's ages range between the 18-20 years and 39-59 years age group categories, with the 29-38 years age group category recording a frequency of 88 out of 207 valid responses. The responses for Scrum practitioner job title are 57.5% for the software developer, and 19.8% for Scrum master. The majority work experience of the individuals within the population sample is lower than six years in total, with 76 of the 207 responses recorded in the three to five

years category. Chapter 5 of this dissertation provides a detailed description of the demographics of the survey questionnaire respondents.

There are no demographical and geographical quotas; however, most of the survey respondents derive from the Gauteng and Western Cape provinces. Gauteng is the province identified as the primary office location for 49.8% of the sample. The Western Cape is the province with the second-highest response for primary office location.

The reason for this could be because the two provinces have the most prominent urban centres resulting in higher levels of migration for better job opportunities (Morris 2018: internet). Cape Town, Johannesburg and Pretoria are the main geographical cities for the online survey; but this does not exclude the Scrum practitioners from the rest of the country. Section 5.3 of Chapter 5 provides further descriptions of the dispersion of the demographics based on province.

4.4.2 Sampling Method

With regards to sampling, Floyd and Fowler (2009: 8) list five essential characteristics of a suitable sampling method; these are:

- Deciding to select a probability or non-probability sample.
- The sample frame, and the generalisation thereof.
- The sample size.
- The sample design, and its implementation strategy.
- The response rates.

Taking what is mentioned above in mind, the sampling types that were in contention for inclusion in this research study were between self-selection sampling, purposive sampling, and quota sampling. The decision was taken to conduct the survey using the non-probability, self-selection sampling method mainly because it uses less time to complete in comparison to other methods, and the ability to achieve a more considerable amount of responses is greater. Table 4.2 gives a summarised description of the factors considered when choosing a sampling method.

The sampling method was applied to the population in the form of an online survey questionnaire discussed in Section 4.5. The population sample responses were gathered primarily through social media platforms and word of mouth. The description of how the author found the respondents are discussed further in the data collection section of this chapter (Section 4.7).

4.5 Measuring Instruments

The measuring instruments used will now be discussed, including its nature and composition, and the rationale for its inclusion.

4.5.1 Survey Questionnaire

The definition of a good survey questionnaire is one that contains the following pertinent points:

- Relevant, well-structured questions.
- Running the questionnaire through a pilot study.
- Able to elicit the required response data from the population sample.

Floyd and Fowler (2009: 5), describes a good survey design as one that has a combination of three research activities, namely:

- Sampling.
- Designing Questions.
- Data Collection.

Table 4.2: Factors considered when choosing a Sampling Method (Source: Saunders et al. 2003: 172).

Method	Sample representation	When to consider	Costs	Sample control
Self-selection	Low	When exploratory research needed	Low	Low
Purposive	Low	When working with tiny samples	Reasonable	Reasonable

Method	Sample representation	When to consider	Costs	Sample control
Quota	Reasonable to high	When an alternative to probability sampling is needed	Moderately high to reasonable	Relatively high

The end goal of any good questionnaire is to determine what the samples biographical details, attitudes, behaviour, opinions, beliefs and convictions are toward independent variables (Welman et al. 2005: 152). Because the questionnaire was self-administered, it was important that the author made sure that the questions contained in the questionnaire were clear, understandable and straightforward (Gillham 2000: 10-11). The questionnaire included ordinal measurements for ranking.

The rationale for using a questionnaire can thus be summarised as follows:

- Inexpensive.
- Less time-consuming.
- It offers greater anonymity.
- A large number of reachable respondents.
- Pre-coded data.

4.5.2 Attitude Scales

"An attitude is a disposition towards a particular issue, the so-called attitudinal object." The attitudinal object includes political issues, a single person, a group of people, and a custom (Welman et al. 2005: 156).

The measuring instrument for the attitudinal aspects toward Scrum is the Likert-type scale. The Likert-type scale is the most popular attitude scale due to its ease of compilation (Welman et al. 2005: 156). A seven-point Likert-type scale was used to measure the respondent's attitude toward adoption challenges of Scrum. The designed response items are as follows:

- 7=Strongly agree

- 6=Agree
- 5=Agree somewhat
- 4=Neither agree nor disagree
- 3=Disagree somewhat
- 2=Disagree
- 1=Strongly disagree

The rationale for using the aforementioned attitudinal measuring instrument is to check whether there was any causal or correlational relationship between the independent variables and the dependent variable, as well as checking for any significant relationship between the independent variables and the dependent variable.

4.6 Reliability and Validity

In this section, the data relevance and value are discussed based on the reliability of the measuring instruments and the validity of the sampling.

4.6.1 Validity

Construct validity refers to the measuring instrument measuring what it is intended to measure and not irrelevant constructs or measurement error (Kumar 2005: 153; Welman et al. 2005: 142).

A pilot study is a small-scale research study conducted before the full-scale study proceeds. A pilot study's usefulness is when a new measuring instrument is used or developed by the researcher, and the researcher needs to determine the validity thereof, to minimise data collection errors (Kumar 2005: 10; Welman et al. 2005: 148). Therefore, a pilot study administered to 15 valid respondents allowed for criticism on the content, layout, and instructions of the questionnaire.

During the full-scale study, the author used EFA to test the validity of the scale. EFA is a statistical method used to describe the variability of the observed variables in terms of the unobserved constructs (Gerber & Hall 2016: 7). To validate the questionnaire items against the

initial 19 factors in the SACCF required the author to conduct a first order and second order EFA, respectively. The first order EFA took the 78 questionnaire items to construct the newly validated 14 factors. The 14 factors went through a second order EFA to develop the four constructs. The validity analysis began by generating the first order EFA scores. Once the first order EFA scores were summarised, the second order EFA followed. When not explicitly mentioning the second order EFA, all EFA mentions refer to the first order EFA.

The Bartlett's test for Sphericity was conducted to determine if it was useful to conduct factor analysis. The correlation structure between the individual variables are significant, and it is therefore worthwhile to conduct the EFA. To test the sampling adequacy, the author used the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. The KMO value was 0.88 which made it viable to conduct an EFA (see Table 4.3).

Table 4.3: KMO and Bartlett's Test Results for the First Order EFA.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.879
Bartlett's Test of Sphericity	Approx. Chi-Square	15765.511
	Df	3003
	Sig.	.000

To determine the number of factors derived from the individual statements, Eigenvalues > 1 and the Scree plot (see Figure 4.1) was used. The constructs cumulative percentage was 75.80%

The author used the Principal Axis Factoring (PAF) extraction method with oblique rotation. The oblique rotation implemented the Oblimin with Kaiser Normalization method because it was required to explore the correlations between the factors.

To summarise, the author applied EFA to the responses taken from 78 questionnaire items. The PAF method was used to extract the factors, followed by oblique rotation implementing the Oblimin with Kaiser Normalization method. Of the 78 questionnaire items, only 14 factors were retained for rotation due to the Eigenvalues being higher than or near one. The first 14 factors as a collective accounted for 75.8% of the total variance.

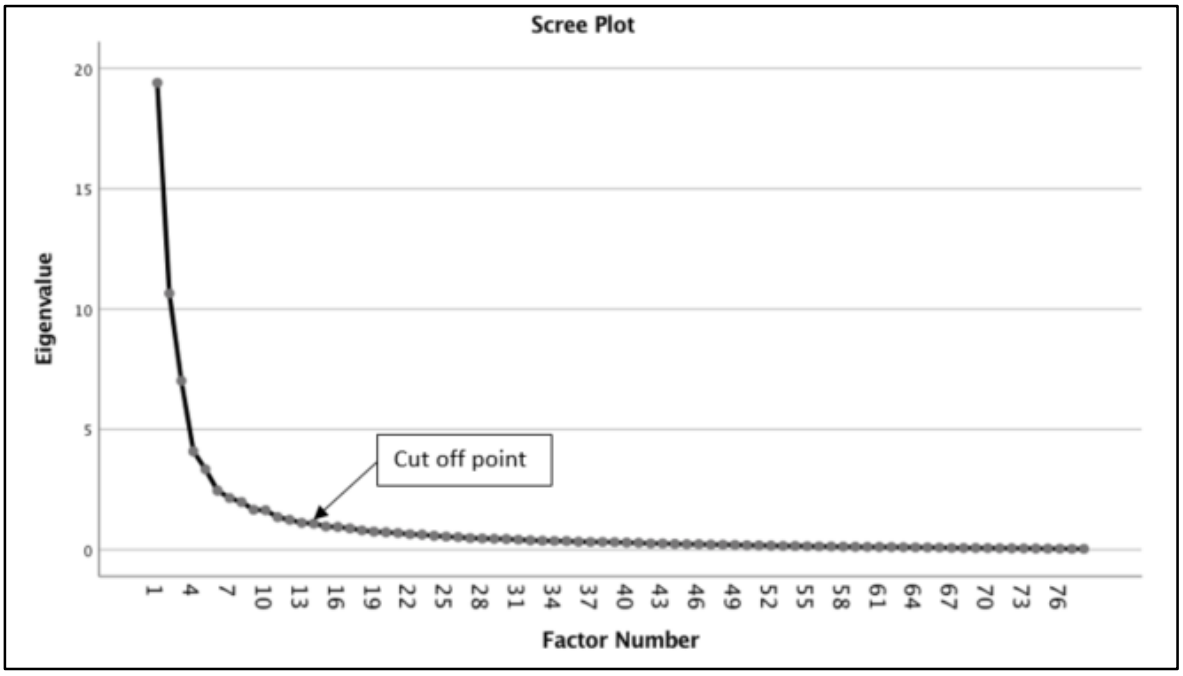


Figure 4.1: Scree Plot for the First Order Factor Numbers.

Table 4.4 presents the items with its commonalities and corresponding loadings. Questionnaire items that load on a given factor need to have a factor loading of 0.40 or higher for that given factor, and have a factor loading of less than 0.40 for all other factors. Factor loadings of 0.35 or higher were included for the EFA Rotated Factor Pattern to check if there were any loadings close to the 0.40 cut off point. Questionnaire item E1.16 had a factor 1 loading of 0.41 and a factor 14 loading of 0.39. Questionnaire item E1.21 had a factor 1 loading of 0.39.

Because of the factor loading cut-off criteria of 0.40, 12 items were found to load on the first factor, which was subsequently labelled "Organisational Behaviour". Eight items loaded on the second factor, labelled "Sprint Management". Nine items loaded on the third factor, labelled "Relative Advantage". Four items loaded on the fourth, fifth, sixth, and the seventh factor respectively, labelled "Experience", "Training", "Specialisation", and "Recognition". Seven items loaded on the eighth factor, labelled "Customer Collaboration". Three items loaded on the ninth factor, labelled "Compatibility". Five items loaded on the tenth factor, labelled "Over-Engineering". Three items loaded on the eleventh and twelfth factor respectively, labelled "Escalation of Commitment", and "Complexity". Eight items loaded on the thirteenth factor, labelled "Teamwork", and four items loaded on the fourteenth factor labelled "Resource Management".

Table 4.4: The First Order EFA Rotated Factor Pattern and Final Communality Estimates of the Survey Questionnaire.

Items	Communalities	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14
E1.28	.759	.791													
E1.30	.783	.789													
E1.29	.718	.784													
E1.22	.718	.710													
E1.24	.846	.685													
E1.26	.710	.657													
E1.31	.777	.643													
E1.27	.729	.623													
E1.25	.827	.588													
E1.23	.766	.537													
E1.16	.699	.412													.385
E1.21	.683	.387													
D1.14	.839		.874												
D1.15	.820		.842												
D1.16	.846		.835												
D1.17	.738		.764												
D1.13	.755		.756												
D1.18	.697		.730												
D1.19	.757		.702												

Items	Communalities	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14
D1.20	.593		.593												
F1.2	.769			.881											
F1.1	.752			.861											
F1.6	.713			.766											
F1.4	.697			.759											
F1.3	.595			.729											
F1.11	.728			.663											
F1.5	.480			.526											
F1.15	.476			.445											
F1.10	.542			.421											
C1.1	.769				.817										
C1.2	.732				.791										
C1.3	.646				.761										
C1.4	.656				.681										
E1.2	.866					.854									
E1.3	.848					.768									
E1.4	.843					.751									
E1.1	.682					.730									
D1.11	.896						-.945								

Items	Communalities	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14
D1.10	.764						-.825								
D1.12	.670						-.731								
D1.9	.413						-.561								
E1.5	.812							-.688							
E1.8	.853							-.683							
E1.7	.788							-.679							
E1.6	.695							-.503							
E1.18	.806								.739						
E1.19	.817								.732						
E1.20	.800								.632						
E1.17	.560								.506						
E1.11	.598								.477						
E1.10	.698								.476						
E1.9	.515								.354						
F1.13	.870									-.964					
F1.12	.836									-.820					
F1.14	.540									-.488					
C1.10	.802										-.843				
C1.11	.697										-.839				

Items	Communalities	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14
C1.9	.738										-.821				
C1.8	.517										-.508				
C1.12	.402										-.497				
C1.6	.849											-.839			
C1.5	.787											-.800			
C1.7	.629											-.694			
F1.7	.703												-.595		
F1.8	.636												-.514		
F1.9	.611												-.485		
D1.3	.760													-.878	
D1.2	.737													-.836	
D1.6	.659													-.686	
D1.1	.637													-.609	
D1.8	.766													-.592	
D1.5	.767													-.582	
D1.7	.801													-.573	
D1.4	.552													-.551	
E1.13	.708														.712
E1.14	.599														.689

Items	Communalities	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14
E1.12	.457														.476
E1.15	.613														.473

F1=Organisational Behaviour, F2=Sprint Management, F3=Relative Advantage, F4=Experience, F5=Training, F6=Specialisation, F7=Recognition, F8=Customer Collaboration, F9=Compatibility, F10=Over-Engineering, F11=Escalation of Commitment, F12=Complexity, F13=Teamwork, F14=Resource Management.

Table 4.5 maps the questionnaire item numbers to the questionnaire item statements. There was not enough space to place the lengthy questionnaire item statements in Table 4.4 with the commonalities and factor loadings. To follow is the second order EFA loadings and rotations.

Table 4.5: Mapping of the Questionnaire Item Numbers to the Questionnaire Item Statements.

Questionnaire Items	Questionnaire Statements
E1.28	The company structure is flexible with few activities which govern how individuals within roles are coordinated.
E1.30	The organisation has an open environment.
E1.29	The company structure is flexible with few activities which govern how procedures are administered.
E1.22	Management sees mistakes as part of the learning process.
E1.24	The company culture promotes employee happiness.
E1.26	Team members are given the liberty to have their own thoughts in relation to project related tasks.
E1.31	The organisation has an integrated environment.
E1.27	The company encourages the sharing of ideas amongst teams.
E1.25	The company culture promotes innovative thinking.
E1.23	The organisation has managers that encourage investigating innovations that improve productivity.
E1.16	The resources are well managed by the organisation's management.
E1.21	Management is open to innovation.
D1.14	The Scrum rules within the sprint are badly implemented.
D1.15	The Scrum roles within the sprint are badly assigned.
D1.16	The Scrum events within the sprint are badly executed.
D1.17	The team sees change as problematic.
D1.13	The sprint is badly managed.
D1.18	The team sees change as undesirable.
D1.19	Team members are not willing to consider different ideas or opinions.
D1.20	Individuals within the team are reluctant to try new things.

Questionnaire Items	Questionnaire Statements
F1.2	The use of Scrum contributes to teamwork.
F1.1	Scrum improves software quality.
F1.6	Scrum contributes towards effective problem-solving.
F1.4	Scrum improves individuals' motivation towards task completion.
F1.3	Scrum shortens the time delay in the development process of a product.
F1.11	The Scrum methodology is suitable for managing software development projects.
F1.5	Scrum improves project management.
F1.15	All roles, events and artifacts of Scrum are necessary.
F1.10	Scrum has several artifacts, roles and events, which are clear and descriptive.
C1.1	During your working career, you were able to acquire or be trained in more than one skill.
C1.2	During your working career, you were able to work on more than one project.
C1.3	During your working career, you were able to work in more than one team.
C1.4	During your working career, you noticed an improvement in your work performance levels.
E1.2	Training, in general, is encouraged within the company.
E1.3	Acquiring knowledge through training is seen as contributing to the organisation’s objectives.
E1.4	Acquiring knowledge through training is seen as contributing to the individual’s growth within the organisation.
E1.1	The organisation, in general, provides training opportunities for its employees.
D1.11	Tasks are assigned to individuals based on their expertise.
D1.10	Tasks are assigned to individuals based on their proficiencies.
D1.12	Individuals within the team hold specialist roles.

Questionnaire Items	Questionnaire Statements
D1.9	Individuals within the team have specialist skills.
E1.5	The organisation has an employee recognition process.
E1.8	Employee excellence is rewarded.
E1.7	The organisation provides recognition at the individual level.
E1.6	The organisation provides recognition at the team level.
E1.18	The organisation regularly includes the client in project related communication.
E1.19	The organisation regularly includes the client in project related decision making.
E1.20	The organisation's product is aligned with client requirements.
E1.17	The client is seen as part of the project team.
E1.11	The alignment of the project shapes the correctness of the product with the client expectations.
E1.10	The correctness of the product is shaped by the alignment of the project with the business requirements.
E1.9	The software organisation has quality control measures in place for software development.
F1.13	Scrum can be adapted on a project size basis.
F1.12	Scrum can be adapted on a project complexity basis.
F1.14	Scrum is flexible as a methodology.
C1.10	You should add additional software code to the software project if the team is unaware of the importance thereof.
C1.11	You should add additional software code to the software project in the absence of technical leadership.
C1.9	You should add additional software code to the software project if the client does not realise the necessity thereof.
C1.8	Changing the method to resolve a software development problem should be the sole responsibility of the individual providing the solution.

Questionnaire Items	Questionnaire Statements
C1.12	You should add additional software to the software project for future scalability.
C1.6	You should persist with a software development problem with all the effort it requires to provide the solution.
C1.5	You should persist with a software development problem until you can provide the solution.
C1.7	You should persist with a software development problem until the planned solution has been completed.
F1.7	Scrum is easy to follow.
F1.8	Scrum is simple to understand.
F1.9	Scrum is easy to master.
D1.3	The attitudes of individuals within the team negatively affects communication.
D1.2	The behaviour of individuals within the team negatively affects communication.
D1.6	Team members struggle with tasks due to a lack of teamwork.
D1.1	There is a general lack of communication within the software project team.
D1.8	Team members struggle to guide each other.
D1.5	Individuals struggle to work together as a team to complete tasks.
D1.7	Team members struggle to help each other.
D1.4	The cultural diversity within the team negatively affects communication.
E1.13	Labour resources within the organisation are enough for the completion of tasks.
E1.14	Non-labour resources within the organisation are enough for the completion of tasks.
E1.12	Dedicated employees responsible for the task oversees quality assurance.
E1.15	Resources are quickly added to projects when needed.

The second order EFA on the 14 factors derived from the first order EFA output. The PAF extraction method and the Oblimin with Kaiser Normalization (oblique) rotation method were used to calculate the scores. The second order EFA generated the KMO and Bartlett's Test results displayed in Table 4.6.

Table 4.6: KMO and Bartlett's Test Results for the Second Order EFA.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.779
Bartlett's Test of Sphericity	Approx. Chi-Square	1204.446
	df	91
	Sig.	.000

The Eigenvalues generated from the PAF extraction method resulted in 4 constructs, with the Eigenvalues displayed in the Scree plot depicted in Figure 4.2. The cumulative percentage explained by the four constructs is 67.8%.

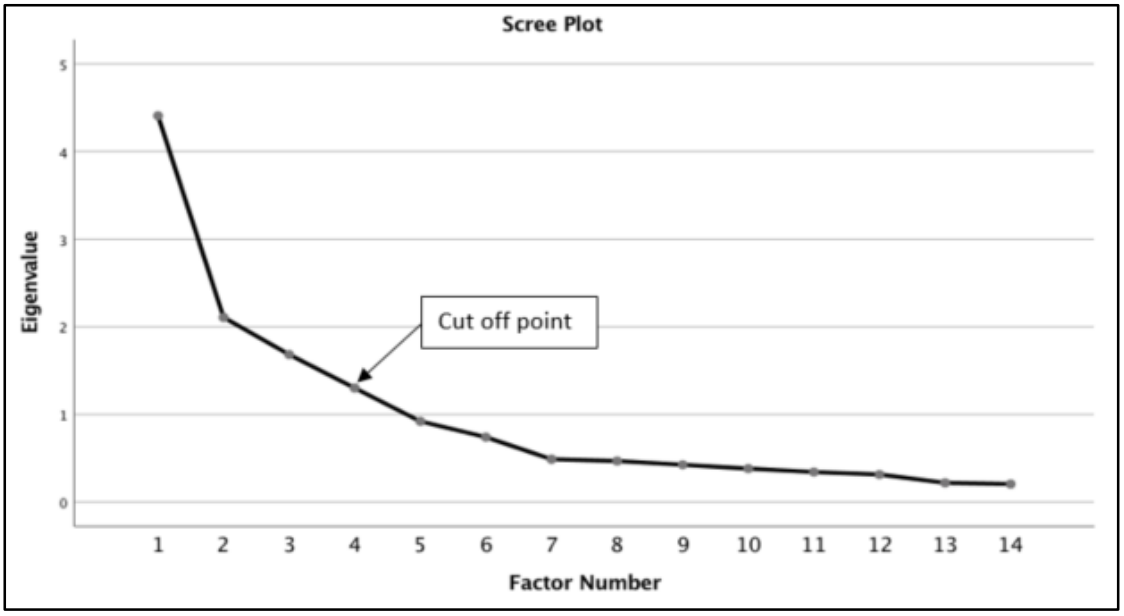


Figure 4.2: Scree Plot for the Second Order Factor Numbers.

To summarise, the application of the second order EFA was made to the 14 factors calculated in the first order EFA. The PAF method was used to extract the factors, followed by the Oblimin with Kaiser Normalization (oblique) rotation method. Of the 14 input factors, only four factors were retained for rotation, because of their Eigenvalue being higher than or near one. The first

four factors as a collective accounted for 67.8% of the cumulative variance. These four factors are consequently referred to in the remainder of this dissertation as the four constructs.

Table 4.7 presents the items with its commonalities and corresponding loadings. Items that load on a given factor need to have a factor loading of 0.40 or higher for that given factor and have a factor loading of less than 0.40 for all other factors. With a factor loading cut-off criteria of 0.40, five items were found to load on the first factor, which was subsequently labelled "Organisation". Three items loaded on the second factor, labelled "Team". Three items loaded on the third factor, labelled "Technology" and three items loaded on the fourth factor labelled "Individual". The "Specialisation" item loaded on the fourth factor with a score of 0.26. While the "Specialisation" item factor score was low, it was retained as the third item of factor 4, because it did not make a significant difference to the correlation and regression analysis of the factor.

The following subsection looks at the reliability of the survey questionnaire used in this research study.

4.6.2 Reliability

Reliability can be described as being concerned with the replication of research findings across repeated trials (O'Leary 2004: 58; Welman et al. 2005: 145). As mentioned by Welman et al. (2005: 147), internal consistency is the reliability of the administered measuring instrument to the representative sample. In this study, no repeated trials were carried out. Therefore reliability could not be measured across different research findings.

Cronbach's coefficient alpha is a measure of the internal consistency of a measurement instrument (Welman et al. 2005: 147), one of the measures of reliability. The coefficient alpha was used to determine the reliability of the scale items. For the factors derived from the first order EFA, estimates of internal consistency as measured by Cronbach's coefficient alpha all exceeded 0.80. Table 4.8 reports on the good reliability. Subsequently, factor scores were calculated by taking the average of the responses for the reliable factor items.

Table 4.7: The Second Order EFA Rotated Factor Pattern and Final Communality Estimates of the Survey Questionnaire.

Items	Communalities	Factor 1 loadings: Organisation	Factor 2 loadings: Team	Factor 3 loadings: Technology	Factor 4 loadings: Individual
Organisational Behaviour	.758	.876			
Customer Collaboration	.662	.811			
Recognition	.582	.774			
Resource Management	.537	.727			
Training	.482	.663			
Sprint Management	.874		.918		
Teamwork	.607		.770		
Over-Engineering	.278		.423		
Compatibility	.588			-.787	
Relative Advantage	.620			-.784	
Complexity	.597			-.697	
Escalation of Commitment	.602				.709
Experience	.422				.658
Specialisation	.243				.262

Table 4.8: Coefficient Alpha Reliability Estimates, Means, Standard Deviations, and Correlations for the First Order Factors.

Variables	Items	Items left out	Mean	SD	Cronbach	Reliability
Factor 1: Organisational Behaviour	E1.28,E1.30,E1.29, E1.22,E1.24,E1.26, E1.31,E1.27,E1.25, E1.23,E1.16	None	56.62	15.53	0.961	Good
Factor 2: Sprint Management	D1.14,D1.15,D1.16, D1.17,D1.13,D1.18, D1.19,D1.20	None	25.35	13.01	0.953	Good
Factor 3: Relative Advantage	F1.2,F1.1,F1.6, F1.4,F1.3,F1.11, F1.5,F1.15,F1.10	None	52.07	9.13	0.920	Good
Factor 4: Experience	C1.1,C1.2,C1.3, C1.4	None	24.73	4.76	0.888	Good
Factor 5: Training	E1.2,E1.3,E1.4, E1.1	None	22.02	5.70	0.928	Good
Factor 6: Specialisation	D1.11,D1.10,D1.12, D1.9	None	20.73	5.36	0.868	Good
Factor 7: Recognition	E1.5,E1.8,E1.7, E1.6	None	19.70	6.63	0.931	Good
Factor 8: Customer Collaboration	E1.18,E1.19,E1.20, E1.17,E1.11,E1.10	None	32.66	7.66	0.915	Good
Factor 9: Compatibility	F1.13,F1.12,F1.14	None	17.26	3.47	0.854	Good
Factor 10: Over-Engineering	C1.10,C1.11,C1.9, C1.8,C1.12	None	17.93	7.60	0.851	Good
Factor 11:	C1.6,C1.5,C1.7	None	16.42	4.63	0.889	Good

Variables	Items	Items left out	Mean	SD	Cronbach	Reliability
Escalation of Commitment						
Factor 12: Complexity	F1.7,F1.8,F1.9	None	16.38	3.76	0.810	Good
Factor 13: Teamwork	D1.3,D1.2,D1.6, D1.1,D1.8,D1.5, D1.7,D1.4	None	27.17	12.85	0.933	Good
Factor 14: Resource Management	E1.13,E1.14,E1.12, E1.15	None	19.47	5.60	0.804	Good

For the constructs derived from the second order EFA, Cronbach's alpha reliability estimates exceeded 0.80 for responses to "Organisation", and "Technology", indicating good reliability. For constructs "Team" and "Individual" reliability estimates were 0.71 and 0.60 respectively, which indicated acceptable reliability. Table 4.9 reports on the Reliability Estimates, Means, and Standard Deviations. A calculation was done on subsequent factor scores by taking the average of the responses for the reliable factor items.

Table 4.9: Coefficient Alpha Reliability Estimates, Means, Standard Deviations, and Correlations for the Second Order Factors.

Variables	Items	Items left out	Mean	SD	Cronbach	Reliability
Factor 1: Organisation	Organisational Behaviour, Customer Collaboration, Recognition, Resource Management,	None	25.91	5.89	0.877	Good

Variables	Items	Items left out	Mean	SD	Cronbach	Reliability
	Training					
Factor 2: Team	Sprint Management, Teamwork, Over-Engineering	None	10.15	3.78	0.710	Acceptable
Factor 3: Technology	Compatibility, Relative Advantage, Complexity	None	16.99	2.91	0.804	Good
Factor 4: Individual	Escalation of Commitment, Experience	Specialisation out (0.327)	11.65	2.33	0.601	Acceptable

4.7 Data Collection

Before the formal data collection process took place, a pilot study was conducted using a convenience sample of 15 valid respondents. The data collection location was at the Pretoria head office of the Council for Scientific and Industrial Research (CSIR), a non-profit research organisation based in SA. The pilot study led to the revision of the wording and structure of the questionnaire.

For the formal online survey, the author identified different platforms that could assist with the collection of responses from the population sample of SA Scrum practitioners. Initial invites were advertised in the form of pamphlets, distributed during the 2018 Agile Africa Conference, see Appendix C. After that, Scrum practitioners within the author's network were invited to participate through word of mouth, followed shortly after that by posting the invitation on social media platforms, such as Linkedin and Twitter. The methods above did not result in many

responses; the response count was a mere ten completions. The final and most successful method of data collection was by sending the survey invitation via Linkedin's personnel messaging request. The digital survey invitation and questionnaire was created using the Google Forms application, see Appendix D.

The data collection process was scheduled for three months, due to the number of respondents required for the research findings to be generalisable.

4.8 Data Analysis

Data analyses were conducted with the Statistical Package for Social Sciences (SPSS) statistical software program, operating on a Windows 10 operating system.

The calculation of the 14 factor's and the four construct's scores were used to test the propositions. Factor scores were calculated and determined by taking the averages of the items that loaded onto each factor per individual response, providing the distribution of the factors. The MLR analysis statistical technique was used to determine which of the factors had a strong significant linear relationship with Scrum adoption.

4.9 Chapter Summary

This chapter gave an in-depth description of the methodology. The chosen methodology proved to be satisfactory for this study as it enabled the author to collect and analyse the data necessary for meeting the research objectives. The results of the study are presented in tables and graphs in Chapter 5.

CHAPTER 5: RESEARCH RESULTS

Chapter 5 is structured as follows:

5.1 - Introduction

5.2 - Survey Questionnaire Response Statistics

5.3 - Demographics Description

5.4 - Descriptive Statistics of the Factors

5.5 - Statistical Techniques that Answer the Hypotheses

5.6 - Chapter Summary

5.1 Introduction

The previous chapter described the methodology implementation for this research study. It started with the research design and the variable description, followed by the sample population, measuring instrument reliability and validity, and ending off with the data collection and analysis procedures.

This chapter is concerned with the description of the results generated from the analysed data. The research results will allow the author to identify which factors influence the adoption of Scrum by Scrum practitioners within SA organisations. The research hypotheses described in Section 1.4 of Chapter 1 will also be answered using the correlational analysis, and Multiple Linear Regression (MLR) by determining whether the factors had any significant relationship with Scrum adoption.

5.2 Survey Questionnaire Response Statistics

The number of completed survey responses for the survey was 240. Of the 240 completed responses, 207 were valid, resulting in 86% valid responses. The reason for the high percentage of valid responses was due to the questionnaire having screening questions with filters which ended the survey for respondents who did not meet the eligibility requirements. All questions required a response before the respondent could proceed to the next section of the questionnaire. Due to the method of data collection being an online survey questionnaire (see Section 4.7), the author was not able to measure the response rate of completed survey responses against the survey invitations. The reason for the inability to measure the response rate was because the author could not monitor the number of individuals the survey invitations were shared with between Scrum practitioners.

5.2.1 Survey Sample Confidence Intervals

Table 5.1 displays the confidence interval scores for the 14 first order factors with the mean statistic and the 95% confidence interval lower and upper bound, respectively.

Table 5.1: First Order Factors Confidence Interval for Mean Scores.

Factor	Mean	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Experience	6.18	6.01	6.34
Organisational Behaviour	5.17	4.98	5.36
Sprint Management[1]	4.83	4.60	5.05
Relative Advantage	5.79	5.64	5.92
Training	5.50	5.30	5.70
Specialisation	5.18	4.99	5.36
Recognition	4.92	4.69	5.15
Customer Collaboration	5.44	5.26	5.61
Compatibility	5.75	5.59	5.91
Escalation of Commitment	5.47	5.26	5.68

Factor	Mean	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Complexity	5.46	5.28	5.63
Teamwork[1]	4.60	4.38	4.82
Resource Management	4.87	4.67	5.06
Over-Engineering[1]	4.41	4.20	4.62

1=factor's negatively phrased questions were recoded.

Table 5.2 displays the confidence interval scores for the four second order factors with the mean statistic and the 95% confidence interval lower and upper bound, respectively.

Table 5.2: Second Order Factors Confidence Interval for Mean Scores.

Factor	Mean	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Individual[1]	5.61	5.47	5.75
Organisation	5.18	5.02	5.34
Team[1]	4.34	4.20	4.47
Technology	5.67	5.53	5.79

1=factor's negatively phrased questions were recoded.

5.2.2 Testing the Questionnaire Response Data for Normality

A Shapiro Wilk test ($p>0.05$) was done to determine if the adoption scores were approximately normally distributed for each category of the factors. A visual inspection was done on the box plots, histogram, and normal Q-Q plots. Adoption scores were not approximately normally distributed for each category of the factor. Normality was lacking, and therefore non-parametric tests were employed.

5.3 Demographics Description

More than half of the respondents have used Scrum for three or more years, with 55% of all recorded Scrum practitioners falling within the last three categories, see Figure 5.1. Table 5.3 depicts the Scrum usage duration frequencies.

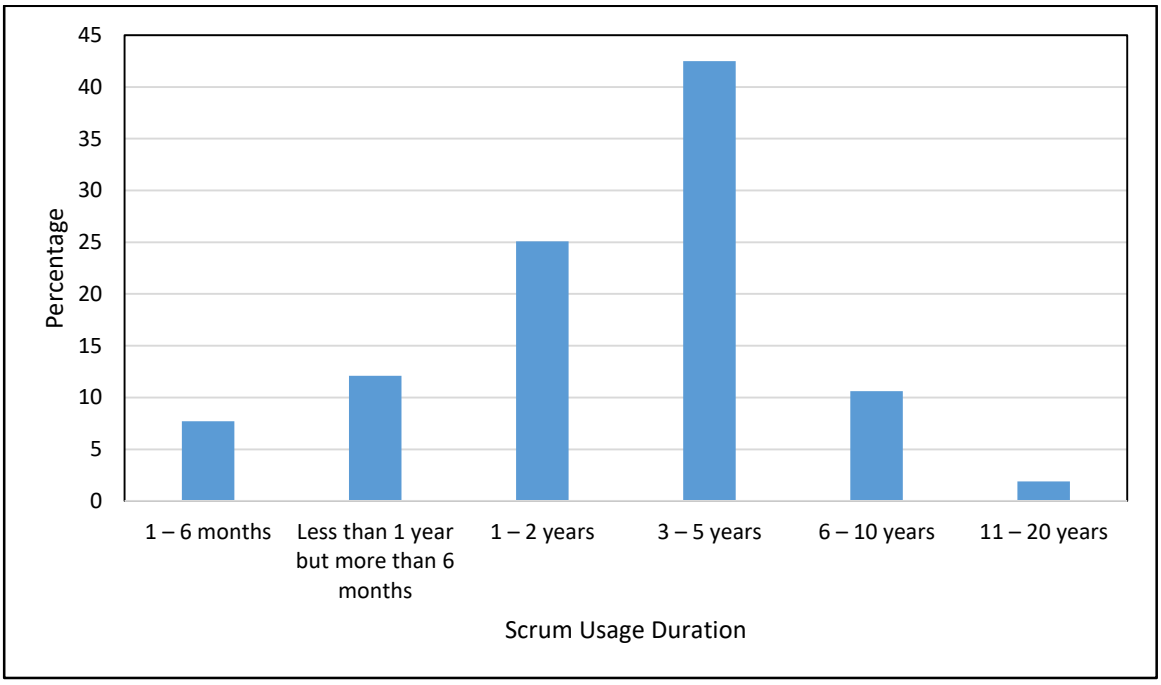


Figure 5.1: Scrum Usage Duration within SA Working Environment.

Table 5.3: Scrum Usage Duration Frequencies.

Scrum Usage Duration	Frequency
1 – 6 months	16
Less than 1 year but more than 6 months	25
1 – 2 years	52
3 – 5 years	88
6 – 10 years	22
11 – 20 years	4
Total	207

N Missing 0, 6 Levels

The majority of the responses came from Scrum practitioners within the 29-38 years age group category with 42.5%, while the 24-28 years age group category was 34.3% of the total sample population (see Figure 5.2). The two age groups had a combined percentage of 76.8%. Table 5.4 displays the age group frequencies.

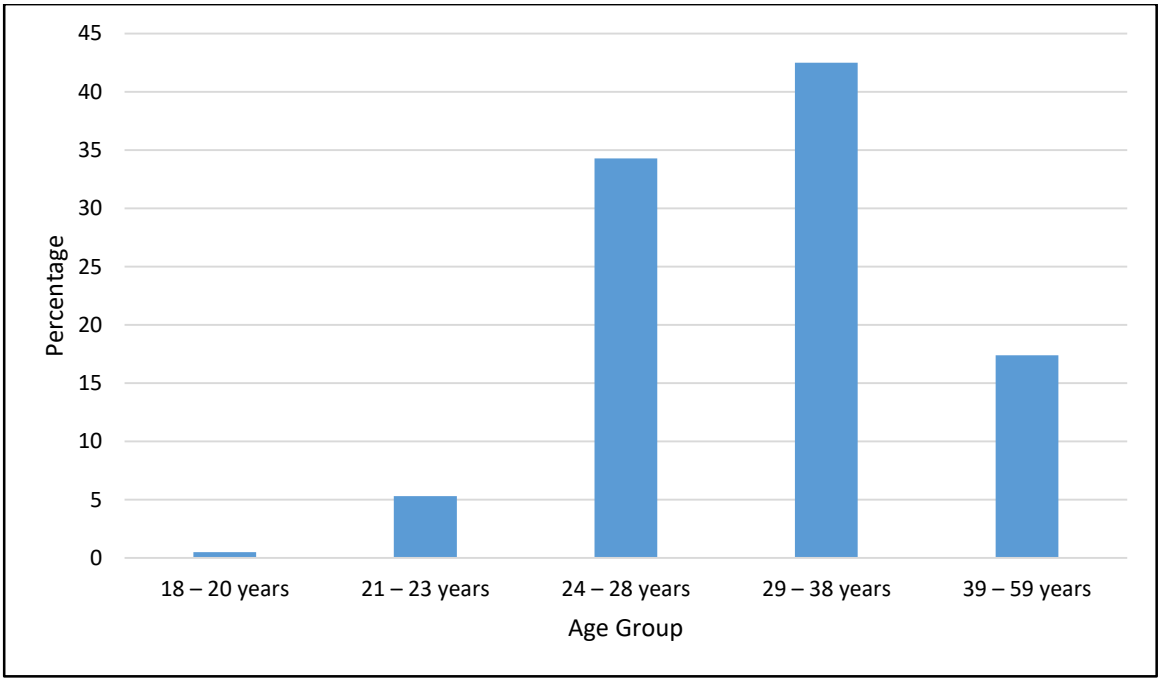


Figure 5.2: Age Group Categories.

Table 5.4: Age Group Frequencies.

Age Group	Frequency
18 – 20 years	1
21 – 23 years	11
24 – 28 years	71
29 – 38 years	88
39 – 59 years	36
Total	207

N Missing 0, 5 Levels

Of the nine provinces in SA, almost all the respondents' primary office locations resided within either Gauteng, Western Cape, or KwaZulu-Natal, with a combined percentage of 93.3% (see Figure 5.3). Table 5.5 displays the frequencies of the primary office location by province.

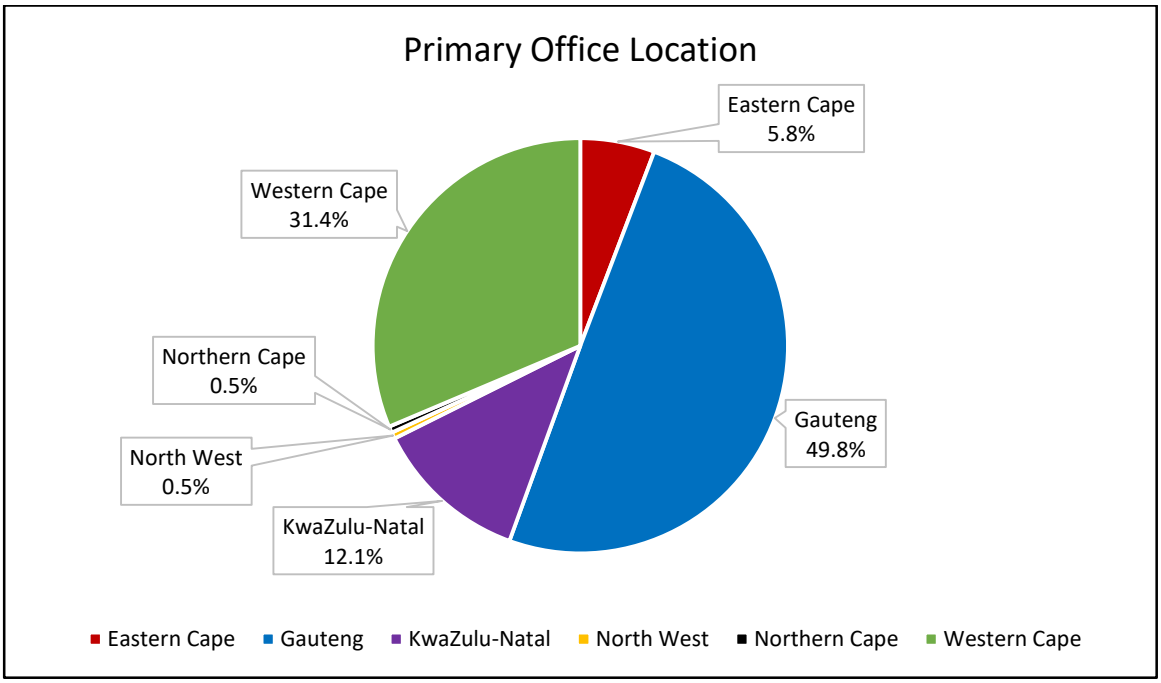


Figure 5.3: Primary Office Location by Province.

Table 5.5: Primary Office Location by Province Frequencies.

Province	Frequency
Eastern Cape	12
Gauteng	103
KwaZulu-Natal	25
North West	1
Northern Cape	1
Western Cape	65
Total	207

N Missing 0, 6 Levels

The Software Developer job title (simultaneously labelled as Software Engineer) was responsible for 57.5% of all responses, see Figure 5.4. The job title labelled "Other", refers to any job title that was not given a category of its own. Examples of such job titles are Editor and Accounting Manager. Table 5.6 displays the frequencies of the job title categories.

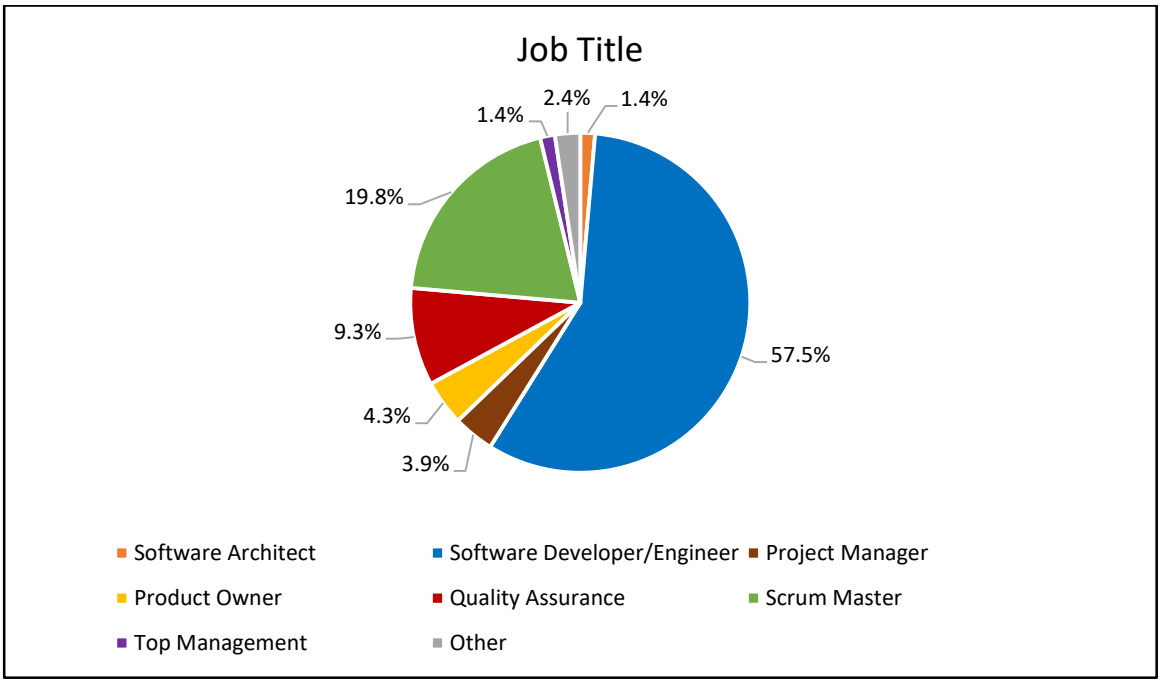


Figure 5.4: Scrum Practitioner Job Title.

Table 5.6: Job Title Frequencies.

Job Title	Frequency
Software Architect	3
Software Developer/Engineer	119
Project Manager	8
Product Owner	9
Quality Assurance	19
Scrum Master	41
Top Management	3
Other	5
Total	207

N Missing 0, 8 Levels

The majority of respondents' work experience fall within the 3-5 years category with 36.7%, followed by 11-20 years' experience with 25.1% (see Figure 5.5). The category with the lowest response count was 1-6 months with three responses (1.4%) out of a total of 207 (see Table 5.7).

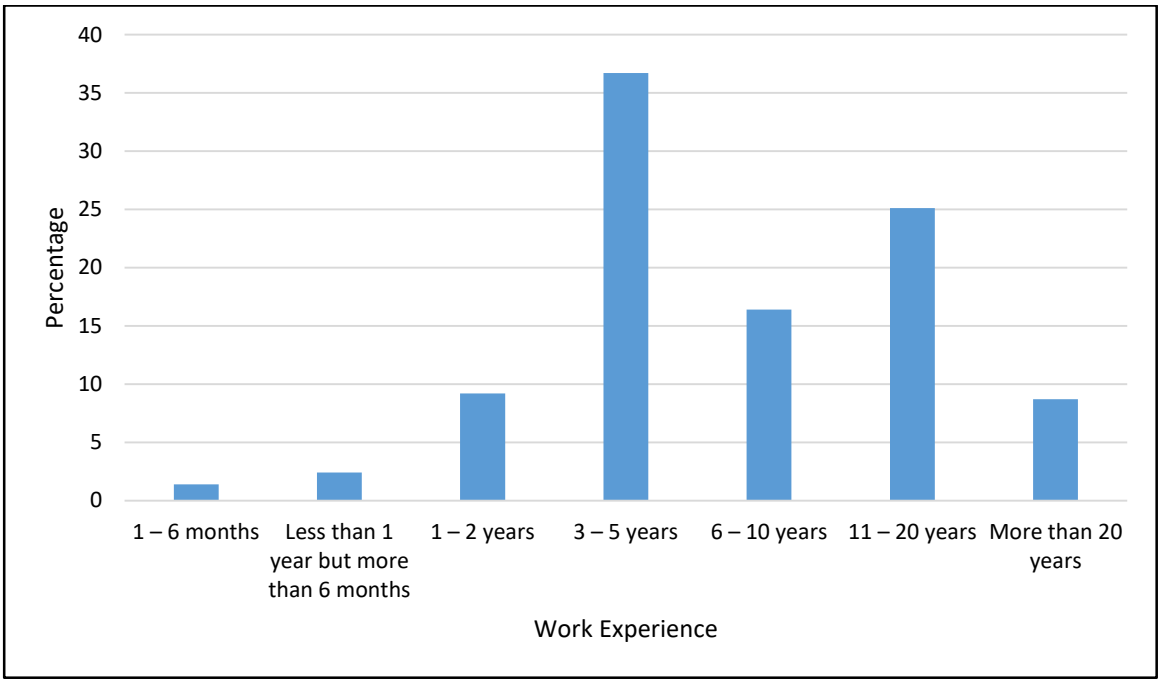


Figure 5.5: Work Experience.

Table 5.7: Work Experience Frequencies.

Work Experience	Frequency
1 – 6 months	3
Less than 1 year but more than 6 months	5
1 – 2 years	19
3 – 5 years	76
6 – 10 years	34
11 – 20 years	52
More than 20 years	18
Total	207

N Missing 0, 7 Levels

The majority of the respondents have spent a relatively short time at their current organisation, with more than 60% having spent less than three years within the organisation (see Figure 5.6). The frequency of the largest category is 1-2 years with 54 (26.1%) responses (see Table 5.8).

The descriptive statistics is to follow in the next section.

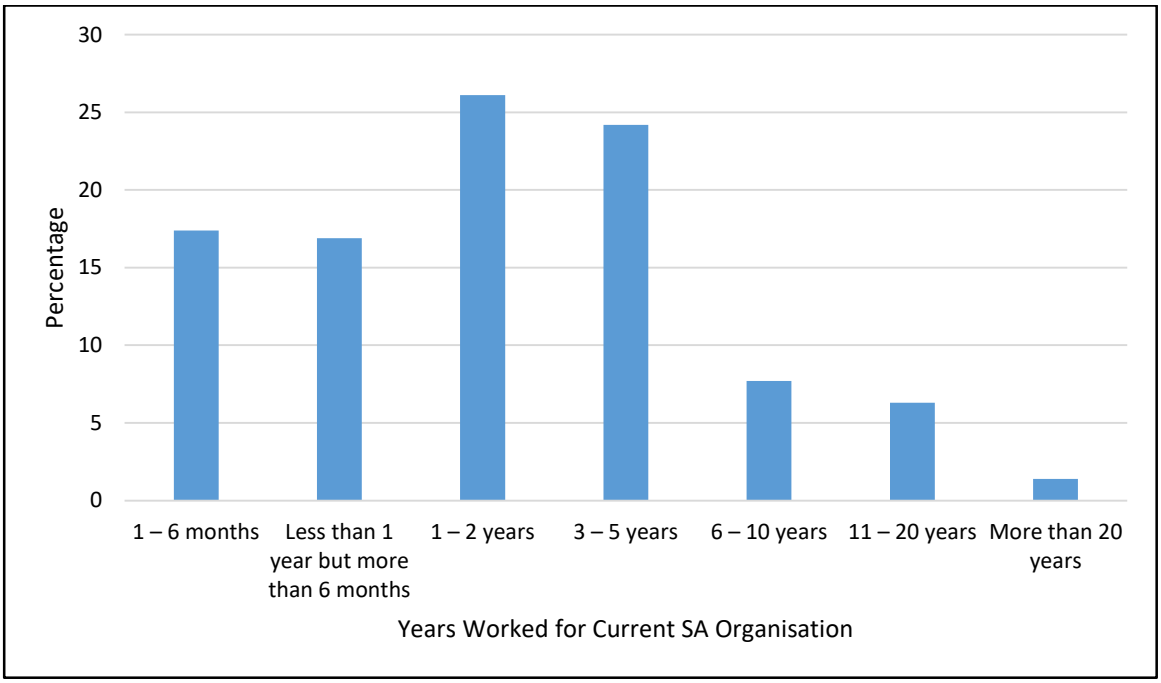


Figure 5.6: Years Worked for Current SA Organisation.

Table 5.8: Years Worked for Organisation Frequencies.

Years Worked for Organisation	Frequency
1 – 6 months	36
Less than 1 year but more than 6 months	35
1 – 2 years	54
3 – 5 years	50
6 – 10 years	16
11 – 20 years	13
More than 20 years	3
Total	207

N Missing 0, 7 Levels

5.4 Descriptive Statistics of the Factors

Descriptive statistics were conducted on the factors to measure the central tendency (mean) and measures of variability (standard deviation).

The mean and standard deviation for the 14 first order factors and four second order factors is displayed in Table 5.9 and Table 5.10 respectively. The total experience measurement of SA Scrum practitioners (n=207) averaged 6.18 (SD=1.19). On average, participants had a high level of agreeableness on experience. Sprint management averaged 4.83 (SD=1.63), suggesting a moderate level of agreeableness on statements related to sprint management.

Table 5.9: Descriptive Statistics for all First Order Factors used in the Research Study.

	Mean	**Std. Deviation**
Experience	6.18	1.19
Organisational Behaviour	5.17	1.41
Sprint Management[1]	4.83	1.63
Relative Advantage	5.79	1.02
Training	5.50	1.43
Specialisation	5.18	1.34
Recognition	4.92	1.66
Customer Collaboration	5.44	1.28
Compatibility	5.75	1.16
Escalation of Commitment	5.47	1.55
Complexity	5.46	1.25
Teamwork[1]	4.60	1.61
Resource Management	4.87	1.40
Over-Engineering[1]	4.41	1.52

1=factor's negatively phrased questions were recoded.

Table 5.10: Descriptive Statistics for all Second Order Factors used in the Research Study.

	Mean	**Std. Deviation**
Individual[1]	5.61	1.02
Organisation	5.18	1.18
Team[1]	4.34	0.97
Technology	5.67	0.97

1=factor's negatively phrased questions were recoded.

5.5 Statistical Techniques that Answer the Hypotheses

5.5.1 Testing the Fourteen First Order Factor Relationship Strength

A correlation matrix was used to test for relationship strength between the different factors. A Spearman correlation analysis was conducted on all the factors as opposed to a Pearson correlation analysis, due to the skewness of the data discovered during the normality tests. Spearman correlation analysis revealed statistically significant correlations for the relationships between adoption and all the factors at the 0.01 level, except for Teamwork which was significant at the 0.05 level (p=0.018), and Over-Engineering with no significance (p=0.514), see Table 5.12. The mapping of the factors to its definitions are displayed in Table 5.11. For legibility reasons, the factor codes with their definitions are added as footnotes to the factor correlations in Table 5.12.

Table 5.11: Mapping of the Factor Codes to its Definitions.

Factor Codes	Factor Definitions
F1	Scrum Adoption
F2	Experience
F3	Organisational Behaviour
F4	Sprint Management[1]
F5	Relative Advantage
F6	Training
F7	Specialisation
F8	Recognition
F9	Customer Collaboration
F10	Compatibility
F11	Escalation of Commitment
F12	Complexity
F13	Teamwork[1]
F14	Resource Management
F15	Over-Engineering[1]

1=factor's negatively phrased questions were recoded.

A discussion of the relationships between the factors and its significance are in the partial results below.

- A significant and positive relationship between Scrum Adoption and Relative Advantage ($r=0.66$, $N=207$, $p<0.001$). The correlation was moderate to strong in strength.
- A significant and positive relationship between Scrum Adoption and Compatibility ($r=0.50$, $N=207$, $p<0.001$). The correlation was moderate in strength.
- A significant and positive relationship between Organisational Behaviour and Training ($r=0.58$, $N=207$, $p<0.001$). The correlation was moderate in strength.
- A significant and positive relationship between Organisational Behaviour and Recognition ($r=0.66$, $N=207$, $p<0.001$). The correlation was moderate to strong in strength.
- A significant and positive relationship between Organisational Behaviour and Customer Collaboration ($r=0.72$, $N=207$, $p<0.001$). The correlation was strong in strength.
- A significant and positive relationship between Compatibility and Relative Advantage ($r=0.64$, $N=207$, $p<0.001$). The correlation was moderate in strength.
- A significant and positive relationship between Training and Recognition ($r=0.65$, $N=207$, $p<0.001$). The correlation was moderate to strong in strength.
- A significant and positive relationship between Training and Customer Collaboration ($r=0.51$, $N=207$, $p<0.001$). The correlation was moderate in strength.
- A significant and positive relationship between Recognition and Customer Collaboration ($r=0.55$, $N=207$, $p<0.001$). The correlation was moderate in strength.
- A significant and positive relationship between Organisational Behaviour and Resource Management ($r=0.64$, $N=207$, $p<0.001$). The correlation was moderate in strength.
- A significant and positive relationship between Sprint Management and Teamwork ($r=0.71$, $N=207$, $p<0.001$). The correlation was strong in strength.
- A significant and positive relationship between Relative Advantage and Complexity ($r=0.51$, $N=207$, $p<0.001$). The correlation was moderate in strength.
- A significant and positive relationship between Training and Resource Management ($r=0.39$, $N=207$, $p<0.001$). The correlation was weak to moderate in strength.
- A significant and positive relationship between Recognition and Resource Management ($r=0.48$, $N=207$, $p<0.001$). The correlation was moderate in strength.

- A significant and positive relationship between Customer Collaboration and Complexity ($r=0.39$, $N=207$, $p<0.001$). The correlation was weak to moderate in strength.
- A significant and positive relationship between Customer Collaboration and Resource Management ($r=0.57$, $N=207$, $p<0.001$). The correlation was moderate in strength.
- A significant and positive relationship between Compatibility and Complexity ($r=0.58$, $N=207$, $p<0.001$). The correlation was moderate in strength.
- A significant and positive relationship between Complexity and Resource Management ($r=0.42$, $N=207$, $p<0.001$). The correlation was moderate in strength.

5.5.2 Testing the Four Second Order Factor Relationship Strength

The author used a correlation matrix to test relationship strength between the four constructs, as well as between the four constructs and the dependent variable. A Spearman correlation analysis was conducted as opposed to a Pearson correlation analysis, due to the skewness of the data discovered during the normality tests. Spearman correlation analysis revealed statistically significant correlations for the relationships between Scrum Adoption and the four constructs at the 0.01 level, see Table 5.13.

A discussion of the relationships between the factors and its significance are in the partial results below.

- A significant and positive relationship between Scrum Adoption and Technology ($r=0.53$, $N=207$, $p<0.001$). The correlation was moderate in strength.
- A significant and positive relationship between Scrum Adoption and Organisation ($r=0.30$, $N=207$, $p<0.001$). The correlation was weak in strength.
- A significant and positive relationship between the Organisation and Individual ($r=0.39$, $N=207$, $p<0.001$). The correlation was weak to moderate in strength.
- A significant and positive relationship between Individual and Technology ($r=0.38$, $N=207$, $p<0.001$). The correlation was weak to moderate in strength.
- A significant and positive relationship between the Organisation and Technology ($r=0.42$, $N=207$, $p<0.001$). The correlation was weak to moderate in strength.

Table 5.12: Correlations between all the Factors used in the Research Study.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15
F1	1.00	.30**	.28**	.30**	.66**	.22**	.23**	.20**	.34**	.50**	.22**	.34**	.16*	.20**	.05
F2	.30**	1.00	.14*	.32**	.29**	.26**	.25**	.19**	.20**	.23**	.27**	.19**	.21**	.06	.09
F3	.28**	.14*	1.00	.25**	.29**	.58**	.24**	.66**	.72**	.27**	.30**	.36**	.16*	.64**	-.18*
F4	.30**	.32**	.25**	1.00	.10	.25**	.01	.09	.26**	.09	.08	.10	.71**	.16*	.26**
F5	.66**	.29**	.29**	.10	1.00	.29**	.27**	.24**	.35**	.64**	.28**	.51**	.01	.24**	-.02
F6	.22**	.26**	.58**	.25**	.29**	1.00	.28**	.65**	.51**	.23**	.21**	.26**	.10	.39**	-.01
F7	.23**	.25**	.24**	-.01	.27**	.28**	1.00	.24**	.31**	.32**	.34**	.31**	-.07	.24**	-.23**
F8	.20**	.19**	.66**	.09	.24**	.65**	.24**	1.00	.55**	.24**	.16*	.34**	.07	.48**	-.09
F9	.34**	.20**	.72**	.26**	.35**	.51**	.31**	.55**	1.00	.29**	.29**	.39**	.11	.57**	-.12
F10	.50**	.23**	.27**	.09	.64**	.23**	.32**	.24**	.29**	1.00	.22**	.58**	.01	.25**	-.04
F11	.22**	.27**	.30**	.08	.28**	.21**	.34**	.16*	.29**	.22**	1.00	.27**	-.02	.30**	-.33**
F12	.34**	.19**	.36**	.10	.51**	.26**	.31**	.34**	.39**	.58**	.27**	1.00	.01	.42**	-.14*
F13	.16*	.21**	.16*	.71**	.01	.10	-.07	.07	.11	.01	-.02	.01	1.00	.13	.28**
F14	.20**	.06	.64**	.16*	.24**	.39**	.24**	.48**	.57**	.25**	.30**	.42**	.13	1.00	-.24**
F15	.05	.09	-.18*	.26**	-.02	-.01	-.23**	-.09	-.12	-.04	-.33**	-.14*	.28**	-.24**	1.00

F1=Scrum Adoption, F2=Experience, F3=Organisational Behaviour, F4=Sprint Management, F5=Relative Advantage, F6=Training, F7=Specialisation, F8=Recognition, F9=Customer Collaboration, F10=Compatibility, F11=Escalation of Commitment, F12=Complexity, F13=Teamwork, F14=Resource Management, F15=Over-Engineering.

N Missing 0

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5.13: Correlations between the Four Constructs and Scrum Adoption.

	Scrum Adoption	Individual	Organisation	Team	Technology
Scrum Adoption	1.00	.29**	.30**	.20**	.53**
Individual[1]	.29**	1.00	.39**	.16*	.38**
Organisation	.30**	.39**	1.00	.25**	.42**
Team[1]	.20**	.16*	.25**	1.00	.07
Technology	.53**	.38**	.42**	.07	1.00

N Missing 0
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
1=factor's negatively phrased questions were recoded.

5.5.3 Testing the Statistical Significance of the Factor Relationship

Before continuing with the regression analysis, the assumptions are first discussed: the assumption of no multicollinearity, the assumption of no autocorrelation of residuals, the assumption of normality of residuals, and the assumptions of linearity and homoscedasticity. After that the regression analysis begins by reporting the results of the 14 factors, followed by the results of the four constructs.

All the Tolerance values were above .01, and all the VIF values were below 10, the assumption of no multicollinearity was met. The Durbin-Watson statistic fell within an expected range, which suggests that the assumption of no autocorrelation of residuals was met. The assumptions of linearity and homoscedasticity were met, because the Scatterplot of standardised residual and standardised predicted value did not curve or funnel out. The normal probability plot of the residuals was approximately linear, which suggests that the assumption of normality of residuals was met. The raw statistics on the regression assumptions are available for perusal in Appendix E, namely meeting the regression assumptions.

For the 14 factors, MLR was conducted to examine whether Over-Engineering, Relative Advantage, Recognition, Experience, Teamwork, Specialisation, Escalation of Commitment, Compatibility, Resource Management, Customer Collaboration, Complexity, Training, Sprint Management, and Organisational Behaviour impact on Scrum adoption. The overall model

(predictors: Over-Engineering, Relative Advantage, Recognition, Experience, Teamwork, Specialisation, Escalation of Commitment, Compatibility, Resource Management, Customer Collaboration, Complexity, Training, Sprint Management, Organisational Behaviour) explained 52.90% of the variance of Scrum Adoption, which was revealed to be statistically significant ($F(14,206)=15.40$, $p<0.0001$). Table 5.14 displays the Anova results, and the model summary is in Table 5.15.

An inspection of the individual predictors of the overall model revealed that Relative Advantage (Beta=0.688, $p<0.0001$), Sprint Management (Beta=0.109, $p<0.05$), and Complexity (Beta=0.041, $p<0.05$) are significant predictors of Scrum Adoption (Table 5.16). Higher levels of Relative Advantage are associated with higher levels of Scrum Adoption, higher levels of Sprint Management are associated with higher levels of Scrum Adoption, and higher levels of Complexity are associated with lower levels of Scrum Adoption.

Table 5.14: Results of ANOVA for Regression of the 14 Factors.

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	107.832	14	7.702	15.395	.000[b]
	Residual	96.063	192	.500		
	Total	203.895	206			

a. Dependent Variable: Scrum Adoption
b. Predictors: (Constant), Over-Engineering, Relative Advantage, Recognition, Experience, Teamwork, Specialisation, Escalation of Commitment, Compatibility, Resource Management, Customer Collaboration, Complexity, Training, Sprint Management, Organisational Behaviour

Table 5.15: Model Summary for Regression of the 14 Factors.

Model Summary[b]								
					Change Statistics			
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2
1	.727[a]	.529	.495	.70734	.529	15.395	14	192

a. Predictors: (Constant), Over-Engineering, Relative Advantage, Recognition, Experience, Teamwork, Specialisation, Escalation of Commitment, Compatibility, Resource Management, Customer Collaboration, Complexity, Training, Sprint Management, Organisational Behaviour
b. Dependent Variable: Scrum Adoption

Table 5.16: Regression Coefficients of the 14 Factors.

Coefficients[a]						
Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.506	.454		1.114	.267
	Experience	-.021	.051	-.026	-.419	.676
	Organisational Behaviour	.000	.062	.000	.003	.998
	Sprint Management[1]	.109	.049	.178	2.239	.026
	Relative Advantage	.688	.068	.702	10.168	.000
	Training	-.031	.052	-.045	-.604	.547
	Specialisation	.004	.042	.006	.103	.918
	Recognition	-.019	.047	-.032	-.410	.682
	Customer Collaboration	.118	.062	.151	1.900	.059
	Compatibility	.085	.058	.099	1.477	.141
	Escalation of Commitment	.011	.041	.018	.280	.780
	Complexity	-.116	.056	-.146	-2.061	.041
	Teamwork[1]	-.013	.047	-.021	-.279	.781
	Resource Management	-.042	.051	-.059	-.830	.407
	Over-Engineering[1]	.004	.039	.005	.092	.927

a. Dependent Variable: Scrum Adoption
1=factor's negatively phrased questions were recoded.

For the four constructs, MLR was conducted to examine whether Individual, Technology, Team, and Organisation impact on Scrum Adoption. The overall model explained 33.40% of the variance in Scrum Adoption, which was revealed to be statistically significant ($F(4,206)=25.34$, $p<0.0001$), see the Anova results in Table 5.17, and the model summary in Table 5.18. An inspection of the individual predictors revealed that Technology (Beta=0.580, $p<0.0001$) and

Team (Beta=0.126, $p<0.05$) are significant predictors of Scrum Adoption (see Table 5.19). Higher levels of Technology are associated with higher levels of Scrum Adoption, and higher levels of Team are associated with higher levels of Scrum Adoption.

Table 5.17: Results of ANOVA for Regression of the 4 Constructs.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	68.127	4	17.032	25.340	.000[b]
	Residual	135.768	202	.672		
	Total	203.895	206			

a. Dependent Variable: Scrum Adoption
b. Predictors: (Constant), Team, Technology, Individual, Organisation

Table 5.18: Model Summary for Regression of the 4 Constructs.

Model Summary[b]								
					Change Statistics			
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2
1	.578[a]	.334	.321	.81983	.334	25.340	4	202

a. Predictors: (Constant), Team, Technology, Individual, Organisation
b. Dependent Variable: Scrum Adoption

Table 5.19: Regression Coefficients of the 4 Constructs.

Coefficients[a]						
		Unstandardised Coefficients		Standardised Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.197	.445		2.692	.008
	Team[1]	.126	.062	.123	2.040	.043
	Technology	.580	.064	.566	9.009	.000
	Individual[1]	.016	.053	.019	.303	.763
	Organisation	-.033	.054	-.039	-.616	.539

a. Dependent Variable: Scrum Adoption
1=factor's negatively phrased questions were recoded.

5.6 Chapter Summary

This chapter presented the findings of this research study beginning with the response rate, confidence intervals, and the assumptions of the statistical techniques. After that the sample was described followed by the mean and standard deviation in the descriptive statistics.

To answer the research hypotheses, the Spearman correlation analysis was conducted on all the factors for significance. All the factors except for one (Over-Engineering) had correlational significance with Scrum Adoption (dependent factor). The Multiple Linear Regression (MLR) results for the 14 first order factors identified three significant factors (Sprint Management, Relative Advantage, and Complexity) contributing toward Scrum Adoption, and the four second order factors identified two significant constructs (Team, and Technology) contributing toward Scrum Adoption.

The next chapter discusses the critical evaluation of this research studies research contribution by describing the several iterations of the Scrum Adoption Challenges Conceptual Framework (SACCF). Thereafter follows a detailed discussion of the empirical findings, ending the chapter with the chapter summary.

CHAPTER 6: CRITICAL EVALUATION OF THE RESEARCH CONTRIBUTION

Chapter 6 is structured as follows:

6.1 - Introduction

6.2 - Scrum Adoption Challenges Conceptual Framework

6.3 - Discussion of the Empirical Findings

6.4 - Chapter Summary

6.1 Introduction

The journey from Chapter 2 up to and including Chapter 5 allowed the author to give the reader a full overview of the research performed in this dissertation. The research topic of factors that contribute significantly to Scrum adoption as perceived by Scrum practitioners working within SA organisations originated when the author initially attempted to identify a research gap of how software project success could improve using Agile methodologies. As a result, the first publication into this field, by the author, was the first iteration of the Conceptual Framework (CF), which the author identified as the Scrum Adoption Challenges Detection Model (SACDM) (Hanslo & Mnkandla 2018).

This chapter is constructed as follows: Section 6.2 revisits the Scrum Adoption Challenges Conceptual Framework (SACCF) providing the rationale behind the CF iterations. Section 6.3 discusses the empirical findings derived from the research results. Section 6.4 concludes this chapter by providing a summary of the dissertation contributions, as well as the critical evaluation of the contributions.

6.2 Scrum Adoption Challenges Conceptual Framework

Chapter 3 focused on the proposal of the SACCF. The SACCF was proposed as a custom model developed from the Diffusion of Innovation (DOI) theory. The DOI theory formed the theoretical base, while the four constructs used in the SACCF was adapted from the study of innovation adoption by Sultan and Chan (2000).

The reason for using a custom model to evaluate Scrum adoption was due to the Scrum methodology as a social phenomenon, which required the model to include behavioural aspects, which was lacking in the DOI theory, as mentioned in Subsection 3.3.3 of Chapter 3. The Conceptual Framework (CF) in this research study was, therefore, a synthesis of research conducted on the DOI theoretical model, Agile and Scrum adoption, Software Development Methodology (SDM) adoption, and Information System (IS) literature.

The purpose of the CF was to allow the author to empirically evaluate which of the Scrum and Agile adoption challenges derived from the narrative review contribute towards Scrum adoption. Having developed the SACCF, the author realised that this framework served a dual purpose, by allowing the author to evaluate the adoption challenges, as well as allow other researchers to use the SACCF to conduct adoption research of their own. What might change are the factors included in the SACCF.

Figure 6.1 depicts the first iteration of the CF taken from the author's published conference paper titled Scrum Adoption Challenges Detection Model: SACDM (Hanslo & Mnkandla 2018: 955). The figure is repeated here for ease of discussion.

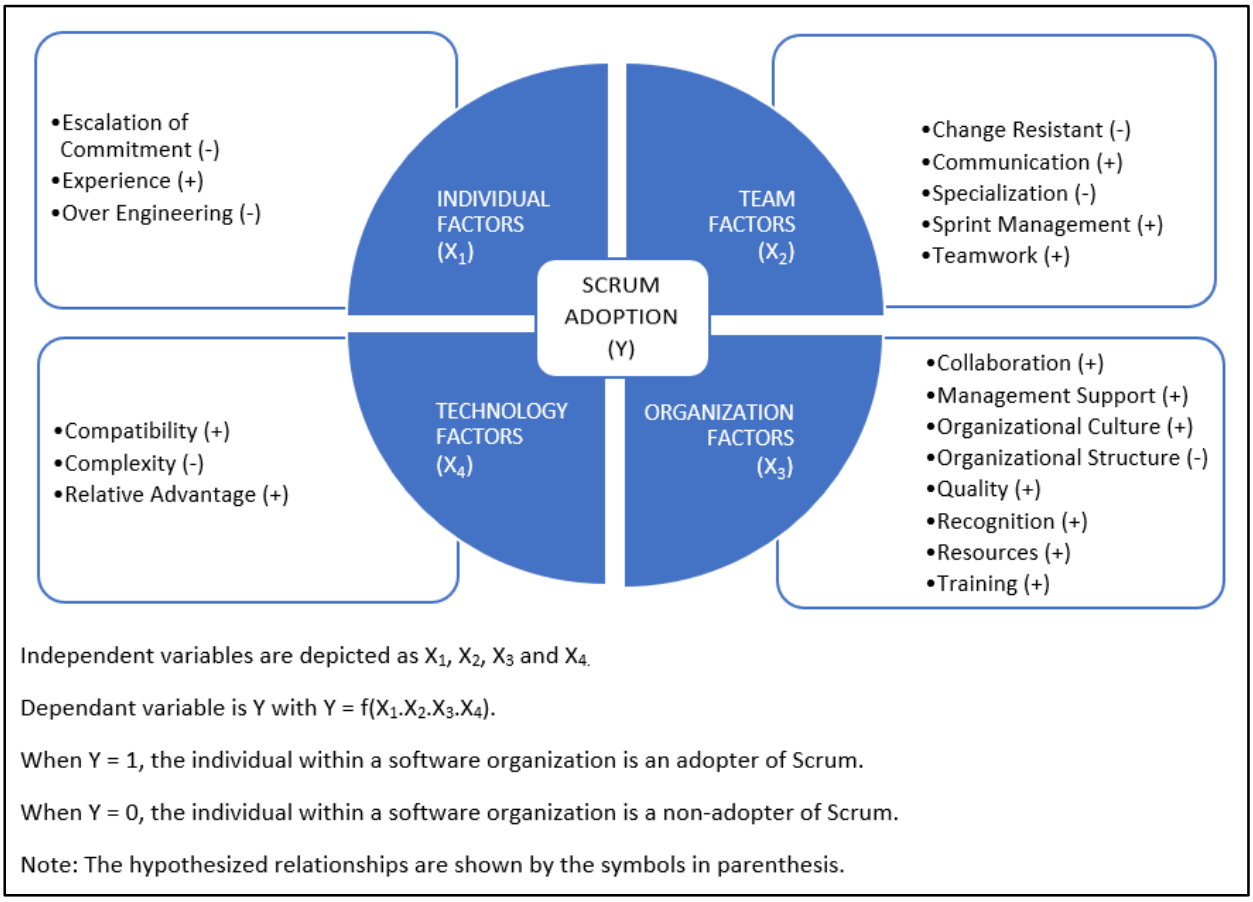


Figure 6.1: The First Iteration of the Conceptual Framework (Source: Hanslo & Mnkandla 2018).

The first iteration of the CF used discriminant analysis and logistic regression as the statistical analysis techniques. These two techniques were used to validate the factor classification, and to conduct predictive analysis on the relationship between the dependent and independent variables, respectively. While the first iteration of the CF was a potentially good fit for the author's dissertation, it did come with its drawbacks. Firstly, when the author conducted the literature review, no CF or model on Scrum adoption challenges existed. The lack of an existing CF meant that a more explorative statistical analysis method was ideal for this study. Secondly, for the author to conduct predictive analysis using logistic regression, the assumption of a large sample size had to be met. This assumption would require a much larger sample dataset than the achieved 207 valid responses. The author estimated that if logistic regression were implemented, the minimum amount of responses required would have been 475 valid responses (y=19*10/.4). Due to the lack of a large sample size, and the need to conduct statistical analysis of an

exploratory nature, the author made use of the Exploratory Factor Analysis (EFA) statistical technique, and Multiple Linear Regression (MLR) predictive analysis.

The second iteration took the limitations above and requirements into consideration and have included EFA and MLR into the conceptual model. Section 3.5 of Chapter 3 depicts the updated SACCF. The second iteration of the CF was therefore used as the conceptual model to evaluate whether the predicted factors and constructs are a good fit for the empirical study and whether the factors have a significant relationship with Scrum adoption. The testing and validation of the SACCF were done using a survey questionnaire.

The third and final iteration of the CF was developed based on the analysed survey results. Therefore, because the final iteration of the SACCF depends on the research findings, it was decided by the author to discuss it in Section 6.3 during the discussion of the empirical findings.

The following section discusses the empirical findings.

6.3 Discussion of the Empirical Findings

6.3.1 Introduction

The general objective investigated the factors that have a significant relationship with Scrum adoption as perceived by Scrum practitioners working within SA organisations. Some conclusions are drawn from the results presented in Chapter 5 which pertains to the general objective.

The author is aware that the gathered sample data is relatively small (n=207). However, the author thinks that the results still provide findings and insights that are generalisable to Scrum adoption challenges encountered by Scrum practitioners.

The following subsection discusses the changes to the factors of the CF and hypotheses testing as a result of the questionnaire item factor loadings.

6.3.2 The Conceptual Framework Factor Loadings affecting the Hypotheses Testing

It is important to note that initially, the author wanted to test 19 research hypotheses, based on the 19 independent variables of the SACCF. However, during the validation of the scale, the EFA applied to the questionnaire items extracted 14 factors. The loading of the questionnaire items to new factors meant that the initial predicted model based on the literature review had to be evaluated. The author inspected the questionnaire items with its commonalities and corresponding factor loadings and discovered that the initial 19 independent variables loaded correctly into the 14 factors. The new factor loadings, therefore, made logical sense. In Table 6.1 the 19 hypothesised factors are mapped to the newly validated 14 factors.

Table 6.1: Mapping of the initial 19 Factors to the newly Validated 14 Factors.

Fourteen Factors Loaded from Questionnaire Items	**Nineteen Hypothesised Factors based on Literature Review**
Organisational Behaviour	➢ Organisational Structure ➢ Management Support ➢ Organisational Culture
Sprint Management	➢ Sprint Management ➢ Change Resistance
Relative Advantage	➢ Relative Advantage
Experience	➢ Experience
Training	➢ Training
Specialisation	➢ Specialisation
Recognition	➢ Recognition
Customer Collaboration	➢ Collaboration ➢ Quality
Compatibility	➢ Compatibility
Over-Engineering	➢ Over-Engineering
Escalation of Commitment	➢ Escalation of Commitment
Complexity	➢ Complexity
Teamwork	➢ Teamwork ➢ Communication

Fourteen Factors Loaded from Questionnaire Items	Nineteen Hypothesised Factors based on Literature Review
Resource Management	➢ Resources

While most of the mappings in Table 6.1 is self-explanatory, the author would like to explain four factors which have more than one variable. The four factors are:

- Organisational Behaviour
- Sprint Management
- Customer Collaboration
- Teamwork

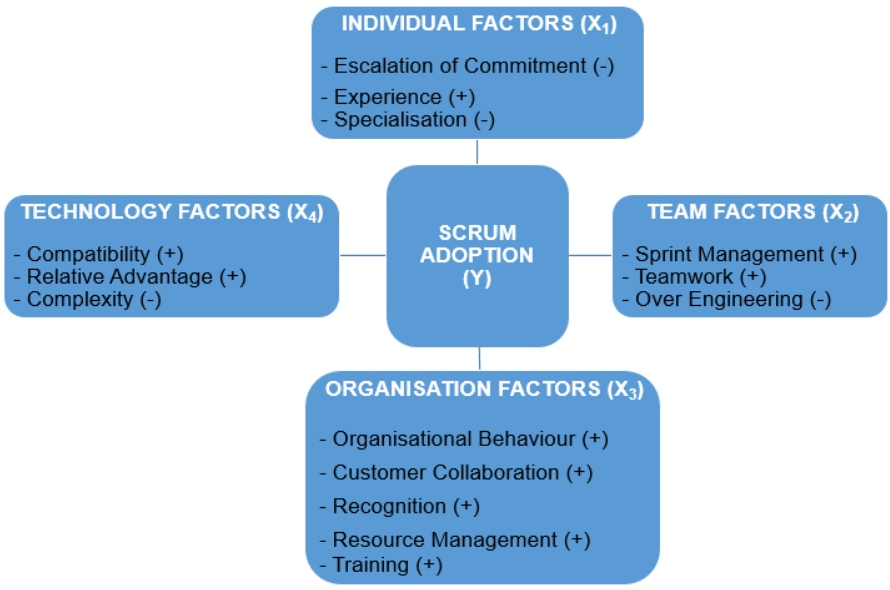
The term Organisation Behaviour (OB) is defined as the actions and attitudes of individuals that work within an organisation. OB is, therefore, the study of human behaviour within the organisational settings, how human behaviour interacts with the organisation, and the organisation itself (George et al. 2005: 1). George et al. (2005: 9), also states that how managers manage others is significantly affected by OB. Due to the explanation above of OB, it made sense to the author to load organisational structure, management support, and organisational culture as a single factor under the heading OB.

The loading of sprint management and change resistance into the single factor also made logical sense to the author. Firstly, sprint management as explained in Subsection 3.4.4 of Chapter 3, is a time-boxed activity which manages and monitors the sprint. Therefore, the Scrum practitioners under most circumstances will be performing their tasks within a Scrum sprint. However, the author is aware that this may not be the case for every task performed. As a result, if the team is resisting change, it would be displayed when the change is requested or performed during the Scrum sprint. To re-iterate the fourth value of Agile development, which is "responding to change over following a plan", it is therefore fitting that sprint management and change resistance loaded as the sprint management factor, because change resistance by default is a part of the sprint management cycle.

The loading of collaboration and quality into the customer collaboration factor has been an easy decision for the author to make. Customer collaboration entails working closely with the client to deliver what was requested at the quality expected. The last merged factor loading was teamwork which consists of teamwork and communication. This factor loading was a simple decision for the author, and in hindsight, the author realises that the two had to be grouped from the beginning. The reason for the statement above is because teamwork requires individuals to work together to complete tasks, and communication is a critical component to complete sprint tasks within the team. An important note to the reader is that the resources factor has been renamed to resource management because resource shortage or surplus is a management related concern.

Figure 6.2 displays the third and final iteration of the CF. As is evident from the diagram, the conceptual model is much more refined than the previous two versions. Specialisation which was previously under the team construct is now under the individual construct, and over-engineering which was an individual factor is now a team factor. The reason for these realignments is because specialisation or specialised skills can be narrowed down to the individual level. While over-engineering within a Scrum team environment, if encountered and allowed, means that the team was not vigilant enough during all their communication sessions to identify when an individual was doing more than what was required. The author was quite pleased that even after the questionnaire items second order factor loadings, the four constructs of the SACCF, namely organisation factors, team factors, technology factors, and individual factors were retained (see Table 4.7).

While the author is pleased with the validated CF factors and constructs, the effect it has on the evaluation of the initial hypotheses is of concern. The author, however, believes that while the factors have changed from 19 to 14, it should not affect the hypotheses testing. The reason why the author believes this to be the case was evident in Table 6.1. In the table, the reader will note that none of the initial 19 factors are removed from the SACCF. Those that are no longer a discrete factor have merged with other factors. However, based on the factor loadings and the opinion of the author, these merged factors make sense. As a result, the author strongly feels that the initial 19 hypotheses can tested as individual hypotheses. However, the reader should note that some of the initial factors are loaded into a new factor as mentioned above.



Factors are depicted as X_1, X_2, X_3 and X_4.

Dependent variable is Y with $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \epsilon$.

Note: The hypothesised relationships between the independent variables and the dependent variable are shown by the symbols in parenthesis.

Figure 6.2: Final Iteration of the Conceptual Framework.

The next subsection discusses the research findings concerning hypotheses testing.

6.3.3 Answering the Research Hypotheses

In the next subsection, the author discusses the statistical findings, and whether the author can accept or reject the alternative hypotheses, as stated in Chapter 1. The author will separate this subsection by the outcomes of the 19 hypothesised statements, discussing the findings individually.

a) Escalation of Commitment

Escalation of commitment was hypothesised to have a significant linear (negative correlation) relationship with Scrum adoption. The research by Stray et al. (2012: 153) indicates the alarming effect of this factor on software project outcomes, with up to 40% of projects experiencing it. Chapter 5 reports on the correlational significance between escalation of commitment and Scrum adoption. However, the regression results, on the other hand, tell a

story of no significance with Scrum adoption. The coefficients from the MLR dictates that not only is there no significance with Scrum adoption, but the directionality of the relationship is positive. The author is still of the opinion that escalation of commitment has an adverse effect on Scrum, in general. The author can, therefore, reject the alternative hypothesis by stating that there is no significant linear relationship between escalation of commitment and Scrum adoption.

b) Experience

The lack of experience was included as a potential barrier to Scrum adoption by the author based on the literature review of Agile challenges (Hardgrave et al. 2003: 136). Mastery of skills contributes to the performance of developers (Brooks 1980: 209), which the author believes would allow the Scrum practitioner to have less of a challenge in understanding and adopting a project management method such as Scrum. While there is a weak correlation with Scrum adoption, there is, unfortunately, no significant linear relationship. The author can, therefore, reject the alternative hypothesis by stating that there is no significant linear relationship between experience and Scrum adoption.

c) Over-Engineering

Over-Engineered solutions, as defined within the literature review is often due to lack of communication, and limited domain knowledge by the team executing the task (Santos et al. 2011: 292). The reader should note that over-engineering as a factor has moved to the team construct from the individual construct of the SACCF, as explained in Subsection 6.3.2 of this chapter. While over-engineering may contribute as a challenge during a Scrum sprint, the author thinks that it does not necessarily result in a significant linear relationship with Scrum adoption. The author felt it would be ideal to include a factor to test than to exclude a potentially significant factor. From the findings, it has been concluded that over-engineering has no correlational and no significant linear relationship with Scrum adoption. It is the only factor to display such results. The author can, therefore, reject the alternative hypothesis by stating that there is no significant linear relationship between over-engineering and Scrum adoption.

d) Communication

The author thinks that communication is arguably one of the most crucial skills to have as an individual, team or organisation. The author has witnessed the benefits in the quality of product and service delivery when effective communication is implemented. The literature identified communication as being one of the key challenges (see Table 3.2). The statistical analysis results in Chapter 5 suggested that while communication is a prominent adoption challenge, it is not statistically significant with Scrum adoption. Therefore, while communication has been loaded into the teamwork factor as mentioned earlier in this chapter, the author can still conclude based on the research results that communication does not have a significant linear (positive correlation) relationship with Scrum adoption. Communication, therefore, has a very weak correlation with Scrum adoption (at the 0.05 level). The author is somewhat surprised by this finding and would, therefore, be interested to see if this finding persists in further Scrum adoption studies. Nonetheless, the author can reject the alternative hypothesis by stating that there is no significant linear relationship between communication and Scrum adoption.

e) Teamwork

Working together to complete tasks, and achieving a common goal is what most organisations should be striving for. In the author's opinion, the higher the team cohesion, the higher the probability of successful project outcomes. The author anticipated that the teamwork factor, which was a factor loading of the initial teamwork and communication factors, would have had a significant linear relationship with Scrum adoption. The reason for this view was merely because teamwork and communication are essential aspects of any Agile method (Noruwana & Tanner 2012: 42). To the author's surprise, teamwork has no significant correlation and no significant linear relationship to speak of, with a p-value=0.781. The author can, therefore, reject the alternative hypothesis as there is no significant linear relationship between teamwork and Scrum adoption.

f) Specialisation

As mentioned earlier, due to the questionnaire item factor loadings, specialisation has been grouped under the individual factors construct. With hindsight, the author completely agrees with this amendment, as skill levels can and should be evaluated at the individual level,

allowing for a more refined analysis of the factor. The reason for the inclusion of specialisation as a Scrum adoption challenge is that specialist roles in the Scrum team could hinder the successful completion of a Scrum sprint due to a lack of overlapping skills (Fægri 2010: 28-29). The correlation between specialisation and Scrum adoption is significant at the 0.01 level. However, the linear relationship is far from significant. The author can, therefore, reject the alternative hypothesis as there is no significant linear relationship between specialisation and Scrum adoption.

g) Sprint Management

This factor is part of the team construct and is generally considered an essential aspect of the sprint cycle. It is of the utmost importance that a professional Scrum practitioner in the form of a Scrum Master is always appointed within organisations to facilitate the Scrum framework and sprint process. A mismanaged sprint can lead to other problems for the Scrum team (Tanner & Khalane 2013: 2, 4). The author thinks that sprint management should play an essential role in Scrum adoption by Scrum practitioners. Based on the research findings, sprint management has a significant correlation with adoption at the 0.01 level. A significant (positive) linear relationship with adoption was recorded, with a p-value<0.05 and the t-statistic of 2.24. What this means is that an increase in sprint management relates to an increase in Scrum adoption. The author accepts the alternative hypothesis of a significant linear relationship between sprint management and Scrum adoption.

h) Change Resistance

Change resistance as mentioned earlier in this chapter has loaded with sprint management. The author thinks that this newly loaded factor makes sense, a change affecting the Scrum team usually affects their sprint planning and management. However, because of the new factor loading, it is not definitive as to whether change resistance on its own has a significant linear relationship with Scrum adoption. As a result, the author would like the reader to be cognizant of this discrepancy. Change resistance carries equal weighting under the sprint management factor loading. The narrative review (see Table 3.2) suggests that change resistance is a re-occurring adoption challenge experienced both globally and within SA. Therefore, change resistance within the newly loaded sprint management factor does significantly contribute towards Scrum adoption. The author, accepts the alternative

hypothesis in stating that there is a significant linear relationship between change resistance and Scrum adoption. An increase in change resistance results in a decrease in Scrum adoption.

i) Training

The author thinks training is essential for developing and upskilling an organisation's employees. The narrative review of global Agile adoption challenges demonstrated training, knowledge, and learning as challenges to overcome (see Table 2.4) while within SA training was an insignificant challenge (see Table 2.9). Identified as an organisational construct within this dissertation, the training we are referring to are those that assist the organisation in achieving their goals and objectives. The author thinks that training could contribute toward the adoption of Scrum, as the author perceives training as a method of lessening the challenges during task completion. The research results indicate that while training has a weak significant correlation with Scrum adoption (at the 0.01 level), it does not have a significant relationship with adoption. The author rejects the alternative hypothesis as there is no significant linear relationship between training and Scrum adoption.

j) Recognition

This factor is under the organisational construct (see Figure 6.2). The author thinks that the lack of recognition given to the individual affects an individual's willingness to attempt and complete tasks. The lack of recognition is recorded as affecting the productivity levels of the individual (Bishop 1987). The author, therefore, believes that lack of individual recognition could affect the individual's willingness to adopt any innovation, not just Scrum, especially if the individual is not interested in the innovation. Based on the empirical findings, recognition has a weak correlation with adoption (significant at the 0.01 level), as well as having no significant linear relationship. The author rejects the alternative hypothesis because there is no significant linear relationship between recognition and Scrum adoption.

k) Quality

As mentioned previously in Section 3.4 of Chapter 3, quality in this research study refers to the quality of software delivered to meet client and business expectations. As the client is the receiver of the level of quality produced by the organisation, it is loaded with collaboration to

form the customer collaboration factor. In the author's opinion, the quality delivered during the project milestones can determine whether the project succeeds or fails. The narrative review identified quality as an infrequent adoption challenge (see Table 3.2). Software quality, on the other hand, is a prominent global Scrum adoption benefit (see Table 2.7), suggesting to the author that quality software is a result of Scrum adoption. The empirical findings suggest that there is a significant correlation between customer collaboration and Scrum adoption. What is interesting in the findings is that customer collaboration has just missed the $p<0.05$ significance level, with a p-value=0.059. The author would like to see more research being conducted with customer collaboration as an independent variable of Scrum and Agile adoption, to identify if there is any consistency when compared to this study's findings. The author can, therefore, reject the alternative hypothesis as there is no significant linear relationship between quality and Scrum adoption.

l) Resources

For an organisation to output products and services, it requires resources. The author believes that without a sufficient supply of resources, for example, due to lack of capital, lack of strategic direction, and inadequate resource management the organisation might incur losses and setbacks. The narrative review identified a lack of documentation, budget constraint, high management overhead, and lack of infrastructure and tools as resource challenges for Scrum and Agile adoption (see Table 3.2). During the second iteration of the SACCF the resources factor has been renamed to resource management. However the definition remains the same. Resource management based on the findings have no significant linear relationship while correlation is significant. The author is not surprised with the result as it is hard to believe that poor resource management on its own will cause an individual to reject a framework such as Scrum. The author rejects the alternative hypothesis as there is no significant linear relationship between resources and Scrum adoption.

m) Collaboration

The research findings for customer collaboration is no different to most of the factors discussed thus far. As mentioned under the quality factor, customer collaboration which includes quality has missed the significant linear relationship by a narrow margin, and the author would like to see this factor evaluated in future research studies. The narrative review

identified customer collaboration and lack of business, customer, and product owner involvement during Agile adoption as one of the biggest challenges experienced globally (see Table 2.5, Table 2.6, and Table 3.2). However, for this dissertation it can be concluded that collaboration has no significant linear relationship with Scrum adoption.

n) Management Support

As the definition for Organisational Behaviour (OB) was provided earlier in Subsection 6.3.2, the author will, therefore, refrain from reiterating it. The statement by Sultan and Chan (2000: 111-112) as mentioned in Chapter 3 was that management support has a direct effect on innovation adoption. The author is aware that not all innovations are equal, for example, Scrum requires customer collaboration, iterative and incremental development, while object-oriented programming as an innovation might not. Therefore, the author acknowledges that the statement by Sultan and Chan (2000) might not necessarily hold in the Scrum adoption results of this dissertation. As a newly loaded factor with organisational structure and organisation culture, management support has an insignificant relationship with adoption. The author was under the impression that OB would have displayed findings of significance. The author would like to see this factor evaluated again in other Scrum adoption studies with a larger population sample size. The author rejects the alternative hypothesis as there is no significant linear relationship between management support and Scrum adoption.

o) Organisational Culture

The author appreciates the importance of an organisational culture that promotes innovative thinking as innovation adoption and implementation often depends on the culture of the organisation (Mohan and Ahlemann 2013: 836). The narrative review identified organisational culture as one of the most common Scrum and Agile adoption challenges globally (see Table 2.4, 2.5, 2.6 and 3.2), however, as mentioned by Hoda et al. (2011a: 84), research on organisational culture of Scrum teams are limited. Although OB has a significant correlation with Scrum adoption, it has no relationship of linear significance. The author thinks the reason for the lack of linear significance could be because teams implement Scrum even when culture is a problem, whereby teams continue to adopt Scrum regardless of the challenges faced. The author can, therefore, reject the alternative hypothesis by stating that there is no significant linear relationship between organisational culture and Scrum adoption.

p) Organisational Structure

The author predicted that the lack of a hierarchical organisational structure improves the innovation's adoption rates. The author's sentiment is aligned with previous literature studies as mentioned in the Sultan and Chan (2000: 110-111) study. However, when we look at the research findings for Scrum as the innovation, the correlation significance is weak at 0.28 (at the 0.01 level), and the MLR significance is non-existent ($p=0.998$). The author can, therefore, reject the alternative hypothesis by stating that there is no significant linear relationship between organisational structure and Scrum adoption.

q) Relative Advantage

Relative advantage as discussed in Chapter 3 is one of the five innovation characteristics of the Diffusion of Innovation (DOI) theory. Rogers (2003: 27) went on to say that relative advantage and compatibility are the two characteristics of innovation which contribute the most toward adoption. The author agrees that relative advantage is an essential contributor toward innovation adoption, as suggested in the literature review. The author was pleased to discover that the research results confirmed the author's sentiment. The benefit of this finding strengthens the rationale to include relative advantage in other innovation adoption studies. Relative advantage has a moderate to strong correlation with adoption, significant at the 0.01 level. The coefficients taken from the regression model indicate a significant linear relationship ($p<0.001$) with a t-statistic of 10.168. The author can, therefore, accept the alternative hypothesis by stating that there is a significant linear relationship between relative advantage and Scrum adoption. An increase in relative advantage results in an increase in Scrum adoption.

r) Complexity

While complexity according to Kishore and McLean (2007: 756) is not one of the two characteristics which contribute the most toward innovation adoption, it has a relatively consistent relationship with adoption behaviour. The author agrees that complexity affects an individual's decision to adopt and implement innovation. As a software engineer, the author often adhered to a design rule which is known as the KISS (Keep It Simple, Stupid) principle. The author is therefore of the opinion that the lightweight and simple to understand Scrum framework, contributes positively toward adoption. When looking at the research findings,

the correlation with Scrum adoption is significant at the 0.01 level, with a significant linear relationship at the 0.05 level, with the t-statistic of -2.061. The author can, therefore, accept the alternative hypothesis by stating that there is a significant linear relationship between complexity and Scrum adoption. An increase in complexity results in a decrease in Scrum adoption.

s) Compatibility

As mentioned earlier, compatibility is one of the two most important contributors toward innovation adoption (Rogers 2003: 27). However, research also indicates that the five characteristics of innovation adoption display signs of flexibility (Sultan & Chan 2000: 107). What this suggests is that compatibility's significance is dependent on numerous factors, which include conditions such as the individual's stage of adoption, the individual's experience, and the type of innovation adopted. While compatibility has displayed a consistent relationship with adoption in other innovation research, the findings in this dissertation differ. The author believed the result might be due to poorly constructed questions related to the compatibility factor; however after going through the questions, it does not indicate that this statement holds. Another suggestion by the author for the inconsistency in findings was because the decision to adopt Scrum often does not depend on the individual but the team or organisation. What this suggests is that while the individual does not perceive Scrum to be compatible with them, they still end up adopting it. Compatibility has a moderate correlation with Scrum adoption ($p<0.01$) with an insignificant linear relationship with $p=0.141$. The author rejects the alternative hypothesis as there is no significant linear relationship between compatibility and Scrum adoption.

Now that the author has answered the research hypotheses, four of the initial 19 factors were revealed as having a significant linear relationship with Scrum adoption. The four factors are relative advantage, complexity, change resistance, and sprint management. Factors that came close to having a significant relationship with Scrum adoption was customer collaboration with $p=0.059$. Because of the new factor loadings sprint management and change resistance loaded onto sprint management, as mentioned earlier. Figure 6.3 displays a parsimonious model of all the significant factors and their hypothesised relationship with Scrum adoption in parenthesis, with sprint management referring to the newly loaded sprint management factor.

The following section concludes this chapter.

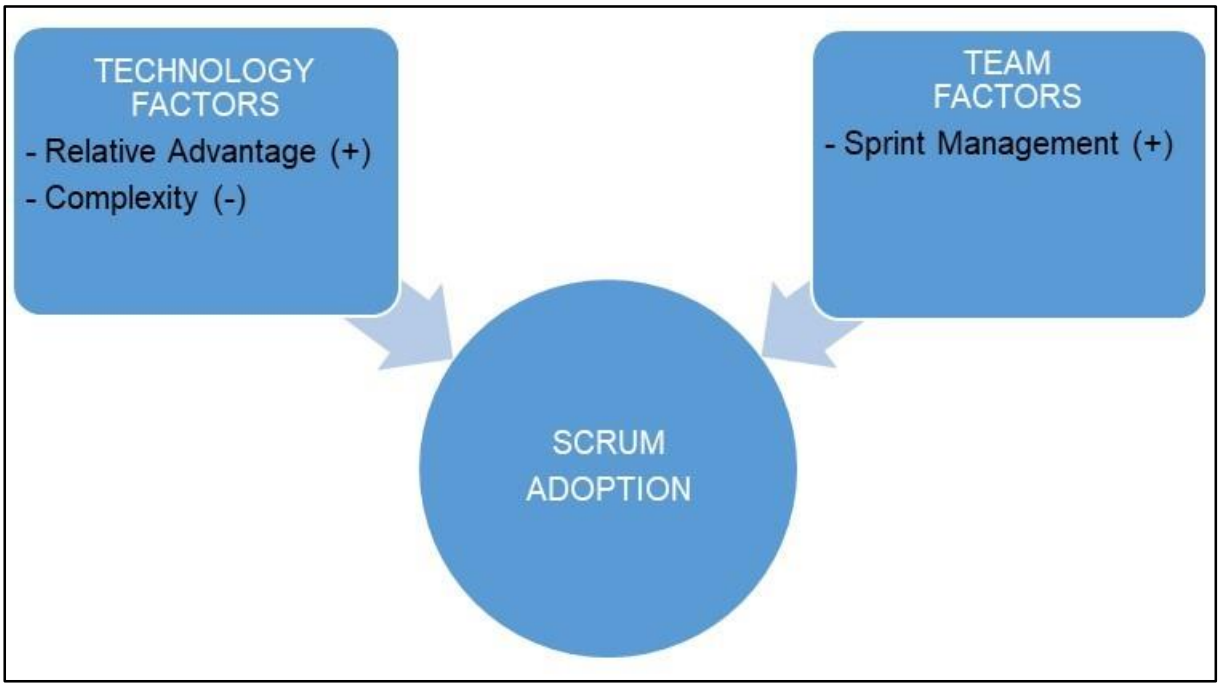


Figure 6.3: Scrum Adoption Parsimonious Model.

6.4 Chapter Summary

This chapter revisited all the contributions made by this dissertation and critically evaluated each contribution. This chapter was divided into two main sections with each contribution discussed in its section. Table 6.2 provides a summary of the contribution's advantages and disadvantages, and how they add value to the greater body of knowledge on Scrum adoption research.

Table 6.2: Summary of the Critical Evaluation of Contributions.

Contribution	Advantages	Disadvantages
Scrum Adoption Challenges Conceptual Framework (SACCF)	The conceptual framework can be used by other researchers to identify Scrum challenges contributing toward Scrum adoption.	The author is aware that this dissertation is the first research study to evaluate the SACCF. Although the author went through three iterations of the framework, the author recommends additional empirical studies using the framework.
Empirical findings on Scrum adoption's relationship with factors of significance	The findings of factors which have a significant linear relationship with Scrum adoption adds to the greater body of knowledge on Scrum research. The findings not only confirmed the importance of the innovation's relative advantage and complexity during the adoption stage, but sprint management was also revealed as a new factor to have a significant relationship with Scrum adoption.	The author is not aware of any disadvantages the empirical findings of factor significance on Scrum adoption may entail.

The author thinks that both contributions are of great value to the field of Scrum adoption. The next and final chapter, Chapter 7, concludes this dissertation by revisiting the research problem and objectives, discussing how this dissertation addressed the problem and objectives; and thereafter follows the author's concluding remarks. Finally, Chapter 7 ends with a discussion on recommendations and potential future research.

CHAPTER 7: CONCLUSION

Chapter 7 is structured as follows:

7.1 - Introduction

7.2 - Revisitng the Problem Statement and Research Objectives

7.3 - Concluding Remarks

7.4 - Recommendations

7.5 - Future Research

7.6 - Chapter Summary

7.1 Introduction

The preceding chapter discussed the empirical findings of this study concerning the research objectives. This chapter concludes the dissertation. The general objective of this study was to investigate the factors that have a significant linear relationship with Scrum adoption as perceived by Scrum practitioners working within SA organisations. The proposed method to achieve this objective was not as straight-forward as initially envisioned by the author. The reason for the author's sentiment is because of the lack of existing Scrum adoption research within SA, and the lack of quantitative research on the phenomenon.

For the author to successfully meet the objectives as discussed in Chapter 1, the author began this dissertation by introducing the reader to the existing literature on Agile and Scrum adoption.

Chapter 2 focused on eliciting the existing Scrum and Agile adoption challenges experienced globally and within the SA context. Because most of the previous research implemented qualitative methods, the author had to consolidate the Scrum and Agile adoption challenges

before the execution of any quantitative analysis. The author, therefore, performed a narrative review to extract and synthesise the existing research data on Scrum and Agile adoption challenges.

Chapter 3 introduced the reader to the Scrum Adoption Challenges Conceptual Framework (SACCF). The SACCF allowed the author to evaluate the research hypotheses. As a result, the SACCF categorised the factors which are hypothesised to have a significant relationship with Scrum adoption into four constructs. The SACCF went through three iterations which resulted in a more refined Conceptual Framework (CF).

Chapter 4 discussed the research methodology and the analysis techniques to be used to meet the objectives of this study.

Chapter 5 presented the research findings derived from the online survey questionnaire's response data.

Chapter 6 critically evaluated all the research contributions which include an in-depth discussion on the research findings, followed by a discussion on the advantages and disadvantages of each of the contributions.

This final chapter concludes the dissertation by revisiting the problem statement and evaluating the extent to which the stated objectives have been met (see Section 7.2). Section 7.3 provides the concluding remarks of the dissertation's findings. Section 7.4 gives recommendations, and Section 7.5 provide input for future research. Section 7.6 concludes this chapter and the dissertation.

7.2 Revisiting the Problem Statement and Research Objectives

This dissertation started with a research problem that *no quantitative study that examines the relationships among the major factors that contribute to the adoption of Scrum as perceived by Scrum practitioners within SA organisations exists*. Addressing the research problem was not straightforward, which resulted in the split of the problem into smaller sub-problems.

The following sub-problems were identified and addressed before the over-arching research problem could be solved.

- At the time the author conducted the literature review, there was very little research conducted on Scrum adoption challenges with the exacerbation of the problem within SA.

- Of the research conducted on Scrum and Agile adoption challenges, most research was conducted using qualitative methods. As a result, there was a need for a quantitative empirical study.

- The author is not aware of any systematic or narrative review on Scrum adoption challenges within the research field. As a result, the author had to conduct a narrative review to extract and synthesise existing Scrum and Agile adoption challenges.

- No conceptual model depicts all the factors which potentially influences Scrum adoption, according to a standardised consolidation of current challenges derived from a narrative or systematic review.

The dissertation therefore first addressed the sub-problems above before the author could address the main problem of the absence of a quantitative study to examine the relationships among the major factors that contribute to the adoption of Scrum as perceived by Scrum practitioners within SA organisations. In order to address all of these problems, the author identified research objectives which this dissertation aimed to achieve. As a result, the author split the research objectives into a general objective, and specific objectives.

The general objective of this dissertation was to investigate the factors that have a significant linear relationship with Scrum adoption as perceived by Scrum practitioners working within SA organisations.

The specific objectives of this dissertation were firstly to provide a generalised conceptual model based on an empirically constructed understanding of the factors that are important to the

adoption of Scrum within organisations. Secondly, to create a consolidated definition of potential Scrum adoption challenges based on a narrative review. Thirdly, to add and grow the research field of Scrum by improving the body of knowledge on Scrum adoption challenges.

The following section provides the reader with the concluding remarks on the findings this research study has made to the field of Scrum adoption.

7.3 Concluding Remarks

This study aimed to contribute to the field of Scrum adoption by investigating the factors which have a significant relationship with Scrum adoption. Early in the research study, it was discovered by the author that this dissertation would need to explore a synthesised set of problems within the field of Scrum adoption to meet the general objective. Due to this requirement, the research study addressed formal definitions of Scrum challenges derived from a narrative review, and the SACCF was used to test the significance of Scrum adoption challenges.

The narrative review was used to consolidate the Scrum adoption challenges experienced within the existing literature. From the findings, the author was able to identify the challenges based on frequency, percentage, and rank. The review resulted in a synthesised list of 19 Scrum and Agile adoption challenges. The author used the 19 challenges as the independent variables of the CF.

The CF was developed to investigate the factors that influence Scrum adoption as perceived by Scrum practitioners working within SA organisations. The SACCF utilised as a CF was required to identify factors that had a significant relationship with Scrum adoption. The 19 challenges were used as the factors to test and evaluate Scrum adoption. The 19 factors were separated into four constructs. Based on the factors, the constructs were labelled as individual factors, team factors, organisation factors, and technology factors, respectively. The SACCF went through three iterations summarised as follows:

- The first iteration of the SACCF was a model that was based entirely on a theory derived from secondary sources.
- The second iteration of the SACCF, improved on the first one, by changing the statistical analysis methods used to evaluate the factors within the model. This

iteration came about due to the questionnaire (scale) design and which statistical techniques would best answer the general research objective.

- The third and final iteration of the SACCF, improving on the second one, was developed as a result of the empirical research findings of the questionnaire item's factor loadings.

The findings of the Exploratory Factor Analysis (EFA) applied to the scale resulted in the newly validated 14 factors from the initial 19 factors. The 14 factors went through a second order EFA resulting in the four constructs. Based on the findings of this study, the SACCF is a valid and reliable CF.

The results of the validity and reliability of the CF allowed the author to continue with the statistical analysis of the questionnaire responses. The findings derived after applying Spearman correlation analysis and Multiple Linear Regression (MLR), revealed that three of the 14 factors have a statistically significant relationship with Scrum adoption. The three factors are sprint management, complexity, and relative advantage. Based on the findings, the dissertation has added results of significance both to Scrum adoption research and to the greater body of knowledge on the Agile philosophy.

The next section discusses the recommendations made by the author.

7.4 Recommendations

The findings from this study add value to organisations practising Scrum. Based on the empirical findings, the following are the recommendations:

The literature and this dissertation confirm the importance of the innovation's technical characteristics, namely, relative advantage and complexity. This study, however, also found new insights into Scrum adoption and its challenges as perceived by the individual Scrum practitioner. Hence, this study suggests that:

- Organisations that are in the adoption stage of Scrum should take cognisance of the findings in this research study, especially the discovery of sprint management having a significant linear relationship with Scrum adoption.

- Organisations should look to increase their Scrum adoption success prospects by implementing strategies which take significant factors into consideration.

The following section discusses the future research.

7.5 Future Research

Considering the significant role Scrum plays within the Agile software development environment, researchers and practitioners should continuously explore Scrum adoption research and its challenges. Due to the limited scope of this study, the author would like to see additional research on the topic in the following areas:

- Researchers should conduct a systematic review of the Scrum adoption challenges experienced by existing Scrum practitioners. The author thinks that this research could increase the validity and reliability of the Scrum challenges and the factor loadings included in the CF.

- While the SACCF was able to confirm factors of significance influencing Scrum adoption, the author would like additional research on the topic to make use of a much larger population sample to improve the generalisability of the findings.

- For the author's doctorate, there is a consideration to develop an Artificial Intelligence (AI) machine learning model. The development of a logistic regression model could allow the author to predict whether an organisation would be successful or unsuccessful at adopting and using the innovation, based on the organisation's current practices. The predictive analysis is achieved by comparing the test data of the organisation to the trained data model derived from the population sample.

The last section of this chapter concludes this dissertation.

7.6 Chapter Summary

Scrum and Agile software development, including Scrum adoption, is a growing phenomenon. The research conducted in this dissertation contributes both towards Agile development practice knowledge and Scrum adoption. The study explored and proposed consolidation of Scrum and Agile challenges, a CF, and the evaluation of the CF using quantitative methods and techniques. The primary objective of this study was only with regards to the investigation of factors that have a significant linear relationship with Scrum adoption as perceived by Scrum practitioners working within SA organisations. The author believes there is significant room for improvement in all the other specific objectives.

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APPENDICES

Appendix A - Operationalisation of Variables

Table A1: Operationalisation of Variables.

Variables	Statements	Operationalisation
Individual Factors		
Experience	During your working career, you were able to acquire or be trained in more than one skill. During your working career, you were able to work on more than one project. During your working career, you were able to work in more than one team. During your working career, you have noticed an improvement in your work performance levels.	Mean of four items
Escalation of Commitment	You should persist with a software development problem until you can provide the solution. You should persist with a software development problem with all the effort it requires to provide the solution. You should persist with a software development problem until the planned solution has been completed. Changing the method to resolve a software development problem should be the sole responsibility of the individual providing the solution.	Mean of four items

Variables	Statements	Operationalisation
Over-Engineering	You should add additional software code to the software project if the client does not realise the necessity thereof. You should add additional software code to the software project if the team is unaware of the importance thereof. You should add additional software code to the software project in the absence of technical leadership. You should add additional software to the software project for future scalability.	Mean of four items
Team Factors		
Communication	There is a general lack of communication within the software project team. The behaviour of individuals within the team negatively affects communication. The attitudes of individuals within the team negatively affects communication. The cultural diversity within the team negatively affects communication.	Mean of four items
Teamwork	Individuals struggle to work together as a team to complete tasks. Team members struggle with tasks due to a lack of teamwork.	Mean of four items

Variables	Statements	Operationalisation
	Team members struggle to help each other. Team members struggle to guide each other.	
Specialisation	Individuals within the team have specialist skills. Tasks are assigned to individuals based on their proficiencies. Tasks are assigned to individuals based on their expertise. Individuals within the team hold specialist roles.	Mean of four items
Sprint Management	The sprint is badly managed. The Scrum rules within the sprint are badly implemented. The Scrum roles within the sprint are badly assigned. The Scrum events within the sprint are badly executed.	Mean of four items
Change Resistance	The team sees change as problematic. The team sees change as undesirable. Team members are not willing to consider different ideas or opinions. Individuals within the team are reluctant to try new things.	Mean of four items
Organisation Factors		
Training	The organisation, in general, provides training opportunities for its employees.	Mean of four items

Variables	Statements	Operationalisation
	Training, in general, is encouraged within the company. Acquiring knowledge through training is seen as contributing to the organisation's objectives. Acquiring knowledge through training is seen as contributing to the individual's growth within the organisation.	
Recognition	The organisation has an employee recognition process. The organisation provides recognition at the team level. The organisation provides recognition at the individual level. Employee excellence is rewarded.	Mean of four items
Quality	The software organisation has quality control measures in place for software development. The correctness of the product is shaped by the alignment of the project with the business requirements. The alignment of the project shapes the correctness of the product with the client expectations. Dedicated employees responsible for the task oversees quality assurance.	Mean of four items
Resources	Labour resources within the organisation are enough for the completion of tasks.	Mean of four items

Variables	Statements	Operationalisation
	Non-labour resources within the organisation are enough for the completion of tasks. Resources are quickly added to projects when needed. The organisation's management manages the resources well.	
Collaboration	The client is seen as part of the project team. The organisation regularly includes the client in project related communication. The organisation regularly includes the client in project related decision making. The organisation's product is aligned with client requirements.	Mean of four items
Management Support	Management is open to innovation. Management sees mistakes as part of the learning process. The organisation has managers that encourage investigating innovations that improve productivity.	Mean of three items
Organisational Culture	The company culture promotes employee happiness. The company culture promotes innovative thinking. Team members are given the liberty to have their thoughts about project related tasks.	Mean of four items

Variables	Statements	Operationalisation
	The company encourages the sharing of ideas amongst teams.	
Organisational Structure	The company structure is flexible with few activities which govern how individuals within roles are coordinated. The company structure is flexible with few activities which govern how procedures are administered. The organisation has an open environment. The organisation has an integrated environment.	Mean of four items
Technology Factors		
Relative Advantage	Scrum improves software quality. The use of Scrum contributes to teamwork. Scrum shortens the time delay in the development process of a product. Scrum improves individuals' motivation towards task completion. Scrum improves project management. Scrum contributes towards effective problem-solving.	Mean of six items
Complexity	Scrum is easy to follow. Scrum is simple to understand. Scrum is easy to master. Scrum has several artifacts, roles and events, which are clear and descriptive.	Mean of four items

Variables	Statements	Operationalisation
Compatibility	The Scrum methodology is suitable for managing software development projects. Scrum can be adapted on a project complexity basis. Scrum can be adapted on a project size basis. Scrum is flexible as a methodology. All roles, events and artifacts of Scrum are necessary.	Mean of five items
Adoption Factor		
Scrum Adoption	As an individual, you have chosen to adopt Scrum for project related tasks. The most recent South African team you worked with where Scrum was used, adopted Scrum to complete project related tasks. The most recent South African organisation you worked for where Scrum was used, adopted Scrum as one of the Agile methodologies to complete project related tasks.	Mean of three items

Appendix B - Survey Questionnaire Design

ADOPTION CHALLENGES OF THE SCRUM AGILE SOFTWARE DEVELOPMENT METHODOLOGY IN SOUTH AFRICA

A study to describe the current scrum adoption challenges experienced by individuals within South African (SA) software organisations.

SECTION A: Screening questions

This section consists of single response questions.

A1. Are you currently working in South Africa?

- **Single selection required.**

Yes	-1	→ **Continue**
No	-2	→ **End online survey**

A2. How many years have you been using Scrum within a South African working environment?

- **Provide rough estimate (single selection required).**

0 months	-1 → **End online survey**
1 – 6 months	-2 → **Continue (for codes 2 - 8)**
Less than 1 year but more than 6 months	-3
1 – 2 years	-4
3 – 5 years	-5
6 – 10 years	-6
11 – 20 years	-7
More than 20 years	-8

A3. Could you please select your appropriate age group?

- **Single selection required.**

Under 18	-01	→ **End online survey**
18 – 20 years	-02	→ **Continue (for codes 02 - 06)**
21 – 23 years	-03	
24 – 28 years	-04	
29 – 38 years	-05	

39 – 59 years -06

60 and over -07 → **End online survey**

SECTION B: Demographic questions

This section consists of single response questions.

B1. With your most recent use of Scrum in which province was the office where you spend most of your working hours?

- **Single selection required**.

Eastern Cape -1

Free State -2

Gauteng -3

KwaZulu-Natal -4

Limpopo -5

Mpumalanga -6

North West -7

Northern Cape -8

Western Cape -9

B2. With your most recent use of Scrum in South Africa, what was your job title?

- **Single selection required.**

Software Architect -01

Software Developer/Engineer -02

Project Manager -03

Product Owner -04

Quality Assurance -05

Scrum Master -06

Top Management -07

Other (please specify) -99

.....

B3. How many years of work experience do you have in total (this includes non-Scrum related work experience)?

- **Single selection required.**

1 – 6 months -1

Less than 1 year but more than 6 months -2

1 – 2 years -3

3 – 5 years -4

6 – 10 years -5

11 – 20 years -6

More than 20 years -7

B4. With your most recent use of Scrum, how many years have you been working for the South African organisation?

- **Single selection required.**

1 – 6 months -1

Less than 1 year but more than 6 months -2

1 – 2 years -3

3 – 5 years -4

6 – 10 years -5

11 – 20 years -6

More than 20 years -7

SECTION C: Individual factors contributing to Scrum adoption challenges

C1. For each of the questions below, please provide your personal view. Indicate your level of agreement by choosing the appropriate answer where 1 strongly disagrees and 7 strongly agrees.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Some what agree	Agree	Strongly agree
C1.1 During your working career, you were able to acquire or be trained in more than one skill. **experience**							
C1.2 During your working career, you were able to work on							

more than one project. **experience**							
C1.3 During your working career, you were able to work in more than one team. **experience**							
C1.4 During your working career, you have noticed an improvement in your work performance levels. **experience**							
C1.5 You should persist with a software development problem until you can provide the solution. **escalation of commitment**							
C1.6 You should persist with a software development problem with all the effort it requires to provide the solution. **escalation of commitment**							
C1.7 You should persist with a software development problem until the planned solution has been completed. **escalation of commitment**							

C1.8 Changing the method to resolve a software development problem should be the sole responsibility of the individual providing the solution. **escalation of commitment**							
C1.9 You should add additional software code to the software project if the client does not realise the necessity thereof. **over-engineering**							
C1.10 You should add additional software code to the software project if the team is unaware of the importance thereof. **over-engineering**							
C1.11 You should add additional software code to the software project in the absence of technical leadership. **over-engineering**							
C1.12 You should add additional software to the software project for future scalability. **over-engineering**							

SECTION D: Team factors contributing towards Scrum adoption challenges

This section is concerned with the most recent South African team you worked within which you were part of the Scrum team. Indicate your level of agreement by choosing the appropriate answer where 1 strongly disagrees and 7 strongly agrees.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Some what agree	Agree	Strongly agree
D1.1 There is a general lack of communication within the software project team. **communication**							
D1.2 The behaviour of individuals within the team negatively affects communication. **communication**							
D1.3 The attitudes of individuals within the team negatively affects communication. **communication**							
D1.4 The cultural diversity within the team negatively affects communication. **communication**							
D1.5 Individuals struggle to work together as a team to complete tasks. **teamwork**							
D1.6 Team members struggle with tasks due							

to lack of teamwork. **teamwork**							
D1.7 Team members struggle to help each other. **teamwork**							
D1.8 Team members struggle to guide each other. **teamwork**							
D1.9 Individuals within the team have specialist skills. **specialisation**							
D1.10 Tasks are assigned to individuals based on their proficiencies. **specialisation**							
D1.11 Tasks are assigned to individuals based on their expertise. **specialisation**							
D1.12 Individuals within the team hold specialist roles. **specialisation**							
D1.13 The sprint is badly managed. **sprint management**							
D1.14 The Scrum rules within the sprint are badly implemented. **sprint management**							

D1.15 The Scrum roles within the sprint are badly assigned. **sprint management**							
D1.16 The Scrum events within the sprint are badly executed. **sprint management**							
D1.17 The team sees change as problematic. **change resistance**							
D1.18 The team sees change as undesirable. **change resistance**							
D1.19 Team members are not willing to consider different ideas or opinions. **change resistance**							
D1.20 Individuals within the team are reluctant to try new things. **change resistance**							

SECTION E: Organisational factors contributing to Scrum adoption challenges

This section is concerned with the most recent South African organisation you worked for in which you were part of the Scrum team. Indicate your level of agreement by choosing the appropriate answer where 1 strongly disagrees and 7 strongly agrees.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Some what agree	Agree	Strongly agree
E1.1 The organisation, in general, provides							

training opportunities for its employees. **training**							
E1.2 Training, in general, is encouraged within the company. **training**							
E1.3 Acquiring knowledge through training is seen as contributing to the organisation's objectives. **training**							
E1.4 Acquiring knowledge through training is seen as contributing to the individual's growth within the organisation. **training**							
E1.5 The organisation has an employee recognition process. **recognition**							
E1.6 The organisation provides recognition at the team level. **recognition**							
E1.7 The organisation provides recognition at the individual level. **recognition**							

E1.8 Employee excellence is rewarded. **recognition**							
E1.9 The software organisation has quality control measures in place for software development. **quality**							
E1.10 The correctness of the product is shaped by the alignment of the project with the business requirements. **quality**							
E1.11 The correctness of the product is shaped by the alignment of the project with the client expectations. **quality**							
E1.12 Dedicated employees responsible for the task oversees quality assurance. **quality**							
E1.13 Labour resources within the organisation are enough for the completion of tasks. **resources**							

E1.14 Non-labour resources within the organisation are enough for the completion of tasks. **resources**							
E1.15 Resources are quickly added to projects when needed. **resources**							
E1.16 The resources are well managed by the organisation's management. **resources**							
E1.17 The client is seen as part of the project team. **collaboration**							
E1.18 The organisation regularly includes the client in project related communication. **collaboration**							
E1.19 The organisation regularly includes the client in project related decision making. **collaboration**							
E1.20 The organisation's product is aligned with the client requirements. **collaboration**							

E1.21 Management is open to innovation. **management support**							
E1.22 Management sees mistakes as part of the learning process. **management support**							
E1.23 The organisation has managers that encourage investigating innovations that improve productivity. **management support**							
E1.24 The company culture promotes employee happiness. **organisational culture**							
E1.25 The company culture promotes innovative thinking. **organisational culture**							
E1.26 Team members are given the liberty to have their thoughts about project related tasks. **organisational culture**							
E1.27 The company encourages the sharing of ideas amongst							

teams. **organisational culture**							
E1.28 The company structure is flexible with few activities which govern how individuals within roles are coordinated. **organisational structure**							
E1.29 The company structure is flexible with few activities which govern how procedures are administered. **organisational structure**							
E1.30 The organisation has an open environment. **organisational structure**							
E1.31 The organisation has an integrated environment. **organisational structure**							

SECTION F: Technology factors contributing to Scrum adoption challenges

In this section, your view on the advantages and disadvantages of Scrum is required. Please provide responses based on your experience using Scrum. Indicate your level of agreement by choosing the appropriate answer where 1 strongly disagrees and 7 strongly agrees.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Some what agree	Agree	Strongly agree
F1.1 Scrum improves software quality. **relative advantage**							
F1.2 The use of Scrum contributes toward teamwork. **relative advantage**							
F1.3 Scrum shortens the time delay in the development process of a product. **relative advantage**							
F1.4 Scrum improves the individuals' motivation towards task completion. **relative advantage**							
F1.5 Scrum improves project management. **relative advantage**							
F1.6 Scrum contributes towards effective problem-solving. **relative advantage**							
F1.7 Scrum is easy to follow. **Complexity**							
F1.8 Scrum is simple to understand. **complexity**							
F1.9 Scrum is easy to master. **complexity**							

F1.10 Scrum has several artifacts, roles and events, which are clear and descriptive. **complexity**							
F1.11 The Scrum methodology is suitable for managing software development projects. **compatibility**							
F1.12 Scrum can be adapted on a project complexity basis. **compatibility**							
F1.13 Scrum can be adapted on a project size basis. **compatibility**							
F1.14 Scrum is flexible as a methodology. **compatibility**							
F1.15 All roles, events and artifacts of Scrum are necessary. **compatibility**							

SECTION G: Scrum adoption questions

In this section, the outcomes of Scrum adoption within the organisation, team and individually is recorded. Indicate your level of agreement by choosing the appropriate answer where 1 strongly disagrees and 6 strongly agrees.

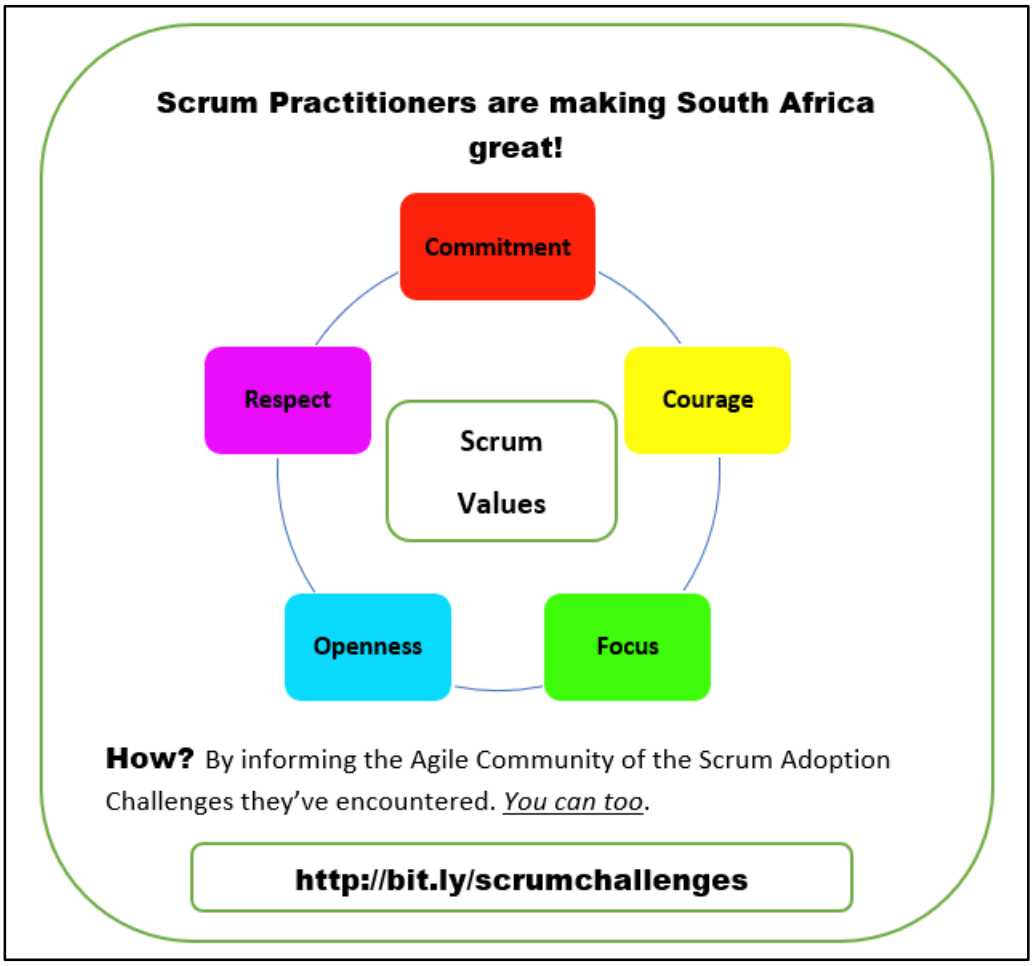
	Strongly disagree	Disagree	Somewhat disagree	Some what agree	Agree	Strongly agree

G1.1 As an individual, you have chosen to adopt Scrum for project related tasks.						
G1.2 The most recent South African team you worked with where Scrum was used, adopted Scrum to complete project related tasks.						
G1.3 The most recent South African organisation you worked for where Scrum was used, adopted Scrum as one of the agile methodologies to complete project related tasks.						

This is the end of the questionnaire; thank you for participating.

Appendix C - Scrum Invitation Pamphlet

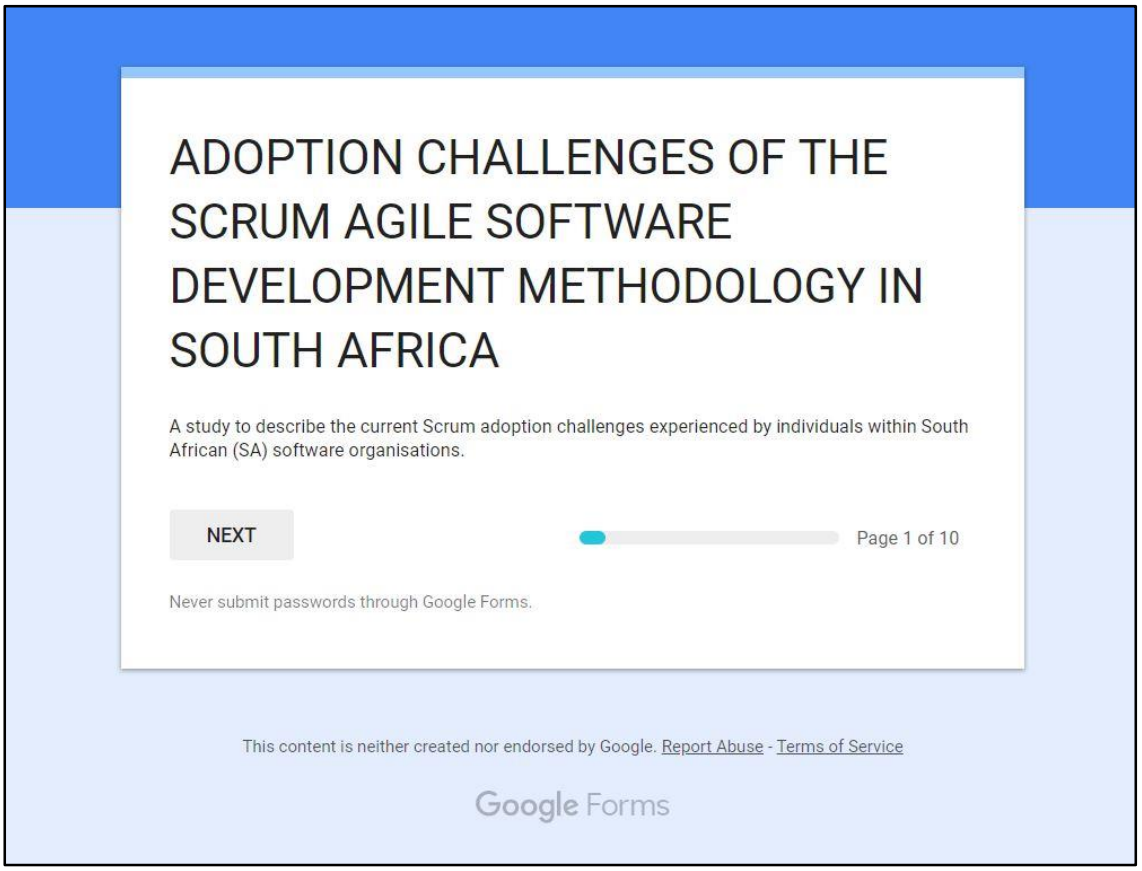
Front View



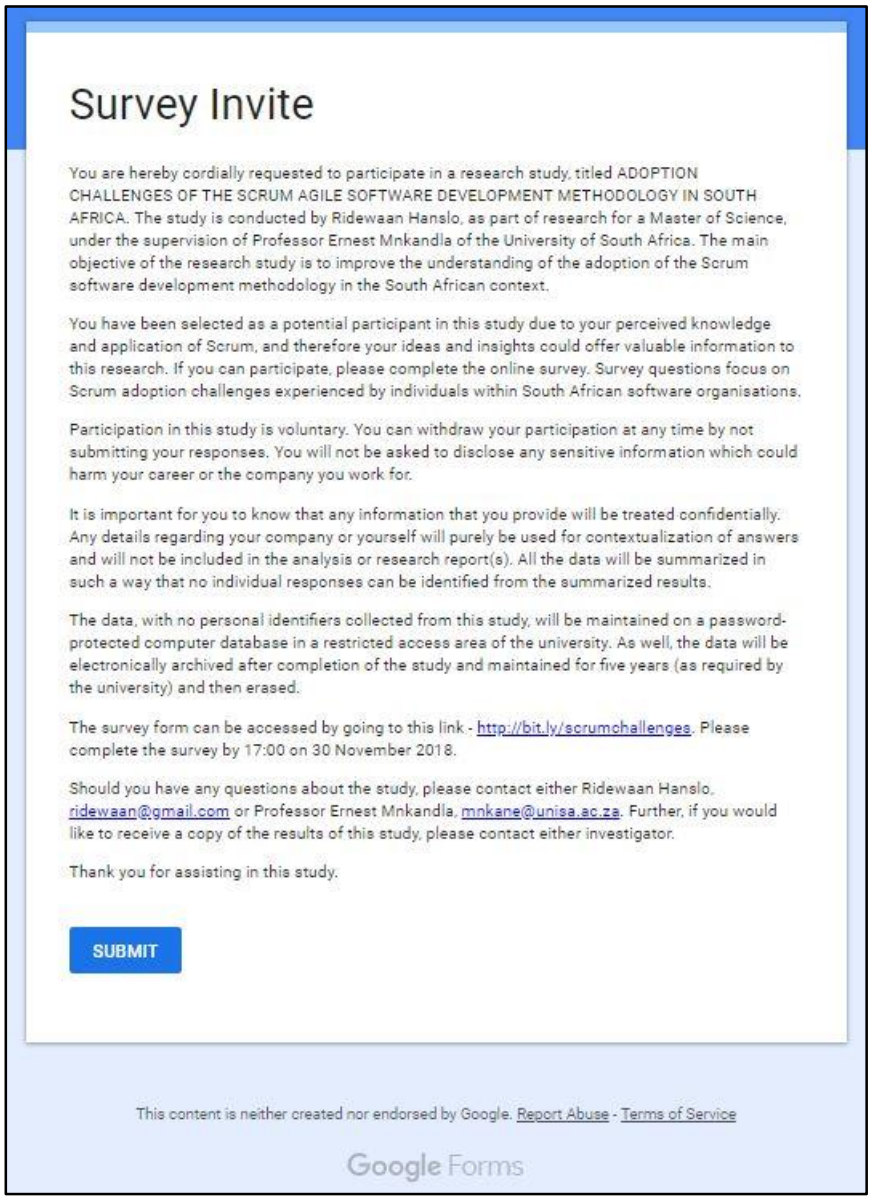
Back View

Appendix D - Google Forms Online Questionnaire and Invite

Questionnaire



Invitation



Survey Invite

You are hereby cordially requested to participate in a research study, titled ADOPTION CHALLENGES OF THE SCRUM AGILE SOFTWARE DEVELOPMENT METHODOLOGY IN SOUTH AFRICA. The study is conducted by Ridewaan Hanslo, as part of research for a Master of Science, under the supervision of Professor Ernest Mnkandla of the University of South Africa. The main objective of the research study is to improve the understanding of the adoption of the Scrum software development methodology in the South African context.

You have been selected as a potential participant in this study due to your perceived knowledge and application of Scrum, and therefore your ideas and insights could offer valuable information to this research. If you can participate, please complete the online survey. Survey questions focus on Scrum adoption challenges experienced by individuals within South African software organisations.

Participation in this study is voluntary. You can withdraw your participation at any time by not submitting your responses. You will not be asked to disclose any sensitive information which could harm your career or the company you work for.

It is important for you to know that any information that you provide will be treated confidentially. Any details regarding your company or yourself will purely be used for contextualization of answers and will not be included in the analysis or research report(s). All the data will be summarized in such a way that no individual responses can be identified from the summarized results.

The data, with no personal identifiers collected from this study, will be maintained on a password-protected computer database in a restricted access area of the university. As well, the data will be electronically archived after completion of the study and maintained for five years (as required by the university) and then erased.

The survey form can be accessed by going to this link - http://bit.ly/scrumchallenges. Please complete the survey by 17:00 on 30 November 2018.

Should you have any questions about the study, please contact either Ridewaan Hanslo, ridewaan@gmail.com or Professor Ernest Mnkandla, mnkane@unisa.ac.za. Further, if you would like to receive a copy of the results of this study, please contact either investigator.

Thank you for assisting in this study.

SUBMIT

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Appendix E - Meeting the Regression Assumptions

Table E1: The Assumption of Multicollinearity of the 14 Factors.

Coefficients[a]										
Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Collinearity Statistics	
		B	Std. Error	Beta					Tolerance	VIF
1	(Constant)	.506	.454		1.114	.267	-.389	1.401		
	Experience	-.021	.051	-.026	-.419	.676	-.122	.079	.656	1.523
	Organisational Behaviour	.000	.062	.000	.003	.998	-.123	.123	.315	3.177
	Sprint Management[1]	.109	.049	.178	2.239	.026	.013	.205	.388	2.575
	Relative Advantage	.688	.068	.702	10.168	.000	.555	.822	.514	1.944
	Training	-.031	.052	-.045	-.604	.547	-.134	.071	.445	2.246
	Specialisation	.004	.042	.006	.103	.918	-.078	.086	.782	1.279
	Recognition	-.019	.047	-.032	-.410	.682	-.112	.073	.400	2.500
	Customer Collaboration	.118	.062	.151	1.900	.059	-.004	.240	.386	2.589
	Compatibility	.085	.058	.099	1.477	.141	-.029	.199	.545	1.836
	Escalation of Commitment	.011	.041	.018	.280	.780	-.069	.092	.605	1.653

Coefficients[a]										
	Complexity	-.116	.056	-.146	-2.061	.041	-.227	-.005	.487	2.055
	Teamwork[1]	-.013	.047	-.021	-.279	.781	-.106	.080	.424	2.359
	Resource Management	-.042	.051	-.059	-.830	.407	-.142	.058	.484	2.068
	Over-Engineering[1]	.004	.039	.005	.092	.927	-.073	.080	.701	1.426

a. Dependent Variable: Scrum Adoption

1=factor's negatively phrased questions were recoded.

Table E2: The Assumption of Multicollinearity of the 4 Constructs.

Coefficients[a]										
Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Collinearity Statistics	
		B	Std. Error	Beta					Tolerance	VIF
1	(Constant)	1.197	.445		2.692	.008	.320	2.074		
	Team[1]	.126	.062	.123	2.040	.043	.004	.247	.911	1.098
	Technology	.580	.064	.566	9.009	.000	.453	.706	.834	1.199
	Individual[1]	.016	.053	.019	.303	.763	-.089	.121	.851	1.175
	Organisation	-.033	.054	-.039	-.616	.539	-.140	.073	.807	1.239

a. Dependent Variable: Scrum Adoption

1=factor's negatively phrased questions were recoded.

Table E3: The Assumption of no Autocorrelation of the 14 Factors.

Model Summary[b]										
					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.727[a]	.529	.495	.70734	.529	15.395	14	192	.000	2.091

a. Predictors: (Constant), Over-Engineering, Relative Advantage, Recognition, Experience, Teamwork, Specialisation, Escalation of Commitment, Compatibility, Resource Management, Customer Collaboration, Complexity, Training, Sprint Management, Organisational Behaviour

b. Dependent Variable: Scrum Adoption

Table E4: The Assumption of no Autocorrelation of the 4 Constructs.

Model Summary[b]										
					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.578[a]	.334	.321	.81983	.334	25.340	4	202	.000	1.982

a. Predictors: (Constant), Team, Technology, Individual, Organisation

b. Dependent Variable: Scrum Adoption

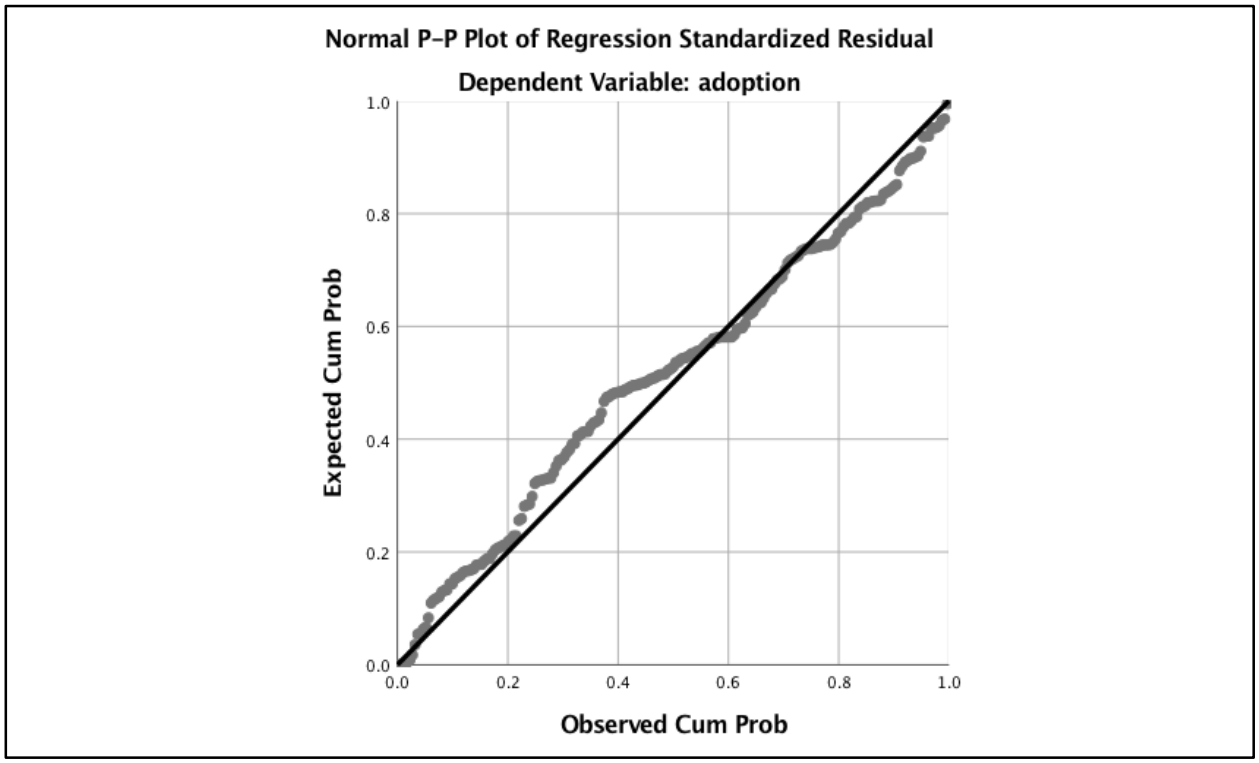

Figure E1: The Normality of Residuals Assumption of the 14 Factors.

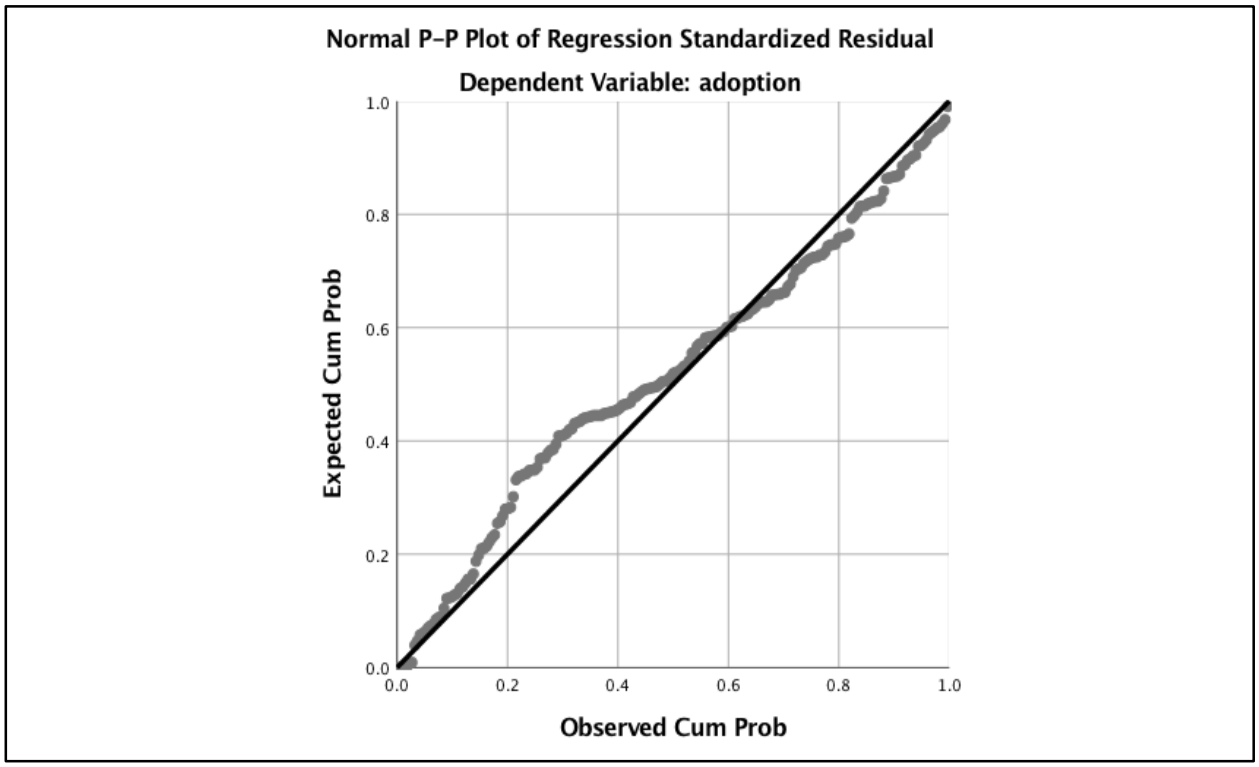

Figure E2: The Normality of Residuals Assumption of the 4 Constructs.

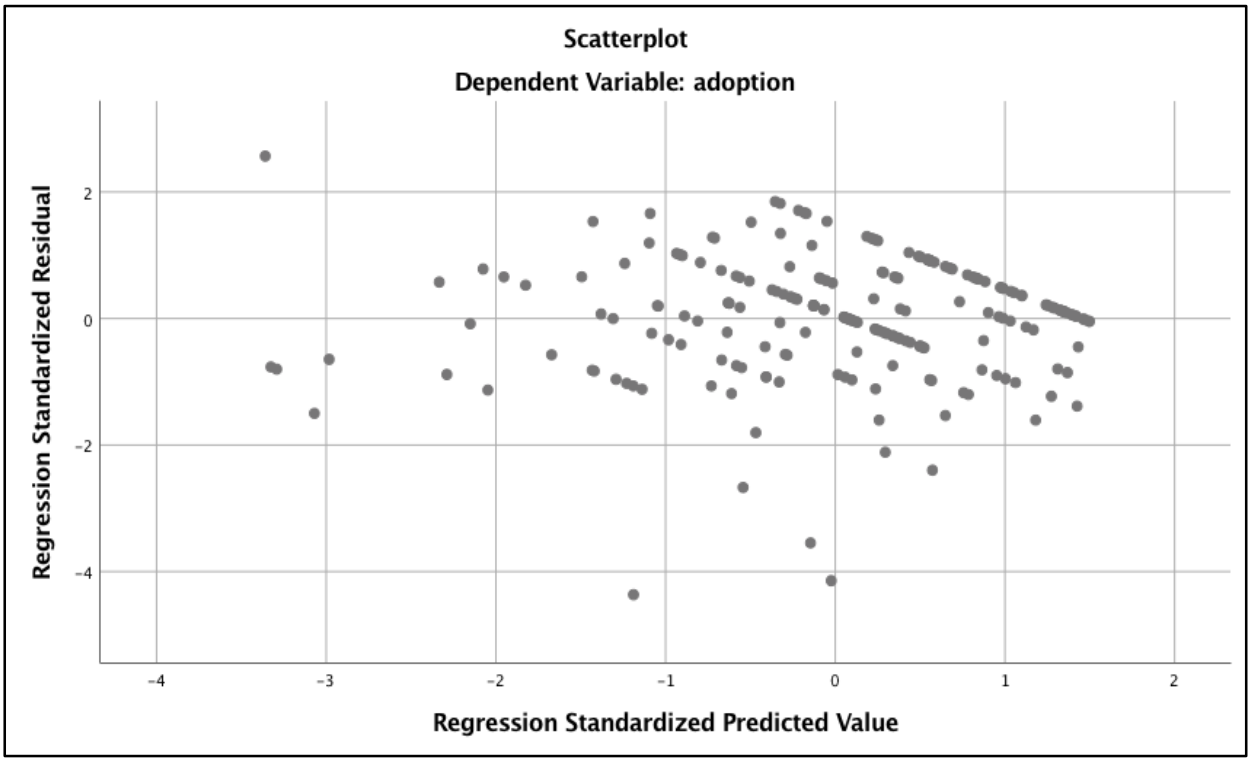

Figure E3: The Assumption of Linearity and Homoscedasticity of the 14 Factors.

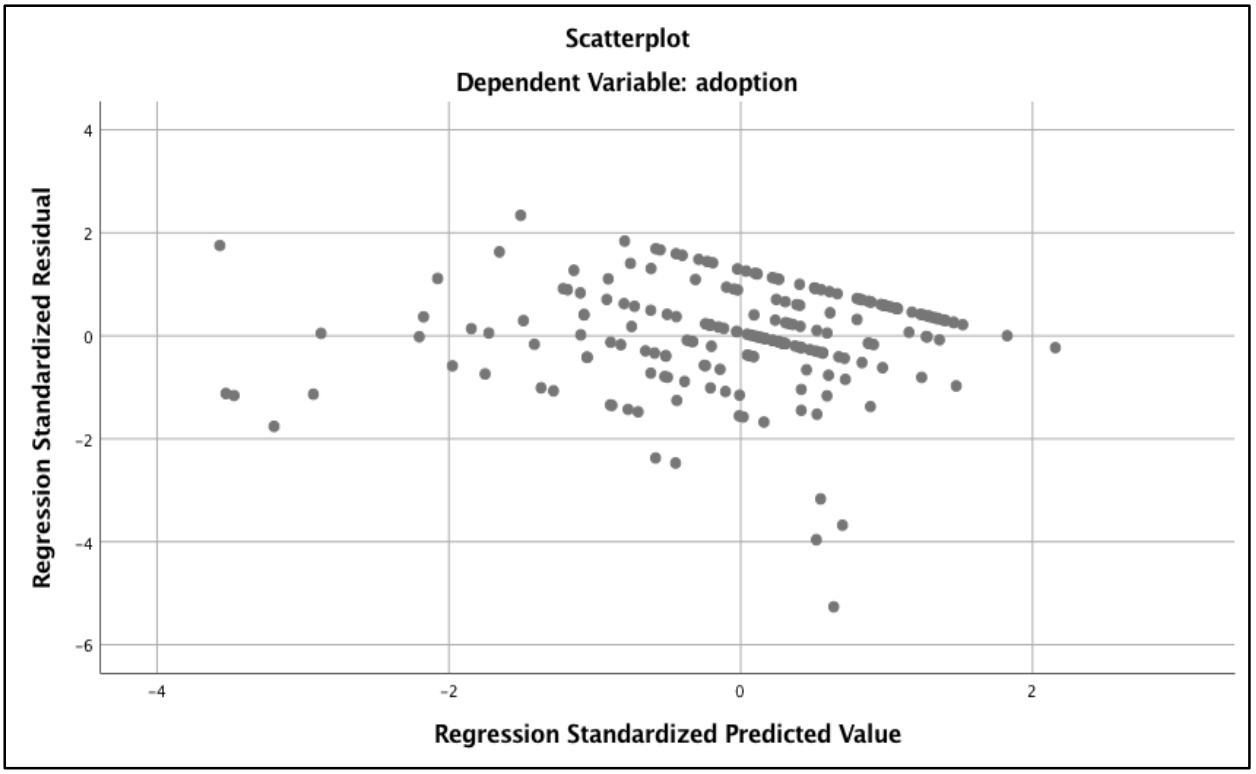

Figure E4: The Assumption of Linearity and Homoscedasticity of the 4 Constructs.

Appendix F - Additional Contributions

The author has added to the research field with the following additional contributions.

- Conference Paper
  - Hanslo, R. & Mnkandla, E. 2018. Scrum Adoption Challenges Detection Model: SACDM. In Federated Conference on Computer Science and Information Systems (FedCSIS). Poznan, Poland: IEEE: 949–957. [Online]. Available: https://ieeexplore.ieee.org/document/8511227

- Reviewer
  - IEEE Software 2018 Manuscript Reviewer. Topic Title - Knowledge Management within the Software Industry: How Scrum Activities Support Knowledge Management Cycle.

- Program Committee
  - A Program Committee member for the FedCSIS 2019 3rd International Conference on Lean and Agile Software Development (LASD'19). [Online]. Available: https://www.fedcsis.org/2019/lasd/committee

- Online Author
  - Provide practical insights for practitioners about common problems encountered during Scrum adoption and how to overcome them. [Online]. Available: https://www.offerzen.com/blog/common-problems-during-scrum-adoption-and-how-to-overcome-them

- Workshops
  - The author offers fellow researchers at the Council for Scientific and Industrial Research (CSIR) with training workshops on the Scrum framework.

- Professional Scrum Master

- Certified as a Professional Scrum Master awarded by Scrum.org on July 9, 2018. [Online]. Available: https://www.scrum.org/user/374119

Appendix G - Ethical Clearance Certificate

UNISA college of science, engineering and technology

Dear Mr. Ridewaan Hanslo (44469950)

Date: 2016-02-29

Application number:
019/RH/2016/CSET_SOC

REQUEST FOR ETHICAL CLEARANCE: (Adoption issues of the Scrum Agile software development methodologies in South Africa)

The College of Science, Engineering and Technology's (CSET) Research and Ethics Committee has considered the relevant parts of the studies relating to the abovementioned research project and research methodology and is pleased to inform you that ethical clearance is granted for your research study as set out in your proposal and application for ethical clearance.

Therefore, involved parties may also consider ethics approval as granted. However, the permission granted must not be misconstrued as constituting an instruction from the CSET Executive or the CSET CRIC that sampled interviewees (if applicable) are compelled to take part in the research project. All interviewees retain their individual right to decide whether to participate or not.

We trust that the research will be undertaken in a manner that is respectful of the rights and integrity of those who volunteer to participate, as stipulated in the UNISA Research Ethics policy. The policy can be found at the following URL:
http://cm.unisa.ac.za/contents/departments/res_policies/docs/ResearchEthicsPolicy_apprvCounc_21Sept07.pdf

Please note that the ethical clearance is granted for the duration of this project and if you subsequently do a follow-up study that requires the use of a different research instrument, you will have to submit an addendum to this application, explaining the purpose of the follow-up study and attach the new instrument along with a comprehensive information document and consent form.

Yours sincerely

Prof Ernest Mnkandla
Chair: College of Science, Engineering and Technology Ethics Sub-Committee

(PROF FW ALDERTON) 2 MARCH 2016
Prof IOG Moche
Executive Dean: College of Science, Engineering and Technology

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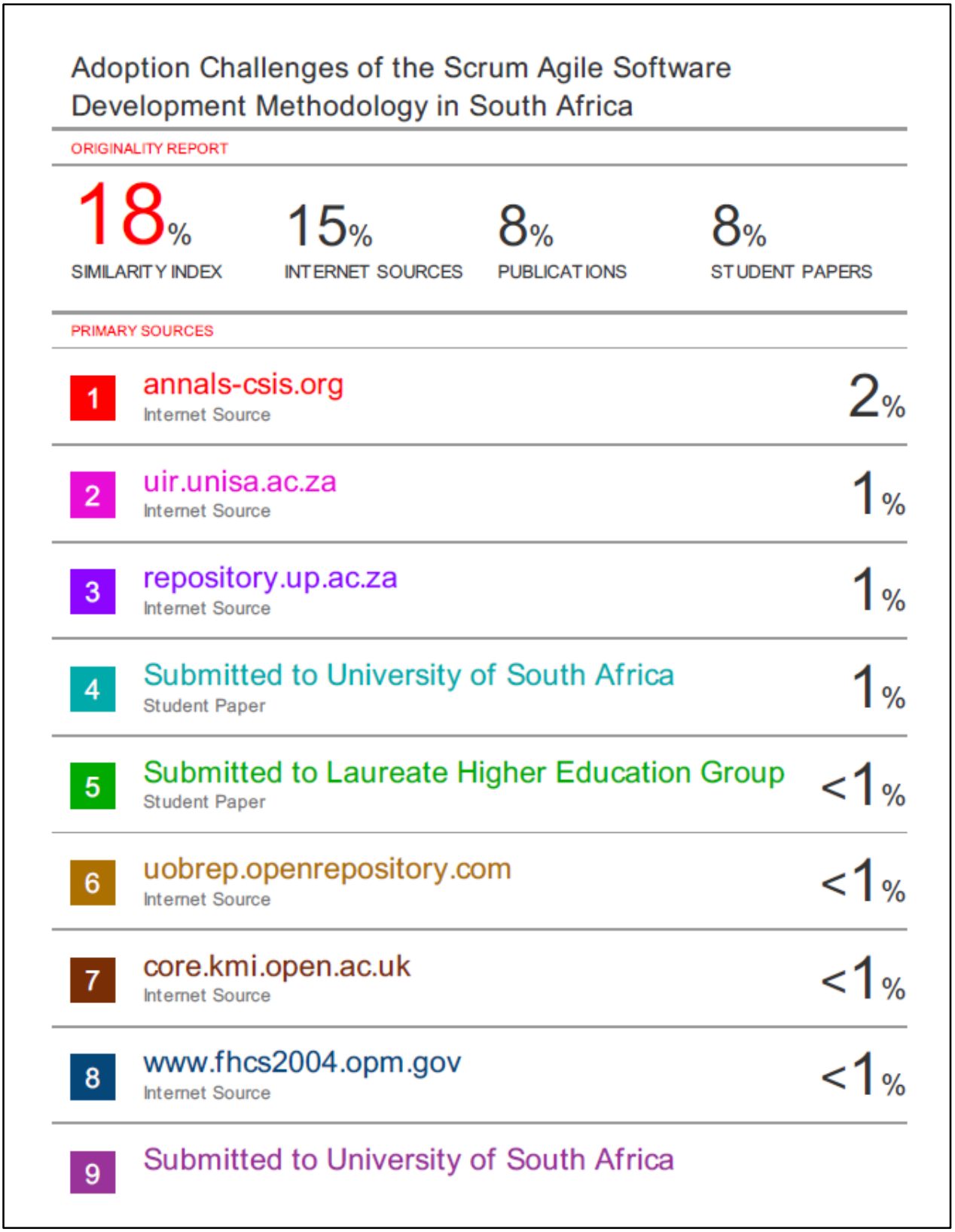
Appendix H - Turnitin Report



Adoption Challenges of the Scrum Agile Software Development Methodology in South Africa

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Appendix I - Proof of Language Editing

This document certifies that the dissertation listed below was edited for proper English language, grammar, punctuation, spelling and flow.

Dissertation Subject:

ADOPTION CHALLENGES OF THE SCRUM AGILE SOFTWARE DEVELOPMENT METHODOLOGY IN SOUTH AFRICA

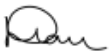
Author:

Ridewaan Hanslo

Student Number: 44469950

Date: May 2019

I confirm that the abovementioned document was edited by myself for language, grammar, punctuation, spelling and flow.



25/04/2019

Diane Horn

☎ 084 549 8119

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