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Understanding Sustained Usage of Agile Methodologies

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A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The University of Auckland, 2015.

Abstract

In today's dynamic and complex environments characterized by continuous change, agile methodologies (AM) have been proposed as solutions to improve an organisation's ability to respond quickly to changing requirements. While most academic research has focused on adoption and adaptation of agile methods, there is limited understanding of their sustained usage and incorporation within the organisation. The objective of this research is to develop a more comprehensive understanding of factors that are pertinent to the sustained usage of AM in organisations. It develops and tests a model that seeks to develop an understanding of the phenomenon of sustained agile usage and its association with agile usage effectiveness, i.e., consequences of sustained agile usage measured in terms of specific improvements in systems development outcomes.

The study uses a mixed method design by blending both qualitative and quantitative research methods. Given the poorly understood situation of sustained agile usage, the model building process required an adaptive and flexible approach which involved iterations between different research cycles rather than a linear sequential approach. The study consists of the following research cycles: i) case study (two case studies) ii) a focus group (twenty-nine software industry agile practitioners) and semi-structured interviews (twenty interviews) and (iii) a survey (114 responses). The initial a priori model based on a comprehensive review of the extant literature was critically examined and refined at the end of each research cycle, which later formed the basis of a subsequent research cycle - this process was repeated after every research cycle.

This thesis presents a model that integrates knowledge from the research fields of systems development methodologies, agile methodologies, software engineering, diffusion of innovations, and IS/IT implementation research, by examining a variety of factors that significantly influence the sustained and effective use of agile methodologies. It contributes to the body of knowledge in a number of ways: First, it presents an empirically validated model of the factors influencing an agile practitioner in the sustained usage of AM. Second, it underscores the importance of the positive influence of sustained agile usage on agile usage effectiveness i.e. it presents empirical evidence on the consequences that perceived sustained agile usage has on agile practitioners' perceptions on improvements in systems development

outcomes. Third, it contributes to industrial practice by providing insights into how agile methodologies can be sustained and effectively used in organisations.

I dedicate this to my parents;

(late) Mr. Vellore Arunachalam Senapathi and

Mrs. Vasanthammal Senapathi

*for their unconditional love, fidelity, and
selflessness in giving me the best of everything.*

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being confident of this very thing, that He who has begun a good work in you will complete it until the day of Jesus Christ; Phillipians 1:6

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Publications from this research

The following table provides a list of research outputs and publications related to this research until 2014.

Reference	Type
Senapathi, M. (2010). Adoption of Software Engineering Process Innovations: The Case of Agile Software Development Methodologies. In A. Sillitti, A. Martin, X. Wang, & E. Whitworth (Editors), <i>Springer-Verlag Berlin</i> , 11th International Conference on Agile Software Development, XP2010, 1-4 June 2010, Trondheim, Norway, pp. 226-231	Conference Proceedings
Senapathi, M. (2010): A Framework for Situated Evaluation of Methodology Usage in Agile Environments. In A. Sillitti, A. Martin, X. Wang, & E. Whitworth (Editors), <i>Springer-Verlag Berlin</i> , Presented at the Doctoral Consortium conducted at the meeting of the The 11th International Conference on Agile Software Development, XP2010, 1-4 June 2010, Trondheim, Norway, pp. 407-409.	Conference Proceedings
Senapathi, M. (2010): A Framework for the Investigation of Factors Affecting the Effective Usage of Agile Methodologies in Organisations. Presented at the IFIP TC8, Information Systems Doctoral Consortium, 19 September, 2010, Brisbane, Australia.	Doctoral Consortium
Senapathi, M. (2011): A Framework for Understanding Post-adoptive Usage of Agile Methodologies. Presented at the Doctoral Consortium conducted at the meeting of the Australasian Conference on Information Systems, ACIS 2011, 27 - 29 Nov 2011, Wollongong, New South Wales, Australia.	Doctoral Consortium
Senapathi, M., & Drury, M. (2012): Let's Stay Agile: Applying the Framework for Agile Sustainability, Workshop conducted at the meeting of the International Conference on Agile Software Development, Dallas, Texas, USA, 13 - 17 Aug 2012.	Focus Group Session
Senapathi, M., Drury, M., & Srinivasan, A. (2013): Agile Usage: Refining a Theoretical Model, Published in <i>AIS Electronic Library (AISEL)</i> – http://aisel.aisnet.org/pacis2013/43 , Pacific Asia Conference on Information Systems (PACIS) 2013, 18 – 22 June 2013, Jeju Island, Korea.	Conference Proceedings
Senapathi, M., Middleton, P., & Evans, G. (2011): Factors affecting Effectiveness of Agile Usage - Insights from the BBCWorldwide Case Study. In A.Sillitti, O. Hazzan, E. Bache, X.Albaladejo (Editors): <i>Springer-Verlag Berlin 2011</i> , 12th International Conference on Agile Software Development XP2011, 10 – 13 May 2011, Madrid, Spain, pp. 132-145.	Conference Proceedings
Senapathi, M., & Srinivasan, A. (2011): Understanding Post-Adoptive Agile Usage -- An Exploratory Cross-Case Analysis, International Conference on Agile Software Development, Agile 2011, Salt Lake City, Utah, USA, 7 – 13 Aug 2011, pp. 117-126.	Conference Proceedings
Senapathi, M., & Srinivasan, A. (2012): Understanding post-adoptive agile usage: An exploratory cross-case analysis. <i>Journal of Systems and Software</i> , 85(6), pp. 1255-1268.	Journal article
Senapathi, M., & Srinivasan, A. (2013): Sustained Agile Usage: A Systematic Literature Review. <i>ACM Digital Library</i> , Proceedings of the 17th International Conference on Evaluation and Assessment in Software Engineering, EASE 2013, 14 – 16 April 2013, Porto de Galinhas, Brazil, pp. 119-124.	Conference Proceedings
Senapathi, M., & Srinivasan, A. (2014): An Empirical Investigation of the Factors Affecting Agile Usage, <i>ACM Digital Library</i> , Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering, EASE 2014, 13 - 14 May 2014, London, UK.	Conference Proceedings

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LIST OF ABBREVIATIONS

AM	Agile Methodology
AC	Agile Coach
ASD	Agile Systems Development
ASDLC	Agile System Development Life Cycle
AK	Auckland
AVE	Average Variance Extracted
BA	Business Analyst
BBCW	BBC Worldwide
CA	Cronbach's Alpha
CASE	Computer Aided Software Engineering
CB-SEM	Covariance-based Structural Equation Modelling
CF	Conceptual Framework
CH	Christchurch
CIO	Chief Information Officer
CR	Composite Reliability
CS	Cross-Sectional
CV	Convergent Validity
DOI	Diffusion of Innovations
FG	Focus Group
ISD	Information Systems Development
IT	Information Technology
ITDM	Information Technology Delivery Manager
ICR	Internal Consistency Reliability
LSD	Lean Software Development
LV	Latent Variable
MC	Methodology Champion
MIS	Management Information System
ML	Maximum Likelihood

MS	Management Support
MV	Manifest Variable
OLS	Ordinary Least Squares
PEOU	Perceived Ease Of Use
PLS-SEM	Partial Least Squares – Structural Equation Modelling
PSP	Personal Software Process
PU	Perceived Usefulness
SAU	Sustained Agile Usage
SDM	Systems Development Methodology
SM	Scrum Master
Stats NZ	Statistics New Zealand
TAM	Technology Acceptance Model
TDM	Tailored Design Method
TFS	Team Foundation Server
TMS	Top Management Support
VIF	Variance Inflation Factor
WIP	Work In Progress
WL	Wellington
XNY	Explanatory
XP	Extreme Programming
XP-EF	Extreme Programming – Evaluation Framework
XPY	Exploratory

Chapter 1. Introduction

1.1. Background and Motivation

The unprecedented rate of change in business and technology and the challenges of today's dynamic and complex environments characterized by continuous change has made it increasingly difficult for organisations to determine and meet customer demands and respond quickly to their changing requirements (Lee & Xia, 2010). Agile methodologies (AM) have been proposed as solutions to improve an organisation's ability to embrace and respond quickly to changing requirements (Beck & Andres, 2004; Lee & Xia, 2010).

AMs reflect the values articulated in the agile manifesto (Alliance, 2001) which emphasise early production of working software through frequent releases, extensive customer collaboration and interaction, and iterative development (Cockburn, 2002; Highsmith, 2002). They differ from traditional methods which emphasise detailed front-end plans, phased and non-iterative approaches to systems development with relatively long time spans between deliverables, heavy documentation, and minimal amount of customer interaction (Boehm & Turner, 2004; Turk, France, & Rumpe, 2005). AM is an umbrella term used to represent a number of method instantiations such as Scrum, Extreme Programming (XP), and Feature Driven Development (FDD) (Conboy & Fitzgerald, 2004). AM were formally introduced to the field of systems development through the formation of the Agile Alliance in 2001 and the publication of the Agile Manifesto¹: (Fowler & Highsmith, 2001).

AM has gained widespread acceptance in both the academic and industrial contexts, and their use in information systems development (ISD) has grown dramatically (Wang, Conboy, & Pikkarainen, 2012). This, in turn, has triggered substantial research mainly relating to the adoption and initial use of AM. The bulk of this research is comprised of case studies, comparative analyses, and experience reports (Dyba & Dingsoyr, 2009; Erickson, Lyytinen, & Siau, 2005). Little has been conducted on issues associated with post-adoption use of AM (Abrahamsson, Conboy, & Wang, 2009):

“studies of issues associated with post-adoption use of AM are much less in number, even though there is increasing need to have a better understanding of AM in use as

¹ <http://agilemanifesto.org>

many organisations have completed adoption stage and AM start to become well-established processes of these organisations”.

Moreover, the extant literature offers a very broad range of experiences without providing a unified view of current practice of AM (Dyba & Dingsoyr, 2008). Despite the ongoing proliferation of AM (e.g. Scrum, Kanban, Scrumban, Lean, AgileUP, DSDM), only a few have been widely accepted by practitioner communities. For example, in a recent industrial survey showed that Scrum (73%) continued to be the most popular methodology used (VersionOne, 2013). Although many benefits from the use of AM have been claimed, research evidence supporting proponents' claims is lacking (Erickson et al., 2005; Lee & Xia, 2010). There is very limited empirical evidence on their actual usage, penetration, and rigorous examination of 'if, how, and why' AM are effective (Begel & Nagappan, 2007; Lee & Xia, 2010; Vijayasarathy & Turk, 2012). This suggests that there is an imprecise understanding of their use and practice in organisations beyond the adoption phase. In particular, there is a lack of clarity on what 'usage' or 'effectiveness' mean in the context of agile development. Most studies that report high adoption rates of AM do not define, much less measure 'effectiveness' of their usage or identify factors that influence their sustained use.

The phenomenon of the *success* or *effectiveness* of AM, and the related question of the key factors that impact sustained agile usage (SAU) have remained unanswered so far. Accordingly, this study sets out to make a contribution to the body of knowledge in this area by studying the factors that impact sustained usage of AM.

1.2. Theoretical Background

The usage of Systems Development Methodologies (SDMs) in general is a versatile concept (Iivari & Huisman, 2007) and, given the lack of strong theoretical and conceptual base in AM research, this study draws from the vast base of empirical studies in the diffusion of innovation, information systems (IS) implementation research, and AM. The diffusion of innovation and IS implementation models have been tested and validated extensively in the IS literature (Cooper & Zmud, 1990; Davis, Bagozzi, & Warshaw, 1989; Fichman & Kemerer, 1993; Gallivan, 2001; Iivari, 1996; Kwon & Zmud, 1987; Raghavan & Chand, 1989) to explain the constructs of the adoption and implementation of new IS innovations (Gallivan, 2001). They have been previously recognised as useful frameworks in enhancing our understanding of complex technologies (McChesney & Glass, 1993; Raghavan & Chand, 1989; Rogers, 2003),

and recently generated interest in the agile research community (Pikkarainen, Wang, & Conboy, 2007). While these well-established theories are suitable for a particular range of adoption scenarios and technology types, they cannot be directly applied to complex innovations such as AM, because the outcomes of such application are sensitive to the fit between the underlying assumptions, specific features of the adoption context and the technology in question (Fichman, 1992). Instead, such theories need further evaluation and extension to make them adequate for the study of AM (Pikkarainen et al., 2007). Therefore, in this study, the application of these theories to the case of AM is evaluated through the development of a comprehensive integrated framework for investigating sustained agile usage and its impact on agile usage effectiveness. The study focuses on how extensively the innovation is used after adoption within the organisation, rather than its adoption per se. In the context of software process innovations, this is generally referred to as the innovation's degree of assimilation into the organisation.

According to Kwon and Zmud (Kwon & Zmud, 1987), diffusion of innovation is a six-staged process comprising initiation, adoption, adaptation, acceptance, routinisation, and infusion. While the initial three phases (initiation, adoption, adaptation) relate to 'adoptive' behaviour of an innovation, the last three phases (acceptance, routinisation, infusion) relate to an innovation's post-adoptive use. The factors which drive an innovation across the adoptive phases differ from those that affect the post-adoptive phases (Karahanna, Straub, & Chervany, 1999). Prior studies on AM have paid more attention to examining factors that drive organisations to initially adopt AM rather than on those that affect their continued or sustained usage. Therefore, this study is specifically interested in identifying the factors affecting the post-adoption or sustained usage of agile practices within organisations.

Adapting the concepts of post-adoptive stages to the context of agile assimilation, Wang et al (Wang et al., 2012) define infusion using the following facets: 1) extensive use: more features of an agile practice are used; 2) integrative use: an agile practice is used to create new workflow linkages among tasks 3) emergent use: an agile practice is used to perform tasks not in the preconceived scope 4) intensive use: an agile practice is used with intensity beyond that suggested by the textbook, and 5) deeply customised use: an agile practice is adapted at a deep level to suit the need of the adopting team. In the current study, the term '*vertical usage*' refers to deeper (e.g. any combination of the above infusion facets) use, adherence, and effective implementation of AM, and '*horizontal usage*' refers to the spread of the innovation across the organisation: for example, spread of the use of Scrum practices from one team/project to

multiple teams/projects, from one region to many regions within an organisation, and to other departments (for example, business, finance) beyond their original intended scope of use. The combination of ‘vertical usage’ and ‘horizontal usage’ is referred as ‘*Sustained Agile Usage*’.

Agile usage effectiveness is defined as any specific improvements in the overall systems development process as a result of continued usage of agile practices as perceived by the organisation. To that extent, three effectiveness measures were identified for assessing agile usage effectiveness (Iivari & Iivari, 2011; Williams, Krebs, & Layman, 2004a): 1) improved productivity in the development process, 2) improved quality of the development process, and 3) customer satisfaction. The underlying premise is that in order to achieve significant improvements in systems development, usage of AM must be sustained. Understanding the relationship between SAU and agile usage effectiveness, where effectiveness is measured as the impact of agile usage on systems development outcomes is crucial to understanding sustained usage of AM in organisations.

The studies conducted by Mangalaraj, Mahapatra, and Nerur (2009a) and Pikkarainen et al. (2007) were two of the first studies that specifically focused on later stages of AM use. Due to lack of strong theoretical and conceptual foundation in the field of AM (Abrahamsson et al., 2009), both studies ((Pikkarainen et al., 2007) and (Mangalaraj, Mahapatra, & Nerur, 2009b)) drew from the theoretical foundations of IS implementation. While Pikkarainen et al., focused on the assimilation of individual agile practices of XP and Scrum using three case studies, Mangalaraj et al., investigated the acceptance of XP at the method level across different teams within the same organisation. Both the studies contributed to building a stronger theoretical base in AM and gaining a better understanding of later stages of AM use. However, the focus on individual methods such as Scrum and XP has resulted in fragmented research by missing the commonalities of ‘agile’ methods (Iivari & Iivari, 2011). Since it might be ‘intellectually economic’ to focus on AMs as a whole (Iivari & Iivari, 2011), this study seeks to cover the totality of agile methods rather than focusing on individual method or practice. It uses the term ‘*agile methodology*’ to cover the totality of agile development methods (such as XP, Scrum, DSDM, lean, Kanban, agile modelling, etc.).

1.3. Problem Statement and Purpose of Study

Understanding sustained usage of AM from a whole or total ‘method’ perspective is a subject matter worthy of scholarly investigation and one that is likely to have a positive impact on

organisational agile systems development initiatives. Understanding SAU has significant implications for organisations. Typically, organisations that have adopted AM are required to make significant changes in their strategies and processes associated with systems development. They invest heavily in training agile practitioners and purchase related agile tools to facilitate the use of AM. If individual users of the method are then unwilling to continue using the adopted agile methodology, all the previous effort and investments, are largely wasted. Conboy, Pikkarainen, and Wang (2007) highlight that it is critical to examine the barriers and facilitators of SAU in order to gain a deeper understanding of the association between SAU and ‘effectiveness’. Therefore, the primary motivation of this study was to gain a better understanding of how agile methods can be effectively used in organisations. Thus, the main research question driving this study is: *How can organisations sustain the use of agile methods?*

To translate the above question into a research problem, it became imperative to build and test a model that

- (i) identified the key factors that impact *sustained agile usage*, and
- (ii) propose a relationship between *sustained agile usage* and *agile usage effectiveness*, i.e. *sustained agile usage* as a factor influencing *agile usage effectiveness*.

The study framed the following investigative questions to address the above questions and objectives:

- What is *sustained agile usage*? How can *sustained agile usage* be operationalised?
- What is *agile usage effectiveness*? How can *agile usage effectiveness* be operationalised?

The above questions are summarised in the table below (Table 1.1). The study uses empirical evidence to provide answers to the following research questions:

Table 1.1.: Research Questions

Research Question One	<i>1. How can organisations sustain the use of agile methods?</i>
Research Question Two	<i>2. What are the factors that impact sustained agile usage?</i> <i>a. What is sustained agile usage?</i> <i>b. How can sustained agile usage be operationalised?</i>
Research Question Three	<i>3. What relation, if any, exists between sustained agile usage and the results effectively achieved in terms of systems development outcomes?</i> <i>3.1 What is agile usage effectiveness?</i> <i>3.2 How can agile usage effectiveness be operationalised?</i>

In order to contribute to building a stronger theoretical foundation in the field of AM, it is urged that agile researchers embrace a more theory-based approach in the future (Dingsøyr, Nerur, Balijepally, & Moe, 2012). Given that the usage of agile methodologies is a versatile concept, the current study integrates technical research in agile systems development with relevant implementation and behavioural research in IS. It draws from well-established theories such as diffusion of innovations and IS implementation research which have been extensively used throughout the IS literature to explain the constructs relating to SAU and its impact on development outcomes.

A high level representation of the final research model (i.e. sustained agile usage model) is shown in Figure 1.1: (1) Innovation (*relative advantage, compatibility*) (2) Sociological (*agile experience, agile coach, agile mindset*) (3) Technological (*agile tool support*) (4) Organisational (*methodology champion, top management support, training*) The model also proposes *sustained agile usage (horizontal usage, vertical usage)* as a mediating factor affecting agile usage effectiveness (improvements in systems development *productivity, quality, predictability, customer satisfaction*).

Prior studies in SDMs have suggested that individuals choose not to continue to use an innovation even after the decision has been made at the organisational level (Orlikowski, 1993). In the context of software process innovations, it is believed that the innovation should be adopted at the individual level in order to be effective (Green & Hevner, 1999). It is believed that in the case of post-adoptive use of an innovation it is the individual user who decides to continue to use an innovation based on a number of factors such as attitude, willingness to learn and change, and their experience based on its initial use. If the use of AM is made mandatory against the willingness of individual practitioners, it might have a negative impact on the work

morale which in turn could have an effect on their long-term or sustained use. Prior studies have highlighted the need for understanding agile usage and implementation at the team level (Mangalaraj et al., 2009a; Wang et al., 2012). Therefore, to add the existing body of knowledge which consists of few early studies on post-adoptive stages of agile use at the *team* level, this study focuses on the *individual* level, i.e., the question of ‘why’ or why individual agile practitioners’ ‘do’ or ‘do not’ sustain the use of AMs.

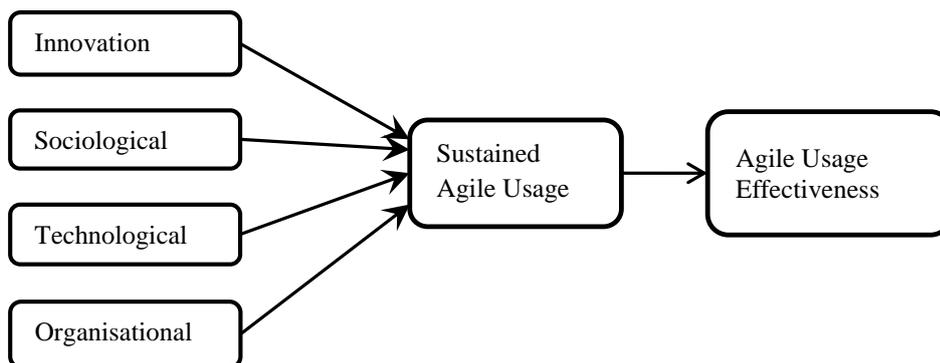


Figure 1.1: The research model

The insights we gain from such studies will be valuable from at least three perspectives: a) provide new theoretical insights into the factors that impact sustained and effective usage of AM, b) improve our understanding of the relation between SAU and systems development outcomes, and c) contribute to industrial practice by providing insights into how AM can be sustained and used more effectively in organisations.

1.4. Research Approach and Methodology

This study is undertaken in agreement with Lee’s viewpoint that the researcher “must collect facts and data describing not only the purely objective, publicly observable aspects of human behaviour, but also the subjective meaning this behaviour has for the human subjects themselves” (Lee, 1991, p. 347), and both are essential to enrich our understanding of a particular phenomenon. For example, an agile systems development initiative may come to an end in an organisation based on the decision made by the management (which would be an objective reality). However, the different stakeholders involved in the initiative may still have their own perceptions on some significant factors that might have had an impact on its cessation and why (which would be a subjective reality). Accordingly, this thesis attempts to combine both qualitative (subjective reality) and quantitative (objective reality) in its design and

conduct. The study follows Lee's integrative framework which consists of three levels of understanding (Lee, 1991):

1. First level (the subjective understanding): this level consists of the everyday meanings and experiences with which human subjects under observation perceive themselves which gives rise to their manifested behaviour in the social and organisational settings in which they operate.
2. Second level (the interpretive understanding): this level consists of the researcher's interpretation of the understanding observed at the first level.
3. Third level (the objective understanding): this understanding is one that the researcher creates (for example, a research model) and tests in order to explain the empirical reality that is being investigated.

The subjective understanding provides the basis on which interpretive understanding is developed. The interpretive understanding, once validated, provides the basis on which to develop the objective understanding, for example, by formulating theoretical propositions and subjecting to controlled empirical testing. From a practical perspective, some of the important advantages of combining objective (ostensibly quantitative) and subjective (ostensibly qualitative) approaches in the same study include (Creswell & Clark, 2007; Teddlie, 2009):

- ability to address both exploratory and confirmatory questions within the same study
- ability to make stronger and more valid inferences from data
- opportunity to bring more diverse and/or complimentary views into the research process

While qualitative methods have been typically used more in IS for exploratory research to develop a deep understanding of a phenomenon and/or inductively generate new theoretical insights, quantitative methods have been typically used for confirmatory studies such as theory testing (Venkatesh, Brown, & Bala, 2013; Walsham, 2006). Mixed methods research combines qualitative and quantitative research methods in a given research study (Teddlie, 2009), and has the ability to address both exploratory and confirmatory questions within the same research inquiry (Venkatesh et al., 2013).

Given the lack of strong theoretical foundations in the field of AM (Conboy, 2009; Wang et al., 2012), mixed methods design was deemed appropriate to meet the objectives of the current study: it first employs an exploratory (qualitative – interviews, focus group) approach (to answer research question 2) as a mechanism to unearth the various factors that influence SAU.

Subsequently, the final set of derived factors is included in a research model and tested using a confirmatory quantitative study (to answer research question 3). The objective is to provide detailed analyses of findings from each of the methods separately, and also attempt to derive meta-inferences based on an integrated view of findings from both methods.

1.4.1. Theoretical Goal

In the physical or natural sciences, a theory is generally expected to be able to provide explanations, predictions, and able to be tested (Gregor, 2006). Similar views exist in the social sciences, where the minimal definition of a theory must meet three primary criteria: (1) constructs must be identified, (2) relationships among these constructs must be specified, and (3) these relationships must be able to be tested (Doty & Glick, 1994; Gregor, 2006). In IS, a number of different definitions exist on what constitutes a theory, of which Weber's definition provides an overarching view - a theory is defined as "an *account* intended to explain or predict some *phenomena* that we perceive in the world" (Weber, 2003). For example, the current study seeks to develop a theoretical model about (1) the agile practitioner's perceptions on the factors that impact agile usage and the agile practitioner's perceptions on agile effectiveness (*phenomena*) and (2) to explain the phenomena (*account*) by specifying the constructs and association among constructs.

Theory development starts with an understanding of a problem that is to be solved or some question of interest (Gregor, 2006). Theory that is developed then depends on this problem, question, or phenomenon that is addressed. Based on this understanding, four primary goals of theory development can be discerned, and the combination of these goals leads to five types of theory shown in Table 1.2 (Gregor, 2006):

- i) *Analysis and description.* The theory provides a description of the phenomena of interest, analysis of relationships among those constructs, the degree of generalisation in constructs and relationships and the boundaries within which relationships, and observations hold.
- ii) *Explanation.* The theory provides an explanation of how, why, and when things happened, relying on varying views of causality and methods of argumentation with an intention to promote greater understanding or insights by others into the phenomena of interest.
- iii) *Prediction.* The theory states what will happen in the future if certain preconditions hold with an approximate or probabilistic degree of certainty.

- iv) *Prescription*. The theory provides a description of the method or structure or both for the construction of an artefact – which if acted upon, will cause an artefact of a certain type to come into being.

Table 1.2: Taxonomy of Theory Types in IS Research

Theory Type	Distinguishing Attributes
Analysis	Says what is. The theory does not extend beyond analysis and description. No causal relationships among phenomena are specified and no predictions are made.
Explanation	Says what is, how, why, when, and where. The theory provides explanations but no predictions or testable propositions.
Prediction	Says what is and what will be. The theory provides predictions and has testable propositions but no well-developed justificatory causal explanations.
Explanation and prediction	Says what is, how, why, when, where, and what will be. The theory provides predictions and has both testable propositions and causal explanations.
Design and action	Says how to do something. The theory gives explicit prescriptions (e.g., methods, techniques, principles of form and function) for constructing an artefact.

Source: Adapted from (Gregor, 2006, p. 620)

1.4.1.1. Structured-case

According to Gregor, theory of explanation and prediction (EP theory) implies both understanding of underlying causes and prediction, as well as description of theoretical constructs and the relationships among them. In the current study, the EP theory is adopted, as the proposed theoretical model identifies both the causative factors (constructs) driving *SAU* that will improve explanation and prediction of relationships between the factors and *SAU*, and also relationships between *SAU* and *agile effectiveness*. In summary, the study seeks to develop an understanding of what, how, and why the phenomenon of *SAU* occurs and its association with *agile effectiveness*, i.e., improvements in systems development outcomes.

Strategies have been suggested for building theory from methods such as case studies, where the theory building process is described as ‘constant iteration backward and forward between steps’ (Eisenhardt, 1989). However, as the study uses a mixed method design (which includes case study), and given the poorly understood situation of post-adoption or sustained agile usage, the model building process required an adaptive, and flexible approach which involves iterations between different research methods/cycles rather than a linear sequential approach. Thus, *structured-case*, a methodological framework which provides a descriptive guide for a iterative theory-building process was used to support the various phases of the research process

(Carroll & Swatman, 2000): ‘structured’ refers to the use of a research process comprising of three structural components: (i) the conceptual framework, (ii) the research cycle, and (iii) the literature-base scrutiny of the theory built. ‘case’ refers to the broad sense of the phenomenon (i.e. SAU) being studied, rather than the narrower sense of a case study method (Stake, 2011). Carroll & Swatman argue that while criteria for performing rigorous IS studies using positivist (Benbasat, Goldstein, & Mead, 1987; Lee, 1989) and interpretivist (Klein & Myers, 1999; Walsham, 1995) paradigms are specified in the literature, such criteria outline what is needed, rather than how to achieve it. Similarly, theory building frameworks (e.g. Eisenhardt’s (1989) eight-step framework) are sequential in that they do not capture the inherent recursion, and iterative nature of the research process (Carroll & Swatman, 2000). Though structured-case is aimed at guiding studies using interpretive paradigm, it was deemed appropriate to be used in the current study as a complementing framework with other existing works and quality criteria specified in the literature to assist the researcher at a higher level of abstraction. It is used to influence and reflect on the planning, selection of various methods used for collecting and analysing the data (e.g. focus group, semi-structured interviews) that represents the iterative nature in which the proposed research model (i.e. SAU model) has been developed. Therefore, ‘structured-case’ is not used in the current study as a prescriptive method, but rather as a guiding framework which is tailored to reflect the characteristics of the research phenomenon (i.e. agile usage), method, context, and the skills and experience of the researcher. The components of the *structured-case* are briefly described below:

(i) The conceptual framework:

A conceptual framework ‘explains, either graphically or in narrative form, the main things to be studied – the key factors, constructs or variables – and the presumed relationships between them’ (Miles & Huberman, 1994, p. 18). It is the researcher’s representation of the conceptual structure brought to the research process (Carroll & Swatman, 2000). In the current study, the initial conceptual framework was developed based on research themes in the areas of post-adoption/sustained usage, current knowledge and theories in the extant literature, and the insights from experts in the research area and from practitioners from the industry. At the end of each research cycle, the framework was critically examined and revised as needed to incorporate understanding about the research themes, which later formed the basis of a subsequent research cycle - this process was repeated after every research cycle. Thus “the conceptual framework is a series of evolving

models that are reviewed and refined over the life of the research project” (Carroll & Swatman, 2000).

(ii) The research cycle

The research cycle is conceptualised using four stages, which in practice allows iteration between stages rather than follow a sequential pattern:

Plan – tasks such as the research design, identification of appropriate cases and organisations, data collection and analysis methods, reporting methods, etc., are planned.

Collect data – data collection is guided by the plan created during the ‘plan’ stage. Data collection may require changes to reflect any unexpected and emergent themes

Analyse – the initial analysis is guided by conceptual framework, but the process is an ongoing and iterative task which is receptive to any emerging new concepts and themes, and

Reflect – reflection is performed after data analysis is completed, and involves reflective and critical thinking. It typically involves: *reviewing the research process, evaluating the outcomes of analysis, reflecting on any emergent themes, and changing the conceptual framework to incorporate the knowledge accumulated.* The reflection stage ends when the conceptual framework is refined to incorporate the learning gained in that research cycle which forms the basis for a new research cycle.

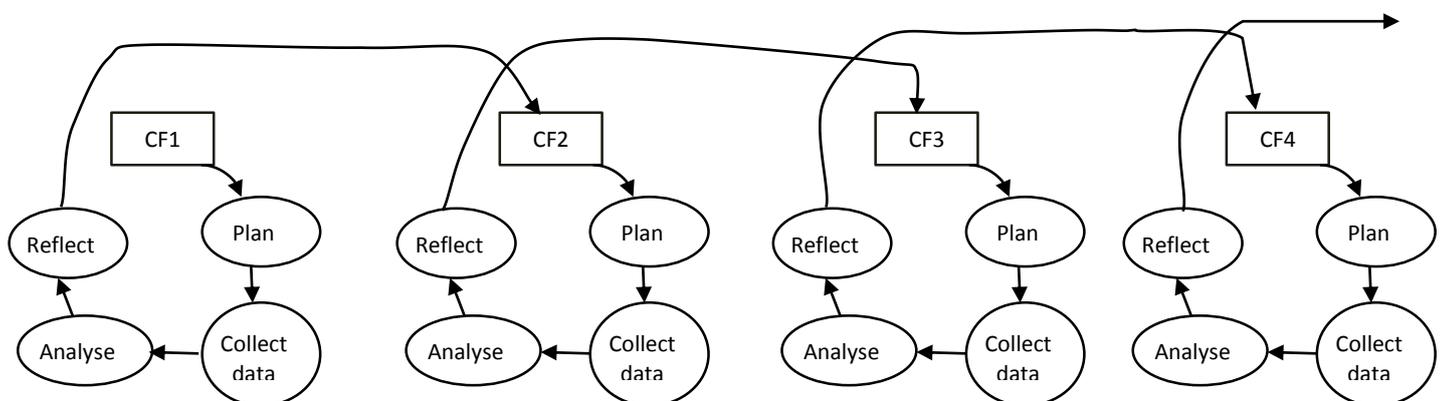
While theories can exist at different levels of complexity, the model developed in the current study can be categorized to be of the middle range, i.e. it involves conceptualisation based on *a priori* constructs and relationships but also aims to link the model to findings and observations from the data (Carroll & Swatman, 2000). The development process based on Carroll & Swatman’s ‘structured-case’ framework as applied to the current study is illustrated in Figure 1.2. The initial conceptual framework (CF1) (*a priori* framework) derived from the literature expresses the researcher’s understanding, and is used to guide the first research cycle, i.e. the design and conduct of the first case study, BBC Worldwide. At the end of this cycle, as an outcome of reflection, the conceptual framework is updated to express the understanding for the second cycle (CF2), i.e. the design and conduct of the second case study, Statistics New Zealand. In a similar fashion, the outcome of the second cycle is used to guide the third cycle (CF3 -> Focus group and Semi-structured interviews).

The last cycle (CF4) reflects not only the understanding gained from CF3 but also the cumulative understanding and reflection gained from all the research cycles – it expresses the final and refined theoretical model to be tested using a survey. It should be noted that cycles three and four (CF3 and CF4) are not directly related to cycles one and two (CF1 and CF2) are case studies, CF3 is a combination of focus group and interviews with entirely separate sets of people, and CF4 is a survey. In order to better structure and facilitate the different types of data analyses adopted in the study, the focus group and a set of interviews was regarded as a single cycle.

The model is built through a conscientious process of reflection, focusing on issues such as “What do these findings mean?”, “How do these findings compare (e.g. cross-case comparison) and relate to the outcomes from previous research cycles?” and returning back to scrutinise the literature and gaining insights from academic experts and practitioners throughout the various cycles of the research process (Carroll & Swatman, 2000). Such a theory building process reflects the problems and issues facing practitioners (Carroll & Swatman, 2000) and is especially relevant for IS, a field characterized by rapid changes in practice and an increasing gap between academic research and practice (Markus, 1997) which is prevalent even today.

The description of each research cycle is presented as a separate chapter in this thesis (Chapter 3 – case 1, Chapter 4 – case 2, Chapter 5 – semi-structured interviews and focus group, Chapter 6 - Survey).

Figure 1.2: A spiral towards understanding



Source: Adopted from (Carroll & Swatman, 2000)

CF1: case study 1 (application of *a priori* model derived from the literature)

CF2: case study 2 (reflection on the findings from case study 1)

CF3: focus group and semi-structured interviews (reflection on the findings from case study approach)

CF4: survey (reflection and testing the final framework from CF3)

(iii) Literature-based scrutiny of the theory built

As the accumulation of scientific knowledge is based on the iterative generation, extension, and testing of “theory” (Brown, Kelley, & Schwarz, 2006), the final conceptual framework is generated iteratively through various phases until the development of the final model. At this stage, the framework is thoroughly compared with a wide selection of the literature (both similar and conflicting) which may lead to critical reassessment of findings with new insights and increase the applicability of the framework to other contexts.

1.5. Contributions of the Study

This study makes significant contributions to both research and industrial practice. It conceptualises, and develops a new framework in the context of AM which combines insights from traditional innovation diffusion models, IS implementation, and AM. The purpose is to understand the key factors that impact SAU and the association between SAU and agile usage effectiveness. In so doing, important contributions to both the research and practitioner communities are made. For the research community, this research provides an integrated model for SAU and effectiveness. By combining key concepts from IS implementation, DOI, SDM, and AM literatures, the proposed SAU model increases our understanding of the sustained and effective use of AM in organisations. Secondly, it provides measures for new constructs such as *agile mindset* targeted specifically for innovative methodologies such as agile and to agile practitioners.

This study contributes to industrial practice in at least two important ways. First, the perception of agile practitioners on various issues relating to sustained and effective agile usage is explored. Support for the research hypotheses points to a need for a number of factors that are critical in sustaining effective usage of agile methods. Second, it provides valuable insights and helpful diagnostics to organisations in their efforts to sustain the effective use of agile methods.

1.6. Organisation of the Study

Having established the rationale, design, methodology, and approach of the current study, the thesis describes the research in eight chapters. Following this introductory chapter, Chapter two reviews and critically evaluates the relevant extant literature which serves as the basis for the development of an *a priori* research model (i.e. conceptual framework (CF) of SAU.

Chapter three describes the overall design that was followed for the case study method. It describes the application of the conceptual framework (CF1) to the first case study, i.e. BBC Worldwide (BBCW). The rationale for using case study method is provided followed by a description of the overall case study design. Later, design, conduct, findings and analysis of the BBCW case study are presented.

Chapter four describes the application of the conceptual framework (CF1) to the second case study, i.e. Statistics NZ (Stats NZ) followed by a discussion of findings and analysis. Next, it describes the cross-case analysis of how the framework was used to inform analysis of post-adoptive usage of agile methods in two organisations, i.e. BBCW and Stats NZ. The overall conduct of the case study approach is evaluated using the case research design quality criteria proposed by Dubé and Paré (2003).

Chapter five describes the research model building exercise. It reports on the development of a theoretical model of agile usage. It describes how two methods, i.e. a focus group and semi-structured interviews were used to further explore and gain insights on the adequacy and nature of the theoretically developed constructs of post-adoptive agile usage, and to add to the interpretation of the results found by analysing previously collected data. First, a brief introduction of data collection methods is presented which is followed by detailed information on the design and conduct of focus groups. Second, it describes the use of semi-structured interviews as a way of conducting qualitative research in IS. Then details on the design and conduct of the interviews is presented. Findings and analysis from both methods are then discussed.

Chapter six discusses the design and conduct of a cross-sectional survey set out to test and validate the proposed model of agile usage. It describes the design of a survey used to measure the constructs and their relationships comprising the agile usage model described in Chapter five. The Chapter starts with an introduction to the survey research followed by a description of the research design. Later, testing and execution of the survey instrument is described.

Chapter seven reports on the data analysis performed on the survey data structural equation modelling. It reports on how model validation exercise was conducted which is then followed by a discussion of the empirical findings.

Chapter eight concludes this thesis by describing the main contributions of the research. It discusses implications for both theory and practice and identifies the study's limitations. It concludes with some recommendations for future research.

Chapter 2. Literature Review

This chapter reviews the literature that serves as background to support the legitimacy of the research questions and objectives of this study. The areas of the literature reviewed are summarised in table 2.1:

Table 2.1: Literature review topics

Section/title	Description	Purpose
2.1 - Evolution of SDM	Review history of SDM	track the roots of agile methodologies in order to position AM within the broader spectrum of SDM
2.2 - Method and Methodology	Review of the concepts, definitions, and frameworks related to systems development methods/methodologies	examine the two widely often interchangeably used concepts
2.3 - Agile Methods	Review “agile” and “agility” concepts in the AM literature	derive a definition of AM for the purpose of this thesis
2.4 - Theoretical foundations	Review theoretical foundations of DOI, IS implementation, and Agile Evaluation framework	Serves as background for the constructs and relationships depicted in the <i>a priori</i> model
2.5 - Post-adoptive usage	Review which dissects and differentiates the concepts of ‘adoptive’ and ‘post-adoptive’ usage	provide background and rationale for conceptualising ‘sustained agile usage’
2.5.1 - Sustained agile usage	Review and explore answers to the following questions: what is method usage? How can it be measured? Does usage relate to ‘method’ use at a higher level such as XP, Scrum or to the individual practice level?	conceptualise ‘sustained agile usage’
2.6 - Agile usage effectiveness	Examine the relationship between sustained agile usage and agile usage effectiveness	provide rationale for conceptualising ‘agile usage effectiveness’
2.7 - Factors that impact sustained agile usage	Review the literature on SDM/agile method use	identify and extract the key factors that impact sustained agile usage
2.8 – Research Model	Present the proposed research model	Provide preliminary theoretical foundation
2.9 Research Scope	Focus of investigation	Highlight and provide justification for the scope of investigation
2.10 Research Design	Describe the epistemological foundations and design approaches	Rationale for the research design chosen in the current study and briefly describe the overall design

2.1. Evolution of Systems Development Methodologies

Iterative, evolutionary, and incremental development is the cornerstone on which agile methodologies were developed, but its practice and published roots go back to as early as late 1950s and early 1960s (Larman & Basili, 2003). It is beyond the scope of this literature review to give a detailed account of the history of systems development methodologies. While scholars

such as Boehm, Brooks, Larman & Basili, have chronicled the evolution of methodologies from a software engineering perspective, others (Avison & Fitzgerald, 2003a) have explored the history of SDM development by dividing it into four main eras (Pre-Methodology, Early-Methodology, Methodology, and Post-Methodology). The purpose of this section is to situate AMs within the larger scope of SDM by tracing the impetus for the emergence of AMs. The literature on the evolution of SDM is reviewed and presented using the four eras proposed by Avison and Fitzgerald (2003a) with specific emphasis on tracking the historical roots of AMs.

2.1.1. Pre-Methodology Era (1960s – 1970s)

During mid-late 50's and early 60's, most developers were scientific researchers with a strong mathematical or engineering background who used an hardware engineering approach to solve technical problems or develop supporting software (e.g. aircraft or rocket engineering) based on the prevailing thesis of the time, “engineer software like you engineer hardware” (Boehm, 1996; Boehm, 2006; Fitzgerald, 2000). During the 60's, people started understanding the differences between software and hardware engineering approaches to development (Boehm, 2006), e.g. ease of modifying software, difference between hardware and software maintenance. As the demand for software exceeded the supply of engineers and mathematicians, organisations started recruiting people from humanities and social sciences to develop software (Boehm, 2006). The 1960's saw the development of some major trends such as adoption of “code and fix” approach to development, use of higher-order languages e.g. COBOL, and generally manageable small applications. As a result, NATO science committee convened two landmark conferences in “Software Engineering” which provided a baseline for evaluating the state of practice of software development at the time and to determine and develop improvements (Boehm, 2006). It was recognised that a more disciplined approach to developing systems was needed to scale up to the increasingly large projects and systems – this led to a number of structured methods including the waterfall model in the 1970s (Boehm, 1996). The waterfall or the system development lifecycle (SDLC) consists of a set of common stages typically followed in sequential order: feasibility study, systems investigation, analysis, design, development, implementation, and maintenance. As the waterfall model became fully elaborated, it was recognised that its milestones did not fit an increasing number of situations (Boehm, 1996). As a result, the waterfall model underwent some modifications. For example, Royce introduced a revised version of the waterfall model (Royce, 1970) in which elements of agile practices such as iterative development, feedback, and adaptation could be seen (Larman & Basili, 2003). Another example was the spiral model which was developed to address the

deficiencies of the waterfall model (Boehm, 1988). As we trace the system development literature of the 1960's, and 1970's, many hybrid variations of the waterfall model which introduced the concept of iterations between its discrete stages can be found (Boehm, 1996). Other references to iterative and incremental development during this era include a 1968 report from the IBM T.J. Watson Research Centre and Robert Glass's view on the benefits of incremental development (Larman & Basili, 2003).

2.1.2. Early Methodology Era (late 70s to early 80s)

Though subsequent versions of the waterfall model added concepts such as “build it twice” prototyping activity before full development, and emphasised verification and validation of the artefacts in each phase before moving to the next phase, it was frequently misinterpreted as a purely sequential process (Boehm, 2006). By the end of the 1970's, many organisations found the waterfall model to be heavily document-intensive, slow-paced, and expensive to use (Boehm, 2006). Other serious limitations of the waterfall model such as failure to meet the real needs of the business, overly conservative systems design, instability, inflexibility, user dissatisfaction, problems with documentation, and application backlog were also recognised (Avison & Fitzgerald, 2003a; Fitzgerald, 2000).

User requirements changed dynamically as organisations' environments continued to change at an increasing pace due to increased competition and internationalisation (Hirschheim, Klein, & Lyytinen, 1995). The communication gap between professional analysts and users continued to grow as computer-based information systems addressed increasingly complicated applications (Hirschheim et al., 1995). At the same time, as technical sophistication and platforms to design and implement systems improved at a fast pace, it provided opportunities for faster and more productive systems implementation – this led to the idea that users needed a first-hand experience of the software before they use it (Hirschheim et al., 1995) This was the purpose behind prototyping which emphasised improved communication and user feedback (Bally, Brittan, & Wagner, 1977; Naumann & Jenkins, 1982). Other proposed prescriptions included iterative and incremental development (IID). IID is based on the concept of developing a software system incrementally, which provides the opportunity of incorporating what was being learned during the development of earlier, deliverable versions of the system (Basili & Turner, 1975). In 1976, Tom Gilb introduced the terms “evolution” and “evolutionary” based on the evolutionary development model (Larman & Basili, 2003). Similar to IID, the evolutionary model's concepts exhibited a clear flavour of agile, light, and adaptive

iteration. Extreme Programming (XP), one of the most popular AMs has lot of similarities to the evolutionary model (MacCormack, 2001).

2.1.3. Methodology Era (mid to late 1980's – mid to late 1990's)

A number of newer approaches emerged during the methodology era (Avison & Fitzgerald, 2003a). The term “methodology” was probably first used during this era where it was defined as a recommended collection of phases, procedures, rules, techniques, tools, documentation, management, and training used to develop a system (Avison & Fitzgerald, 2003a). Popular methodological solutions of this era were the spiral model and the rapid application development (RAD). The spiral software process model introduced the concept of evolutionary development with incremental prototyping and risk analysis at the beginning of each new increment (Boehm, 1988). Based on Gilb's evolutionary development model, the DuPont Company introduced the Rapid Iterative Production Prototyping (RIPP) methodology in 1988 – the main goal was to regularly deliver working prototypes to customers (Abbas, Gravell, & Wills, 2008). James Martin expanded RIPP into a large formalised version and published it as the RAD in 1991 (Martin, 1991). RAD recommended faster development by specifying a combination of techniques and tools such as iterative development, user involvement, and fast delivery which reflect some of the core principles' on which the current agile methods are based on. Not surprisingly, RAD became the basis for one of the well-known AMs, Dynamic Systems Development Method (Stapleton, 1997a).

Object-oriented programming languages and environments such as Smalltalk, Eiffel, and C++ stimulated the rapid growth of object-oriented development, including the development of various object-oriented analysis and design methods which converged via the Unified Modelling Language (UML) also proliferated during this period (Boehm, 2006). Other methodologies that emerged during this era to which AM can be traced back to include the Participatory Design (Muller & Kuhn, 1993) and Soft Systems Methodology (Checkland, 1999). Participatory design emphasised the involvement of end users or business users in the development process. It encompasses a number of techniques (e.g. ethnographic methods, prototyping techniques such as collaborative prototyping) to facilitate user involvement and participation in different phases of the development lifecycle.

In summary, the main objectives of methodologies that emerged during this era were to promote (1) greater flexibility and scalability of approach (2) faster development and delivery of systems and (3) greater involvement of the business user in all stages of the development

(Crinnion, 1992). The main motivations for adopting a methodology by organisations were generally to achieve: better end products (meeting user requirements); a better development process (improving developer control and productivity); and a standardized process (enabling better systems integration and the benefits of a common approach in an organisation) (Avison & Fitzgerald, 2003a). The software capability maturity model (SW-CMM), a five level framework for assessing an organisation's software process maturity was developed by the Software Engineering Institute to address the problems relating to process noncompliance (Boehm, 2006). Each level is made up of Key Process Areas (KPA) that an organisation must meet in order to qualify at that level. SW-CMM is claimed philosophically compatible with AM such as XP and Scrum (Reifer, 2003).

2.1.4. Post-Methodology Era (late 1990s - early 2000s)

The starting of the post-methodology era characterized a serious appraisal by researchers and practitioners alike of the effectiveness of earlier methodologies, many of which had evolved into what are now commonly referred to as traditional or "heavyweight" methods – see for example: (Fitzgerald, 1997, 1998; Introna & Whitley, 1997; Roberts & Hughes, 1996; Wastell, 1996; Wynekoop & Russo, 1995). Traditional methodologies were unsuitable and problematic in dynamic environments such as internet software engineering where customers were unable to definitively state up their needs up-front and therefore required higher levels of customer interactivity (MacCormack, 2001) (Lindvall, Basili, & Boehm, 2002). Empirical studies revealed that the traditional well-established methodologies were not coping with the changing newer environments and that companies were striving to simplify their processes (Lyytinen & Rose, 2003). The new environments were characterized by (Baskerville & Pries-Heje, 2004):

1. highly competitive businesses prone to rapid technological changes
2. innovative practices such as release orientation, parallel development, etc., that enabled rapid delivery of systems
3. precedence of functionality or faster cycle time over quality
4. the need for expert and experienced developers

Moreover, traditional methodologies experienced unacceptably low success rates with systems development efforts, and high complexities involved with their use in highly uncertain environments (Erickson et al., 2005; Lindstrom & Jeffries, 2004; Vinekar, 2006). Other contributing factors were disappointing productivity gains, overly complex methodologies

requiring extensive training and tools, and failure to recognise the critically important social, political, and organisational dimensions of development (Avison & Fitzgerald, 2003a).

These characteristics denoted a new form of systems development based on the philosophy of ‘growing’ systems rather than ‘building’ systems where traditional maintenance of systems is incorporated into a “continuous redevelopment of the entire organisational portfolio of systems” (Baskerville & Pries-Heje, 2004, p. 262). These characteristics which reflected the needs of the rapidly growing dynamic software industry and the emerging mobile environment led to the development of AMs (Abrahamsson, Warsta, Siponen, & Ronkainen, 2003).

The above review illustrates that though AMs have been generally viewed as the “modern” replacement of the waterfall model, their practiced and published roots go back decades (Larman & Basili, 2003). The evolutionary map of agile methods (see Figure 2.1) shows the precursor methods and their major influences on each of the agile methods (Abrahamsson et al., 2003). Examples of some popular AM are Extreme Programming (XP) (Beck, 1999), the Dynamic Systems Development Method (DSDM) (Stapleton, 1997b), Crystal Methodologies (Cockburn, 2001), Scrum (Schwaber & Beedle, 2002), Feature Driven Development (FDD) (Coad, De, & Lefebvre, 1999), and Lean Software Development (LSD) (Poppendieck, 2001). These methods collectively came to be commonly known as “lightweight” methods.

The main purpose of the various methods that evolved at different points throughout the 1990’s was to address the issues and limitations of the prevailing paradigm, i.e., methods and practices based on the waterfall model. As shown in the map (Figure 2.1), AMs constitute a collection of ideas and methods, most of which were based on the experiences and “lessons learnt” by practitioners and therefore the period mid-90’s to mid-2000’s could be regarded as the pre-paradigm period according to Kuhn (Kuhn, 1996). With the formal introduction of AMs in 2001, the Agile Manifesto, the agile community demonstrated a common understanding and committed adherence to the use and application of its values, principles, practices, and methods. If the notion of “paradigm” used by Kuhn (Kuhn, 1996) to describe a “coherent tradition of scientific research” is applied to systems and software development, then the evolution of AMs represents a new paradigm (Rajlich, 2006). The continued and ongoing growth and development of the agile movement into the 2000’s, 2010’s and beyond, in Kuhn’s view, then should represent its transformation from pre-paradigm science to “normal science”. If AMs have made this shift, then it appears they are currently still in an early phase, and lot of

work is yet to be done in evaluating their effectiveness - which should lead to further development and articulation of the paradigm.

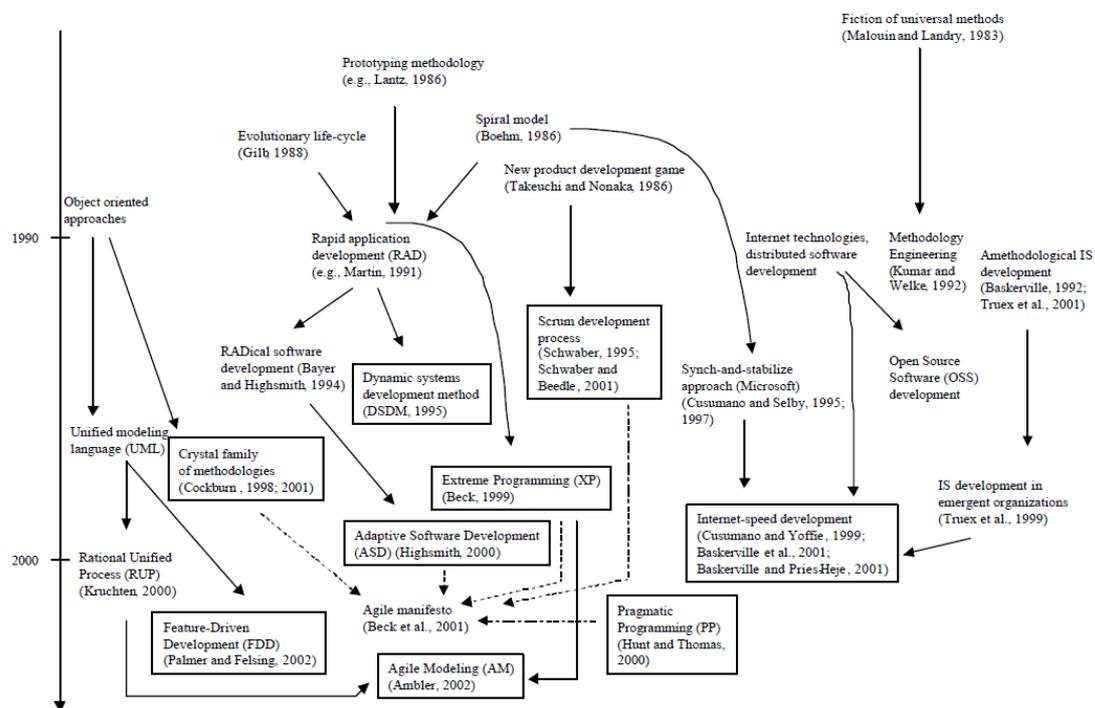


Figure 2.1: Evolutionary map of agile methods – Source: Abrahamsson et al. (2003)

2.2. Method and Methodology

2.2.1. Definitions

Systems development methodologies are one of the central topics in information systems and software engineering (Iivari & Maansaari, 1998). In the mid-90s the number of systems development methods were estimated to be of the order of 1000 (Jayaratna, 1994), and they still continue to grow. The flood of methodology options has led to a number of divergent opinions about what constitutes a method or methodology. As a result, there are a wide range of definitions for what constitutes a systems development method or methodology. The objective of this section is to review the relevant SDM literature in an attempt to gain a better understanding of the theoretical underpinnings of what constitutes a systems development method/methodology in general.

A method is defined as a “*particular procedure for accomplishing or approaching something, especially a systematic or established one*” (Oxford-Dictionary, 2013a) and a methodology “*as a system of methods used in a particular field of study or activity*” (Oxford-Dictionary, 2013a).

Therefore, a *methodology* can be interpreted as a collection of *methods* or seen to encapsulate *methods* in a particular discipline. In the field of information systems development, some believe '*methods*' encompass '*methodologies*' while others believe '*methodologies*' encompass '*methods*' (Wynekoop & Russo, 1997). The "term '*methodology*' is pragmatically well-established within the field of information systems to mean the same as '*method*'" (Jayaratna, 1994), and are used interchangeably even in the context of agile systems development (Cockburn, 2003; Conboy, 2009). This study treats these terms interchangeably.

In the ISD literature, method definitions vary from broad ones such as

"...a set of guidelines that prescribe a behaviour in order to think and act in a situation" (Nielsen, 1989, p. 82), and

"organized collection of concepts, methods, beliefs, values, and normative principles supported by material resources" (Hirschheim et al., 1995, p. 22),

to more specific and precise ones such as

"...specific, step-by-step strategies for completing one or more phases of the systems development life cycle ...[imposing] tools and standards on the SDLC" (Whitten, Bentley, & Barlow, 1989, p. 111), and

" a systematic approach to conducting at least one complete phase (e.g. requirement analysis, design) of systems development, consisting of a set of guidelines, activities, techniques and tools, based on a particular philosophy of system development and the target system" (Wynekoop & Russo, 1997, p. 66).

The divergent opinions of what constituted a methodology during the 1970s and the 1980s is apparent in the fact that there was no single methodology that covered all aspects of systems development and no accepted classification of methodologies that covered all phases of systems development (Hirschheim et al., 1995). However, the major foci of many methodologies that emerged during this period can be broadly categorized into two main groups: (1) process-oriented methodologies (e.g. Yourdon Constantine) and (2) data-oriented methodologies (e.g. Jackson Systems Development) (Hirschheim et al., 1995). In the 1990s, this process-data dichotomy was rejected when the object-oriented methodologies were popularised which proposed modelling the world in terms of software units that encapsulated both methods and data and which communicated with each other through messages

(Hirschheim et al., 1995). During the 90s, several authors continued to create methodologies and approaches that could be used to develop information systems (Brinkkemper, Lyytinen, & Welke, 1996). This was referred to as “method engineering” which is characterized by the following axioms (Introna & Whitley, 1997):

- *Methodology is necessary and sufficient for information systems’ development success* – a suitably designed methodology provides all that is required to specify and analyse a problem situation, and all that is needed to design a solution
- *If systems developers have a suitable methodology at their disposal they will use it* – developers understand the value of methodology and therefore will rather prefer to use it than not using it.

On the other hand, empirical research showed that the use of methodologies in practice was rather limited (Hidding, 1996), and when used only parts of them were used rather than strictly adhering to all the steps prescribed by a particular methodology (Fitzgerald, 1996). Some argued against the concept of methodologies (i.e. ‘method engineering’ or ‘method-ism’) by suggesting that the effective use of a methodology emerges from our understanding of involvement in the problem situation and skilled use of methodologies, tools, and techniques rather than mere adherence to a particular methodology (Introna & Whitley, 1997). Similar views were echoed when the notion that a method should adapt to the requirements of a particular context was manifested in one of the comprehensive definitions of an ISD methodology as a collection of procedures, techniques, tools, and documentation aids which guide the systems developers in their choice of procedures and techniques that might be appropriate at each stage of the project and also help in planning, managing, controlling and evaluating information systems projects (Avison & Fitzgerald, 1995).

Iivari shares a similar view where a ISD methodology is defined as a set of goal-oriented procedures supported by a set of preferred techniques and tools to guide the work of developers and other stakeholders involved in systems development (Iivari, Hirschheim, & Klein, 1998). An amalgamation of the above definitions is an inclusive interpretation that a method is an idea and enactment rather than a rigorous prescription

encompasses the complete range of practices involved in the process of designing, building, implementing, and maintaining an information system, how these activities

are accomplished and managed, the sequence and frequency of these activities, as well as the values and goals of all of the above (Conboy, 2009, p. 329).

Apart from the above, it is also believed that the definition of a methodology should include specific reference to its underlying philosophy, i.e. the underlying assumptions theories and assumptions that have shaped the development of the methodology (Avison & Fitzgerald, 2003b). Based on this rationale, the following definition is proposed:

A systems development methodology is a recommended means to achieve the development, or part of the development, of information systems based on a set of rationales and an underlying philosophy that supports, justifies and makes coherent such as recommendation for a particular context. The recommended means usually includes the identification of phases, procedures, tasks, rules, techniques, guidelines, documentation and tools....(Avison & Fitzgerald, 2003b, p. 528)

2.2.2. ISD Paradigm assumptions

In addition to the underlying philosophical assumptions that shape the development of methodologies, the underlying assumptions (e.g. nature of the organisation, value of principles, value of technology) with which systems development practitioners approach the development process plays a central role in guiding the systems development process (Hirschheim et al., 1995). Application of the notion of ‘paradigm’ to ISD is necessary to understand the relationship between these assumptions underlying different systems development methodologies, where an ISD paradigm is defined as a

fundamental set of assumptions adopted by a professional community that allows its members to share similar perceptions and engage in commonly shared practices (Hirschheim et al., 1995).

Based on the philosophical foundations established by (Hirschheim et al., 1995), Iivari published a four-tier framework to classify and organise all ISDMs published up to that time into four paradigms: functionalism (objective-order), social relativism (subjective-order), radical structuralism (objective-conflict) and neo-humanism (subjective-conflict) (Iivari, Hirschheim, & Klein, 2001). The framework differentiates between the terms *methodology* and *ISD approach* (ISDA), where an ISDA is defined as a class of specific ISDMs that share a set of common and related features which in turn drive interpretations and actions in systems

development (Iivari et al., 2001). The framework is based on the object-oriented inheritance structure:

- each ISDA inherits the paradigmatic assumptions of the paradigm it inherits,
- each ISDM inherits the features of the ISDA (goals, guiding principles and beliefs, fundamental concepts, and principles of the ISD process), and the paradigmatic assumptions of the paradigm it represents indirectly through the ISDA to which it belongs.

For example, “Use Case” is an ISD technique which is part of the ISD methodology “OOSE”, which is an instantiation of the OO approach belonging to the functionalist paradigm. Structured Analysis/Structured Design (SA/SD) is also classified under the functionalist paradigm. Functionalist paradigm views methods, tools and techniques, specifications, design models, people, organisational procedures as formal, objective entities and assumes that systems development is achieved through formal concepts, planned intervention, and rationalist tools (Hirschheim & Klein, 1989). Their (Iivari et al., 2001) classification of OO and SA/SD approaches under the functionalist paradigm is well justified. This is because traditional approaches such as SA/SD presume an objective world that is predictable and stable which anticipate a specific end and therefore focus on arriving at that end in the most efficient manner as possible (Nerur, Cannon, Balijepally, & Bond, 2010). The specifications, and the resulting design models and diagrams, are believed to be objective and consistent with an independent reality in which processes can be directly observed, measured, and verified (Hirschheim & Klein, 1989; Nerur et al., 2010).

However, in their next version of the framework (Iivari, Hirschheim, & Klein, 2004), their classification of AMs as a distinct approach belonging to the functionalist paradigm is questionable for at least three reasons:

1. As discussed in the previous section (2.1, see evolutionary map Figure 2.1), AMs are an amalgamation of previous methods, ideas, and practices from systems development and software engineering. For example, AMs and OO approach share a number of common goals, beliefs and principles as determined by Iivari et al. (2001). Both have goals such as “user requests to modify the system are responded to in a timely manner”, and share the same underlying principles of “iterative and incremental development” (Iivari et al., 2001, p. 193). In their own recent study, the authors highlight some key

issues associated with characterizing AMs as an entirely independent approach (Iivari & Iivari, 2011):

- a. defining it as a separate approach by synthesising principles and practices of various agile methods is not straightforward as the methods significantly differ from each other
 - b. using the Agile Manifesto (<http://agilemanifesto.org/principles.html>) as an authoritative list of characterizing features of a distinct agile approach would require considerable interpretation of what are essential or less essential.
2. Since AMs recognise that change is inevitable and advocates a “sense-making process”(Hirschheim & Klein, 1989) that involves adaptive planning, frequent iterations, user involvement and feedback, and reflective learning, it leans more towards “social relativism” rather than a functionalist paradigm (Nerur et al., 2010). This assessment is well reflected in the following observation (Hirschheim & Klein, 1989, p. 1205): *“the mechanism of prototyping or evolutionary learning from interaction with partial implementations is the way technology becomes embedded in the social perception and sense-making process.”*

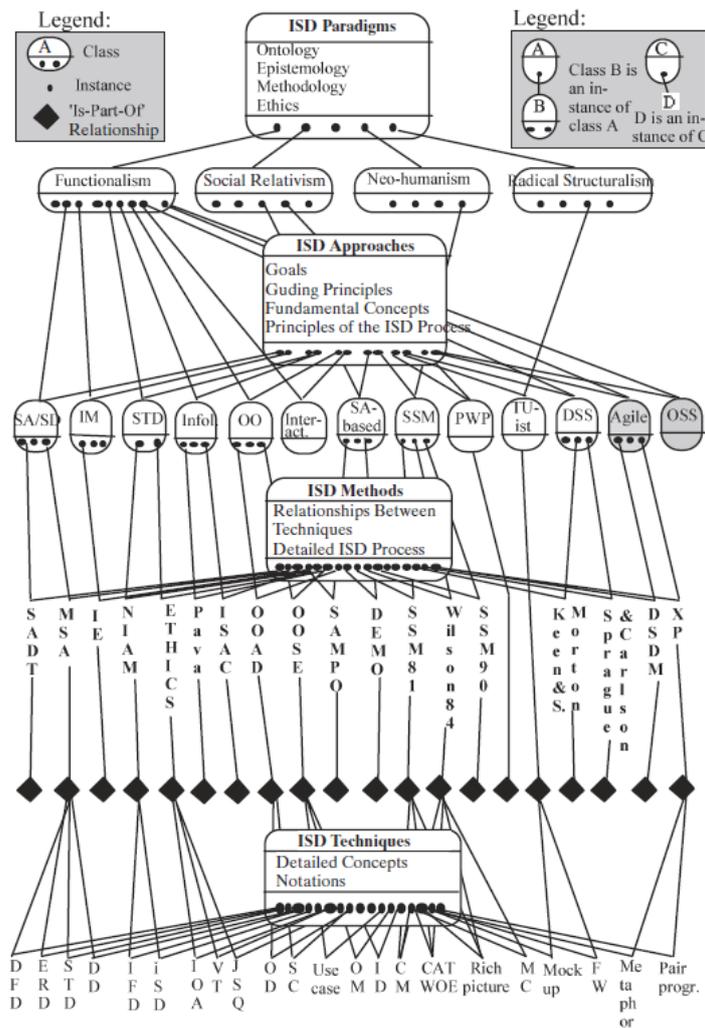


Figure 2.2: Hierarchy of ISD paradigms, approaches, methodologies, and techniques

Source: (Iivari et al., 2004)

- Thirdly, their rationale for including AMs is based on a single source of reference i.e., comparative analysis conducted by Abrahamsson (Abrahamsson et al., 2003), given that a number of relevant sources existed before the framework was published in 2004 (Boehm, 2002; Boehm & Turner, 2003; Cockburn, 2002; Highsmith, 2002b; Larman & Basili, 2003; Strode, 2005; Williams & Cockburn, 2003).

Cockburn attributes most methodological problems to the unclear definition of the ‘scope’ of a methodology (‘scope’ relates to the range of roles and activities that a methodology attempts to cover) (Cockburn, 2002). Cockburn argues that most object-oriented methodologies as described in the then-current books had a relatively small scope which mainly addressed one role (domain designer or modeller) relating to the analysis and design phases, whereas in reality a project involves more than one role – each with many activities, techniques, and deliverables.

Cockburn uses the phrase ‘*Big-M methodology*’ to encompass the main elements and various aspects of a methodology working together: people, roles, skills, teams, tools, techniques, processes, activities, milestones, work products, standards, quality measures, and team values (Figure 2.3). The elements must operate within the team’s value system, and need to align with both the people’s value system and the process being used. The concept highlights the significance of ‘team values’ and ‘people’ working collaboratively together, i.e., methodology as a social construction (Cockburn, 2002), the conventions that the team agrees to follow. Based on this rationale, Cockburn founded ‘crystal methodology’ (one of the AMs referred to as the family of people-centered methods).

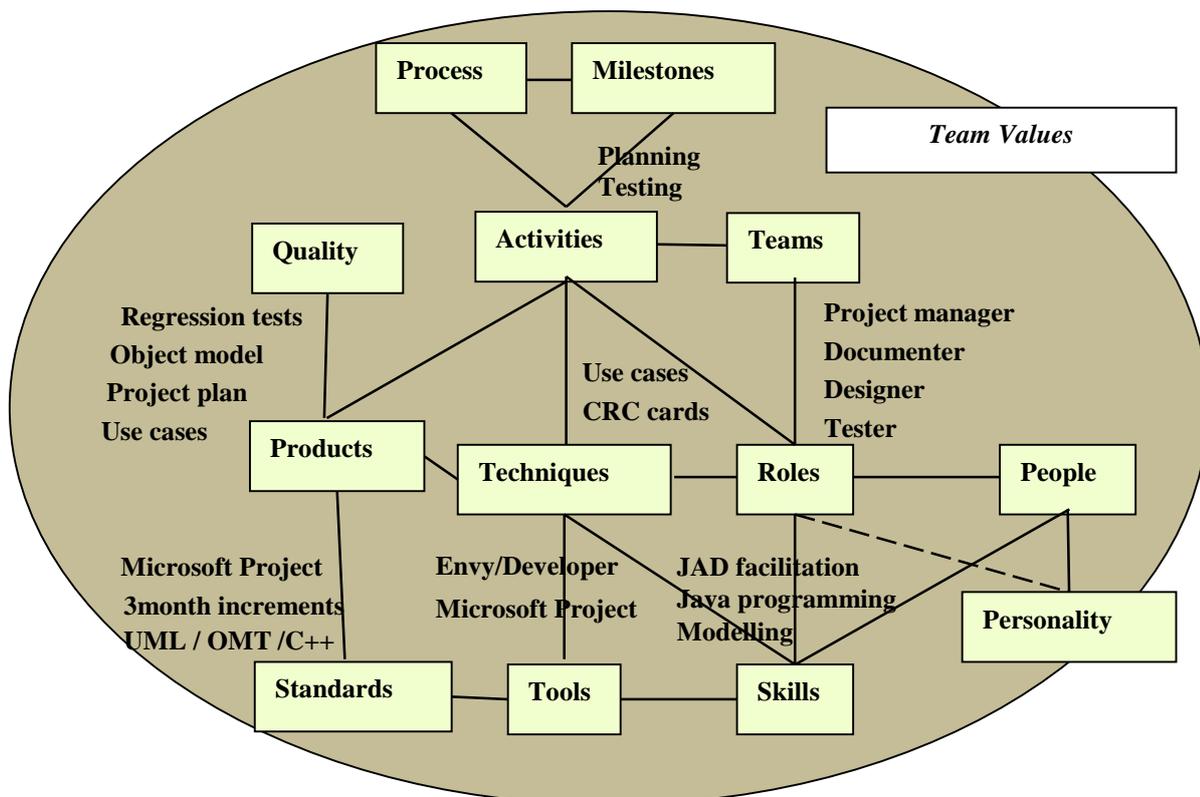


Figure 2.3: Elements of a Big-M Methodology (Cockburn, 2000)

The concept of ‘people working collaboratively together’ is also described using the phrase “Agile Software Development Ecosystem” where an ecosystem is used to describe a vision of dynamic interactions of individuals and teams in an ever-changing environment, based on a “chaordic” perspective (i.e., every organisation exhibits properties of both *chaos* and *order*). (Highsmith, 2002b). Highsmith advocates the use of a *barely sufficient methodology* based on the argument that the word ‘methodology’ conjures a vision of consequential, but incomplete elements such as activities, processes and tools and therefore it is important to focus

on (i) characteristics of ‘*adaptability*’ and ‘*people*’ rather than on ‘*predictability*’ and ‘*process*’, (ii) collaborative values and principles, and a barely sufficient methodology that provides practice-centered (focus on tacit knowledge) rather than a process-centered (focus on explicit knowledge) approach to methodology (Highsmith, 2002b).

It is evident from the above discussion that the lack of consensus in IS research on fundamental concepts such as ‘method’ and ‘methodology’ definitions (Conboy & Fitzgerald, 2004) continues. “Researchers often use the same term to refer to different concepts and different terms to refer to the same concept” (Conboy, Fitzgerald, & Golden, 2005). The same problem persists even in the field of Agile Systems Development (ASD) – the next section attempts to illustrate this point.

2.3. Agile Methodologies

Agile Alliance was formed in 2001 (Alliance, 2001), and a manifesto for ASD formally introduced AMs to the field of ISD (Table 2.2) accompanied by a set of its guiding principles (Table 2.3) (Fowler & Highsmith, 2001). Those involved sought to “restore credibility to the word *method*” (Conboy et al., 2005; Fowler & Highsmith, 2001). The manifesto represents a major revolutionary work in coalescing and extending the critique of formalised ISD methods (Conboy et al., 2005).

Table 2.2: Manifesto for Agile Software Development (Fowler & Highsmith, 2001)

Manifesto for Agile Software Development
<p>We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:</p> <ul style="list-style-type: none"> • Individuals and interactions over processes and tools. • Working software over comprehensive documentation. • Customer collaboration over contract negotiation. • Responding to change over following a plan. <p>That is, while there is value in the items on the right, we value the items on the left more.</p>

Table 2.3: Principles of Agile Methods (Fowler & Highsmith, 2001)

Principles behind the Agile Manifesto
<p>We follow these principles:</p> <ul style="list-style-type: none"> • Our highest priority is to satisfy the customer through early and continuous delivery of valuable software. • Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage. • Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

- Business people and developers must work together daily throughout the project.
- Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
- The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
- Working software is the primary measure of progress.
- Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
- Continuous attention to technical excellence and good design enhances agility.
- Simplicity--the art of maximising the amount of work not done--is essential.
- The best architectures, requirements, and designs emerge from self-organising teams.
- At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly.

Agility is the core concept in ASD. However, there is no formal definition of ‘agility’ in information systems and no consensus as to what constitutes an agile methodology (Conboy & Fitzgerald, 2004). The agile manifesto (Alliance, 2001) cannot be used as a suitable set of criteria for defining ‘agility’ or ‘agile methodology’. This is because all the manifesto principles cannot be practically adhered to by any method that claims itself agile. There are many different agile methodologies, such as Scrum, XP, DSDM, and FDD each with its own prescribed set of practices and principles. They are portrayed as agile even though they focus heavily on some of the manifesto principles and ignore others completely (Conboy et al., 2005). Moreover, these methods are so disparate that while some represent prescriptive operational instructions for developers (i.e., XP), others function more as project management frameworks rather than ISD methods per se (i.e., Scrum) (Conboy, 2009). In yet another view, it is argued that a method can be determined whether it is agile only by retrospective reflection (Cockburn, 2002). Therefore, the objective of this section is to review prior agile literature in an attempt to derive a definition and broader interpretation of what constitutes an ‘agile method’ for the purpose of the current study.

While *agility* in general can be defined as the “quality or state of being agile”, it is likened to a table which stands on four key legs (attributes) (Levine, 2005):

- *speed*: quick, fast
- *nimble*: able to improvise, and use patterns creatively to construct new solutions on the fly, flexible
- *adaptable*: responsive, dynamic and interactive in response to a customer, or to changing circumstances
- *resourceful*: thoughtful or exhibiting some discipline

In the context of ISD, agility as a concept is a multifaceted construct that comprises of different and conflicting capabilities (Lee & Xia, 2010). Lyytinen and Rose (2006) argue that agility is a contextual concept, and can be achieved through different means depending on the requirements of the context and environment. In agreement with this argument, Abrahamsson et al. (2009) suggest that organisations need to adopt their own interpretation of what agility means to them, as opposed to that specified by an individual method such as XP or Scrum. It is also acknowledged that it is important to have strong theoretical foundations on which a cohesive body of knowledge can be built (Abrahamsson et al., 2009). Therefore, this study draws from the existing agile theoretical literature to derive a definition of agility that not only meets the requirements of this research but also attempts to contribute to the cumulative body of knowledge.

In the agile literature, agility has been used by different people to refer to different phenomena (Conboy, 2009). The various founders, practitioners, and researchers of agile methods have different views and opinions on what constitutes ‘agility’ or ‘agile’ method. Accordingly, a number of different definitions pertaining to ‘agility’ and ‘agile methods’ exist (see Table 2.4) For example, Qumer & Henderson-Sellers (Qumer & Henderson-Sellers, 2008b) derive their definition of an “agile method” based on the application of *agility* concept to the notion of a systems development methodology.(Henderson-Sellers & Serour, 2005) Lee and Xia (2010) define software development agility as the team’s capability to efficiently and effectively respond to and incorporate user requirement changes during the project life cycle – they conceptualise agility using two dimensions: *response extensiveness* and *response efficiency*. While *response extensiveness* relates to the extent and scope of software team responses, *response efficiency* relates to the time, cost, resources, or effort associated with software team responses. Their research model identifies *team autonomy* and *team diversity* as antecedents of agility, and three aspects of software development performance (*on-time completion, on-budget completion, and software functionality*).

Based on a literature review of agility across a number of different disciplines such as manufacturing and management, Conboy propose a formative taxonomy to derive a definition of agility in an ISD context (Conboy, 2009). His study is the most serious analysis of the concept of “agility” in Information Systems and Software Engineering, where a rich concept of agility is reconstructed (Iivari & Iivari, 2011):

“the readiness of an ISD method to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy, quality, and simplicity), through its collective components and relationships with its environment” (Conboy, 2009, p. 340)

Conboy’s definition leads to the question if the concept of “agility” can be attributed to individual principles and practices of a specific agile method such as XP or it characterizes the whole realm of AMs (Iivari & Iivari, 2011). For example, it is emphasised that each of the individual practices of XP may not be new by itself, but it is the integration of complementary principles that highlights the uniqueness of XP (Iivari & Iivari, 2011; Turk, Robert, & Rumpe, 2005). The principles and practices of XP might not actually contribute to agility in every instance, and conversely, practices not traditionally recognised as agile might make a significant contribution towards ‘agility’ (Conboy, 2009). This suggests that XP’s “agility” would lie in the unique combination of appropriate principles (Iivari & Iivari, 2011).

The concepts of “economy” and “quality” in Conboy’s definition also implies that agility is not *a priori* characterization of “agile” SDMs, but an emergent property of certain methods (Iivari & Iivari, 2011). This implies that alternative and sometimes contradictory principles and techniques when appropriately combined might lead to the same emergent property at the whole method level. A method can be classified as agile in the emergent sense, if it exhibits emergent agility sufficiently regularly, if reasonably well adhered to by qualified practitioners (Iivari & Iivari, 2011). This leads to the question of how can following or adherence to a method be evaluated? For example, Cao, Mohan, Xu, and Ramesh (2009) reported that faithful appropriation of XP led to better project success. On the contrary, it is also well known that most organisations do not strictly follow or adhere to any one particular agile method, but use a tailored approach by combining a number of agile practices from different agile methods that reflect their contextual requirements (Patton, 2009). For example, some teams or projects in an organisation might adapt practices depending on the contextual needs (e.g., daily stand-up meetings only once a week, combining XP practices such as pair programming with Scrum practices). This implies that an agile method can be adapted according to the requirements of the context and can be categorized as an agile method, as long as it is based on the core foundational principles and values of the agile manifesto. Agile methodology, then, could also imply *amethodical* means of systems development, i.e., where systems development is a random, flexible, negotiated process which idealizes creativity, change, social constructivism, and human independence (Truex, Baskerville, & Travis, 2000).

Despite the various measures and dimensions used in prior literature to conceptualise agility (table 2.4), the common theme underlying these various definitions is the concept of embracing and responding to change (Conboy & Fitzgerald, 2004; Larman, 2004; Lee & Xia, 2010; Qumer & Henderson-Sellers, 2008a). Therefore, it is believed that definition of an agile method should include this concept of ‘change’.

ASD emphasises a practice-centered, rather than a process-centered approach to methodology (Highsmith, 2002b). While processes are mainly described in manuals and focus on explicit knowledge, practices such as daily stand-up meetings, on-site customer, pair programming happen in reality and focus on tacit knowledge (Highsmith, 2002b). As the focus of the current study is on potential improvements in systems development as an outcome of continued usage of agile practices, ‘agile method’ refers more to a mature implementation of a set of agile practices rather than strict adherence to a particular agile method such as Scrum. Secondly, as the ultimate objective of ASD method is to maximise business value (Highsmith, 2002b), it is believed that the method definition should incorporate the view that an ‘agile method’ contributes to perceived improvements in systems development outcomes, such as quality, productivity, and customer satisfaction.

Table 2.4: Definitions of Agility/Agile Methods

Source	Relevant Definitions/Concepts/Ideas – Agility
(Larman, 2004)	Agility is rapid and flexible response to change
(Highsmith, 2004)	Agility is the ability to both create and respond to change in order to profit in a turbulent business environment; it is the ability to balance flexibility and stability
(Boehm & Turner, 2004)	Agility applies memory and history to adjust to new environments, react and adapt, take advantage of unexpected opportunities, and update the experience base for future.
(Erickson et al., 2005)	Agility is associated with such related concepts as nimbleness, suppleness, quickness, dexterity, liveliness, or alertness; it means to strip away the heaviness in traditional software development methodologies to promote quick response to changing environments and changes in user requirements
(Henderson-Sellers & Serour, 2005)	Agility refers to readiness for action or change; it has two dimensions: (1) the ability to adapt to various changes and (2) the ability to fine-tune and reengineer software development processes when needed
(Lyytinen & Rose, 2006)	Agility is defined as the ability to sense and respond swiftly to technical changes and new business opportunities; it is enacted by exploration-based learning and exploitation-based learning
(Cockburn, 2006)	Agility is being light, barely sufficient, and manoeuvrable
(Qumer & Henderson-Sellers, 2008a)	Agility is a persistent behaviour or ability of an entity that exhibits flexibility to accommodate expected or unexpected changes rapidly, follows the shortest time span, and uses economical, simple, and quality instruments in a dynamic environment; agility can be evaluated by flexibility, speed, leanness, learning, and responsiveness
(Conboy, 2009)	Agility is defined as the continual readiness of an ISD method to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy, quality, and simplicity), through its collective components and relationships with its environment

Source	Relevant Definitions/Concepts/Ideas – Agile Methods
(Boehm & Turner, 2003)	Agile methods are very lightweight processes that employ short iteration cycles; actively involve users to establish, prioritize, and verify requirements; and rely on tacit knowledge within a team as opposed to documentation
(Qumer & Henderson-Sellers, 2008a)	A software development method is said to be an agile software development method when a method is people focused, communications-oriented, flexible (ready to adapt to expected or unexpected change at any time), speedy (encourages rapid and iterative development of the product in small releases), lean (focuses on shortening timeframe and cost and on improved quality), responsive (reacts appropriately to expected and unexpected changes), and learning (focuses on improvement during and after product development)

(Source: adapted from (Lee & Xia, 2010))

Based on the above review of the conceptual foundations in the agile extant literature, and in particular drawing from the three definitions' of agility (shown in bold in table 2.4) that are relevant to the current study's purpose, the following definition for an 'agile method' is proposed. An agile methodology is defined as

“a practice-centered method to systems development which focuses on adaptability, creating and embracing change, and learning from change while contributing to maximising business value (quality, productivity, and customer satisfaction), through its collective components and relationships with its environment”.

2.3.1. Agile Methodologies – an Information System Process Innovation

An innovation is interpreted as “an idea, practice, or object that is perceived as new by an individual or other unit of adoption” (Rogers, 2003). In Information Systems, an IS process innovation is defined as any new way of developing, implementing and maintaining information system in an organisational context (Swanson, 1994). Since AMs have been portrayed as new, revolutionary and innovative (Pikkarainen et al., 2007) way of systems development, they can be categorized as a class of IS process innovations. According to Swanson, IS process innovations can be classified as

- i) administrative process innovations (type Ia) that cover administrative changes such as new project management and new control procedures, or participative modes of interactions etc., and
- ii) technological process innovations (type Ib) that cover all tools and technical practices that contribute to improvements in systems development productivity (Mustonen-Ollila & Lyytinen, 2003).

Based on the above classification, AMs can be classified as either type Ia or type Ib process innovation:- for example, while Scrum, a project management framework can be classified as a type Ia innovation, agile practices (e.g. test-driven development) and tools (e.g. Kanban boards, testing tools), can be categorized as type Ib innovations.

According to the IT diffusion framework, which distinguishes both the locus of adoption (individual vs organisation) and the class of technology (type 1 technology with low knowledge-burden and low user interdependence vs. type 2 technology with high knowledge-burden and high user interdependence) (Fichman, 1992), AMs can be classified as an organisational adoption of type 2 innovations.

Adoption is identified as a two staged implementation scenario, i.e., an organisational decision to adopt (primary adoption) followed by individual adoption by projects/teams/individuals (secondary adoption) - ideally, secondary adoption occurs only after the decision has been made at the organisational level (Gallivan, 2001). After primary adoption, management has three options to enforce secondary adoption:

- mandate innovation throughout the organisation,
- provide necessary support and infrastructure and allow the innovation to diffuse voluntarily; or
- phased adoption –initially introduce on few pilot projects - further rate of adoption will depend on the pilot project results and findings.

Though the decision to adopt may be optional, consensus-based, or authority-based, the most common pattern within organisations is a consensus-based primary decision (top management level), followed by authority-based secondary adoption (individual project/team level) (Gallivan, 2001) (see table 2.5). In AMs, though there are few examples of authority-based adoption (Mangalaraj et al., 2009b), consensus-based and optional secondary adoptions are more popular (Dyba & Dingsoyr, 2008; Layman, Williams, & Cunningham, 2004; Pikkarainen et al., 2007; Vijayasarathy & Turk, 2008b). At the secondary level, the adoption could be authority-based (AMs mandated for all projects), consensus-based (either all projects or some projects adopt AMs based on a consensus), or optional adoption (teams have the option to choose).

Table 2.5: A taxonomy of Organisational Innovation Adoption Types (adapted from (Gallivan, 2001)).

			Adoption mandatory?	Primary Adoption (Organisation – Yes)
Do individual development teams/projects adopt the innovation?	Yes	All projects	Yes	Authority-based adoption or Consensus-based full adoption
		Some projects	No	Optional or Consensus-based partial/phased adoption
	No			Adoption but no deployment

In summary, AMs can be classified as a contingent organisational innovation, where the secondary adoption could be authority-based, optional, or consensus-based, type 2 process innovations belonging to either type Ia, or Ib IS innovation category.

The next sections describe Scrum and Kanban, two of the popular and widely used contemporary AMs. They are also the methods implemented in the two cases investigated in the current study, BBC Worldwide – Kanban, and Statistics NZ – Scrum.

2.3.2. Scrum

Ken Schwaber (one of the signatories to the Agile Manifesto in 2001) co-developed the Scrum methodology with Jeff Sutherland in the early 1990s to formalise a framework for empirical process development. Empirical process development is based on the underlying belief that systems development is an “empirical process” rather than a “defined process” as prescribed by traditional rigorous methodologies (Highsmith, 2002a). Empiricism asserts that knowledge comes from experience and making decisions based on what is known (Sutherland & Schwaber, 2011). In comparison with a defined process which can be designed and run repeatedly with predictable results, an empirical process cannot be consistently repeated and therefore requires constant monitoring and adaptation (Schwaber, 1996). Scrum is commonly referred as a framework in which systems development activities such as requirements gathering, and design takes place in an iterative, incremental manner (Deemer, Benefield, Larman, & Vodde, 2012). Scrum has three events (Sprint Planning, Sprint Review, and Daily

Scrum Meeting), three artefacts (Product Backlog, Sprint Backlog, and Burndown Charts) and three roles (Product Owner, Scrum Master, Development Team) The Key roles, artefacts, and events are shown in Figure 2.4.

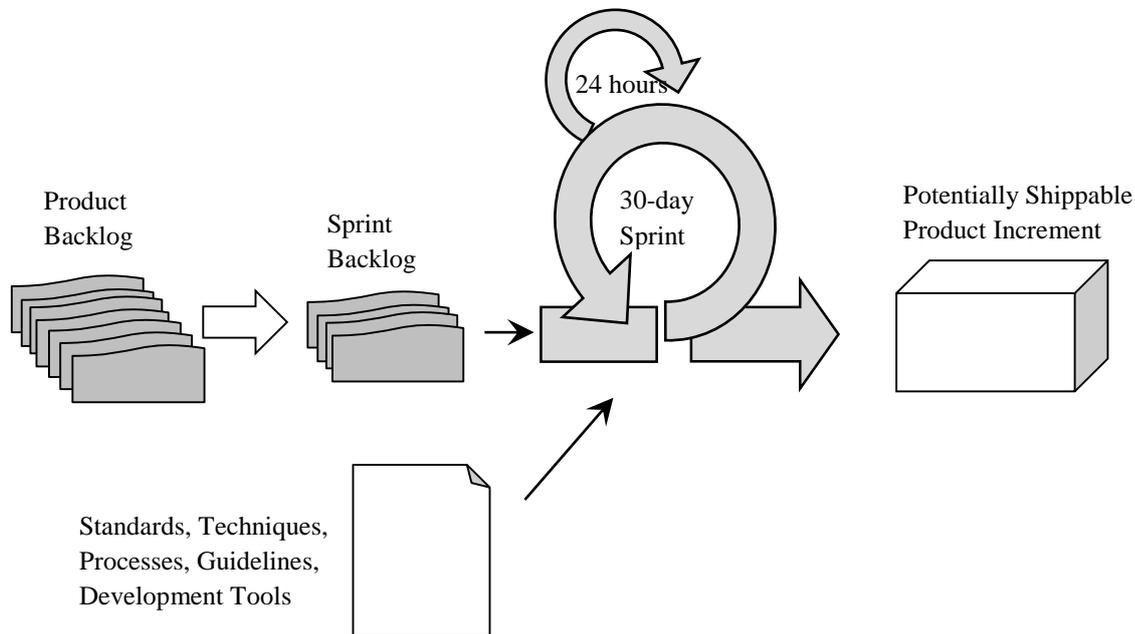


Figure 2.4: Scrum Methodology (the overall process: adapted from (Highsmith, 2002b))

2.3.2.1. Scrum Events and Artefacts

Scrum events and artefacts are specifically designed to enable critical transparency and inspection and is a formal opportunity to inspect and adapt something. The heart of Scrum is a Sprint, a time-box of one month or less during which a “done”, useable and potentially shippable product increment is created (Sutherland & Schwaber, 2011). At the start of the sprint, the team creates a sprint backlog, i.e. a list of the tasks to perform during the sprint. During a sprint, the Scrum team focuses on a clear and relatively stable goal, aimed towards taking a small set of features from idea to done stage, i.e. coded, tested and integrated into the evolving product or system. On each day of the sprint, all team members attend a daily Scrum meeting (time-boxed to no more than 15 minutes) where they identify any impediments to progress (Cohn, n.d.). At the end of a sprint, the team conducts a sprint review with key stakeholders to seek feedback that could be incorporated in the next sprint (Deemer et al., 2012). A sprint retrospective is also held at the end of each sprint which is an opportunity for the team to reflect on the sprint that ended, and identify opportunities to improve (Cohn, n.d.).

2.3.2.2. The Scrum Team

The Scrum team consists of a Product Owner, the Development Team, and a Scrum Master (Sutherland & Schwaber, 2011):

The Product Owner

The Product Owner (PO) is responsible for maximising the value of the product/system being developed and the work of the Development Team. The PO is the sole person responsible for managing the Product Backlog. The key tasks of the PO are: clearly expressing Product Backlog items; ordering the items in the Product Backlog to best achieve goals and missions; ensuring the value of the work the Development Team performs; ensuring that the Product Backlog is visible, transparent, and clear to all; and, ensuring the Development Team understands items in the Product Backlog to the level needed.

The Development Team

The Development Team consists of professionals who do the work of delivering a potentially releasable increment of “Done” product at the end of each Sprint, and have the following characteristics:

- teams are self-organising - they choose how best to accomplish their work, rather than being directed by others;
- they are cross-functional – they have all competencies needed to accomplish the work;
- Scrum recognises no titles for Development Team members other than Developer, regardless of the work being performed by the person;
- accountability belongs to the Development Team as a whole, though individual development team members may have specialized skills and areas of focus;
- Teams do not contain sub-teams dedicated to particular domains like testing or business analysis.

The Scrum Master

The Scrum Master is responsible for ensuring that the Scrum team adheres to Scrum theory, practices, and rules. The Scrum Master helps the Scrum team achieve their highest level of performance by enabling team members to exclusively focus on their selected sprint goals.

The Scrum Master helps those outside the Scrum team understand which of their interactions with the Scrum team are helpful and helps everyone change these interactions to maximise the value created by the Scrum team.

2.3.3. Kanban

Kanban is a lean approach to systems development. It was developed by David Anderson and first implemented in 2004 at Microsoft (Anderson 2010). The term ‘lean’ emerged to describe the automobile production processes developed by Toyota, referring to the fact that Toyota used less space, manpower, materials and time to make their products than their Western competitors (Middleton & Joyce, 2010a). Though software development is somewhat different to manufacturing and product development, at a higher level the principles are the same in any specific application area, and it has been more common in to draw on concepts from the Toyota Production System (Middleton & Joyce, 2010a). Lean development as an evolutionary, incremental approach to software development was advocated by Gilb (Gilb & Finzi, 1988). Other lean software ideas developed by Poppendieck (Poppendieck & Poppendieck, 2003) and Middleton & Sutton (Middleton & Sutton, 2005) explored how lean thinking could be transferred from manufacturing to the more intangible world and culture of systems development (Middleton & Joyce, 2010a). Although it has different intellectual roots, lean development has much in common with ASD as lean ideas helped provide a context and specific tools for the development of agile (Middleton & Joyce, 2010a).

Kanban is based on the Theory of Constraints (TOC) whose main underlying principle is to let a new process evolve by eliminating one bottleneck after another until it no longer constrains performance, i.e. an iterative approach to improving performance systematically by identifying and removing bottlenecks (Anderson, 2010b). Anderson synthesised this technique with ideas from lean development (i.e. Theory of Constraints + lean development) to pioneer a more direct implementation of Kanban system for systems development.

Literally, *Kan-ban* is a Japanese word that means “signal card”, which is used as a signal to tell an upstream step in a process to produce more – the workers at each step in the process are not allowed to do work unless they are signalled with a Kanban from a downstream step (Anderson, 2010b). Kanban (capital K) is used to refer to the methodology of evolutionary and incremental change development approach that utilises a kanban (small k) pull system, visualisation, and other tools to catalyse the introduction of lean ideas into IS development and IT operations (Anderson, 2010b).

The Kanban method is enabled by a set of five core principles:

- (i) Visualise the workflow – represent the work items and the workflow on a wall or electronic board that reflects the current process, which provides greater visibility into what work is being done and any associated issues with the work items or the workflow (Figure 2.5). Visualising is about revealing the mechanism, the interactions, the queues, buffers, waiting and delays in the production of a piece of valuable software (Anderson, 2010a).
- (ii) Limit Work-in-Progress (WIP) – assign explicit limits to how many items may be in progress at each workflow state (Figure 2.5) (Kniberg & Skarin, 2010). It implies the introduction of a pull system from a family of possible solutions such as Kanban.
- (iii) Measure and Manage Flow – flow highlights a focus on keeping work moving at a consistent pace and using the need for flow as the driver for improvement (Anderson, 2010a).
- (iv) Make Process Policies Explicit – making process policies explicit is another level of visualisation which is like holding up a mirror to the working reality and encouraging the whole team to reflect on its effectiveness (Anderson, 2010a).
- (v) Use Models to Recognise Improvement Opportunities – using data and models on system performance: flow time; WIP; delivery throughput; will provide scientific insight into opportunities for improvement (useful models may include work from Eliyahu M. Goldratt on Theory of Constraints, John Seddon and Peter Senge on Systems Thinking)(Anderson & Linden-Reed, 2010).

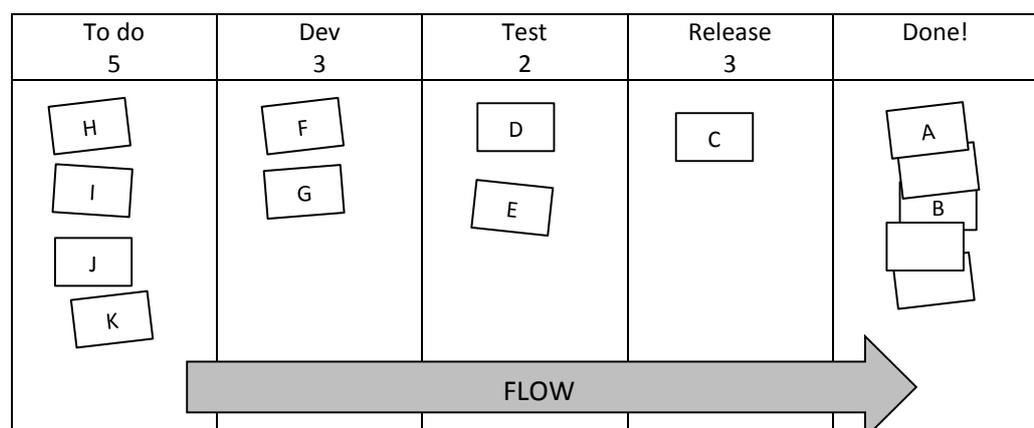


Figure 2.5: A Card wall showing WIP limits and workflow (Kniberg & Skarin, 2010)

In summary, both Scrum and Kanban have much in common with ASD as they are based on the core underlying principles of the Agile Manifesto. However, because of their different

intellectual roots, there are some key differences between the two (Anderson, 2010c) (i) while Scrum uses commitments (daily stand-up meetings at a personal level, and sprint commitment at the team level), Kanban uses WIP limit as its control mechanism. (ii) Scrum requires establishing new roles (e.g. Scrum Master) and responsibilities, whereas Kanban can be implemented without making major changes to the existing process, and (iii) Scrum involves a “container” approach, for example, a Sprint time-boxes a batch of development work in which outside interference is ideally discouraged in order to make the activity within the container, i.e. the Sprint development, as predictable as possible. Kanban emphasises a whole system approach, for example, the combination of visualisation and a WIP limit pull system enables a simple interface with business owners and can cope with multiple competing business owners attending queue replenishment meetings.

2.4. Theoretical Foundations

Although agile method use has grown dramatically in recent years, there is lack of empirical evidence for their effective use and predicted improvements in systems development (Wang et al., 2012). As AM are becoming well-established processes of many organisations, there is an increasing need to have a better understanding of their use beyond the adoption stage (Abrahamsson et al., 2009). However, one of the main challenges related to this branch of research is the lack of sound conceptual foundations and theoretically oriented empirical research into the use of SDM in general (Huisman & Iivari, 2002) and agile methods in particular (Wang et al., 2012). It is not surprising then that agile researchers have started to draw from other well-established theoretical backgrounds. For example, theories such as innovation diffusion frameworks have provoked interest in the agile research community (Mangalaraj et al., 2009b; Pikkarainen et al., 2007) as they provide a promising theoretical lens for this purpose (Wang et al., 2012). Innovation diffusion theories have been recognised as useful frameworks in enhancing our understanding of the diffusion of innovations (McChesney & Glass, 1993; Raghavan & Chand, 1989; Rogers, 2003). Earlier generalisations of DOI focused on individuals’ adoption of personal-use innovations, but did not have the ability to explain diffusion of complex technologies (Lyytinen & Damsgaard, 2001). If such theories are to be applied to complex process innovations such as AM, they should be suitably adapted (Fichman, 1992). Therefore, the objective of this study is to propose an integrated framework that combines key elements from well-established theories such as DOI, IS implementation, and SDM including any existing theories in the extant AM literature.

This section reviews the literature that serves as background for developing an *a priori* model of agile usage, i.e., the theoretical research framework. Theory acts as a lens through which we focus and magnify specific areas of interest to be investigated and filter out those things that are presumed to be ‘noise’ (Truex, Holmström, & Keil, 2006). A theoretical framework provides an overall structure for examining a problem and serves as a guide to examine relationships between concepts (Lee, Lee, & Gosain, 2004). Given the lack of strong theoretical and conceptual base in AM research (Pikkarainen et al., 2007), this study seeks to draw from a number of well-established theoretical foundations to develop the research model.

2.4.1. Innovation Diffusion Frameworks

The origin of Roger’s most widely cited work on diffusion of innovations is based on extensive study of agricultural innovations (Rogers, 2003). It includes a meta-analysis of a wide range of innovations studied in diverse contexts, and is characterized as an information-centric view of the diffusion of innovations (Agarwal & Prasad, 1998). According to Rogers, an idea, practice, or object perceived as new by the individual is characterized as an innovation to that individual (Rogers, 2003). It does not matter if the idea is “objectively” new as measured by the lapse of time since its formal introduction. Rogers describes the innovation process as having five stages:

- Knowledge – the decision-making unit learns and understands the innovation’s existence
- Persuasion – the decision-making unit forms an attitude towards the innovation
- Decision – the decision-making unit decides to either adopt or reject the innovation
- Implementation – the innovation is put to actual use
- Confirmation – reinforcement of the decision already made – adoption decision may lead to either continued adoption and use or discontinuance, and rejection may lead to either continued rejection or later adoption.

The five stages can be broadly classified into two main phases: 1) Initiation and 2) Implementation. Initiation consists of all the planning and activities leading up to the decision to adopt and implementation consists of all the activities and actions relating to putting the innovation to use.

Diffusion of Innovation (DOI) theory identifies several characteristics of an innovation that significantly influence an individual's acceptance of an innovation (Agarwal & Prasad, 1997; Moore & Benbasat, 1991; Rogers, 2003). These characteristics are:

- *Relative advantage*: the degree to which an innovation is perceived as offering an advantage over previous ways of performing the same task
- *Compatibility*: the degree to which an innovation is perceived as being consistent with existing values, practices, and past experiences
- *Complexity*: the degree to which an innovation is perceived as difficult to understand and use
- *Trialability*: the degree to which an innovation may be experimented prior to its actual use
- *Observability*: the degree to which the results of an innovation are visible to others.

Moore and Benbasat (Moore & Benbasat, 1991) extended Roger's set of characteristics by adding two additional perceived attributes to (Agarwal & Prasad, 1998):

a) *image*- it is defined as the degree to which the use of an innovation enhances one's image within an organisation. This construct was included by Rogers as part of relative advantage, as an independent predictor of usage,

b) *result demonstrability* – the tangibility of the results of using an innovation Rogers's observability construct was separated into two constructs: *result demonstrability* and *visibility*.

Technology Acceptance Model (TAM) (Davis, 1986) is an extension of the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1973; Fishbein & Ajzen, 1980) adapted to the field of information systems. It identifies *perceived usefulness* (PU) and *perceived ease of use* (PEOU) as two factors that influence an individual's *intention to use* an information system, with intention to use serving as a mediator of actual system use. PEOU has a direct impact on PU. PU is defined as the user's perception that using a specific innovation will increase his or her job performance within an organisational context. It is similar to the relative advantage in DOI theory (Moore & Benbasat, 1991). PEOU is the degree to which the user perceives the innovation to be relatively free of effort and is similar to the notion of complexity in DOI theory (Moore & Benbasat, 1991).

Though there are some important differences in the origins and the scope of the two models (DOI and TAM), there are many similarities between them beyond the high level of interest they have drawn from IS researchers studying IS adoption (Gallivan, 2001):

- (i) both models identify an innovation's perceived attributes as key independent variables explaining adoption and use,
- (ii) both models feature individuals' perceptions about their actual use as their dependent variable, and
- (iii) both models apply to situations where the individual user's choice to use an innovation is voluntary.

Due to many similarities between the two models (DOI and TAM), and given the fact that many IS researchers (Agarwal & Prasad, 1997; Chan & Thong, 2009; Mangalaraj et al., 2009a; Moore & Benbasat, 1991) have combined elements of both models, they are jointly referred to as "innovation diffusion frameworks" (Gallivan, 2001). For example, Riemenschneider, Hardgrave, and Davis (2002) used elements from the technology acceptance model (TAM, TAM2), Perceived Characteristics of Innovating (PCI), Theory of Planned Behaviour (TPB), and the Model of Personal Computer Utilisation (MPCU) to investigate why individual developers accept or resist new methodologies. Their comparative study identified twelve distinct constructs from the five models including those that overlap. For example, the *PU* construct in TAM and TAM2 is very similar to the notion of *Relative Advantage* in DOI theory and PCI (Moore & Benbasat, 1991), *attitude* in TPB, and *job fit* in MPCU, though all of these measure the same construct.

In general, user acceptance has been operationalised as a dependent variable in a variety of different ways such as acceptance, use intentions, and current usage. However, innovation diffusion research postulates many different dependent variables of interest including both initial use and continued or sustained use of the innovation (Agarwal & Prasad, 1997). While innovation diffusion frameworks have been traditionally used as models of initial acceptance and use, they have also been used to examine post-adoptive or sustained usage of IS innovations. For example, TAM was used to examine both initial and continued use of word processing software (Davis, 1989), and more recently to examine agile acceptance both at the method level (Mangalaraj et al., 2009a) and at the practice level (Wang et al., 2012).

2.4.2. Innovation Assimilation and IS Implementation

Assimilation is an organisational process that is initiated with the adoption of an innovation and can be fruitfully implemented through its full acceptance, utilisation, and institutionalisation (Meyer & Goes, 1988). It refers to the extent and intensity with which an innovation becomes incorporated into the organisation, i.e. degree of assimilation (Gallivan, 2001). In models that include various stages of innovation assimilation, the outcome of interest is not user adoption per se based on a simplistic binary perspective (i.e., either a method is adopted or not), but rather the extent and intensity of its use based on the incremental nature of adoption (Gallivan, 2001; Wang et al., 2012). Based on the works of Zmud and colleagues (Cooper & Zmud, 1990; Saga & Zmud, 1994), Gallivan proposed a six-staged model (Figure 2.6) to understand the various factors that influence innovation assimilation (Gallivan, 2001):

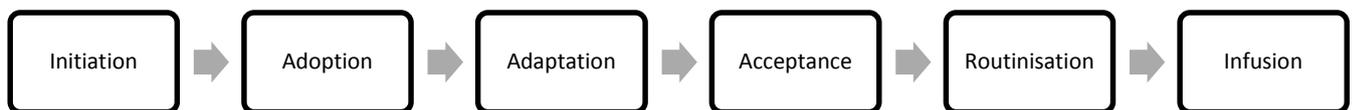


Figure 2.6: Six-stage IS implementation model (Cooper & Zmud, 1990; Gallivan, 2001)

- Initiation: need for change is recognised, a match is identified between an innovation and its application in the organisation
- Adoption: a decision is made to adopt an innovation
- Adaptation: an adaptation to suit the contextual needs
- Acceptance: use of the innovation
- Routinisation: usage is encouraged as a normal activity as a result of increase in the extent and intensity of use
- Infusion: increased usage in a more comprehensive and integrated manner results in increased effectiveness of systems development.

Cooper & Zmud (Cooper & Zmud, 1990) associate these stages with Lewin’s sequential model of unfreezing, changing, and refreezing (Lewin, 1952): *initiation* with unfreezing, *adoption and adaptation* with change, and *acceptance, routinisation, and infusion* with the refreezing stage. The model suggests that “unfreezing” can occur only when users are motivated to change, which can then lead to the transitional phase of “change” incorporating learning and adapting to new information, which further leads to the “refreezing” of the new steady and

stable state (Wastell, Kawalek, & Newman, 2003). Cooper & Zmud suggest that sequential models of innovation assimilation are more appropriate for technologies which are borrowed or adapted rather than custom made. As agile methods relate to the former category, the sequential model of assimilation is suitable to the study of agile method use (Wang et al., 2012). Since agile methods are categorized as an IS process innovation, the IS innovation assimilation models provide a structured mechanism to analyse agile method use (Wang et al., 2012). While the initial three phases (*initiation, adoption, adaptation*) relate to ‘adoptive’ phases of an innovation, the last three phases (*acceptance, routinisation, infusion*) relates to its post-adoptive use and implementation. The refreezing state, which consists of the last three phases describe various degrees of use of an innovation, and therefore is of particular relevance to the concept of sustained use of agile methods used in the current study.

2.4.3. Extreme Programming Evaluation Framework [XP-EF]

The theoretical foundation from the agile literature is drawn from Williams et al’s (2004) Extreme Programming Evaluation Framework (XP-EF). The XP-EF (Figure 2.7) was developed to assess the extent of use of XP practices and the outcomes of its usage in organisations. Though the framework is specific to XP, it was deemed to be used in the development of this study’s research framework for the following reasons:

- i) lack of strong theoretical and conceptual foundations in AM literature in general (Conboy, 2009)
- ii) XP shares the same underlying agile values and principles of the Agile Manifesto on which most well-known agile methods (e.g. Scrum) are also based on
- iii) the framework focuses on the extent of XP use and its effectiveness which is one of the popular agile methodologies
- iv) the suite of measures in the XP-EF was developed using the Goal-Question-Metrics (GQM) paradigm – though GQM was originally defined for software projects in a particular environment its use has been expanded to a larger context spanning many projects (Caldiera & Rombach, 1994) and
- v) the framework is a compilation of validated measures from real case studies (Layman et al., 2004; Williams, Krebs, Layman, Antón, & Abrahamsson, 2004b).

The framework consists of three parts: XP Context Factors (XP-cf), XP-Adherence Metrics (XP-am), and XP Outcome Metrics (XP-om). XP-cf includes factors that are specific to the project’s study environment. The key context factors are grouped into six categories: software

classification, sociological, project-specific, ergonomic, technological, and international. Out of these six categories, sociological and technological factors are of interest in the current study. Sociological factors focus on the social characteristics of team members such as experience, attitude, and motivation. Given that one of the main tenets of AM is *'individuals and interactions'*, and the increasing importance of teams in the systems development process (Mangalaraj et al., 2009a), it was deemed as a relevant and important category to be included in proposed framework of this study.

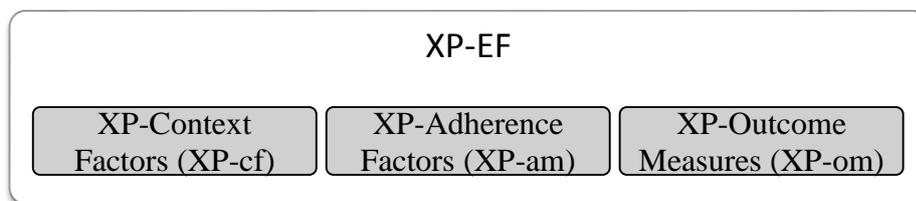


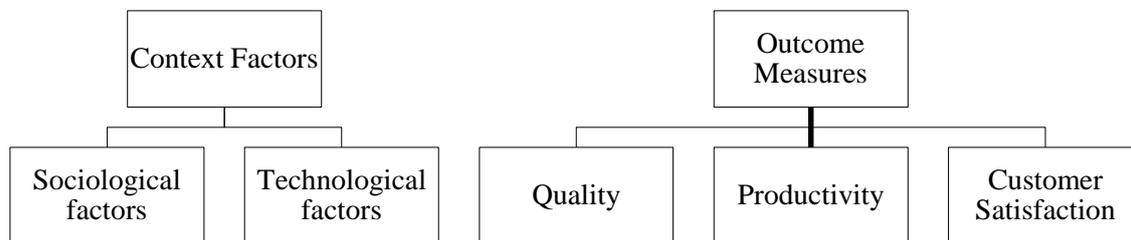
Figure 2.7: Extreme Programming Evaluation Framework (Source: (Layman et al., 2004))

Agile methods are not substitutes for the practice of technical practices and tools in systems. While the significance of technical and engineering practices in systems development has been generally recognised (Green & Hevner, 1999), their importance in facilitating and improving the effective use of agile methods is also documented (Mangalaraj et al., 2009b). Technical agile practices such as test-first development are believed to improve quality of systems development (Williams, Layman, & Krebs, 2004c). Therefore, XP-EF's technological factors (agile practices, tool support) were included as an independent category in the proposed framework of the current study. The other four were excluded because they were either very project-specific/XP specific (e.g. software classification and project-specific) or they did not meet the requirements of the current study (e.g. ergonomic and international).

XP-Adherence (XP-am) metrics consists of both objective and subjective measures of examining the extent to which XP practices are exercised. Examples of objective measures include automated unit testing (count of the number of unit test classes present in the system or compute code coverage), inspection frequency, and release length. Subjective measurement includes the self-reporting by participants about the extent to which each XP practice is used (e.g. test-first design, stand-up meetings, planning game, pair programming, refactoring) on a scale from 0% (never) to 100% (always). Since the XP-am measures were more related to specific characteristics of XP, they were not included. However, the concept of adherence, i.e.

the extent of use is related to the construct ‘*agile usage*’ proposed in the current study which will be discussed in section 2.5.1.

Figure 2.8: Agile Evaluation Framework (adapted from (Williams et al., 2004c))



The three outcome measures (quality, productivity, and customer satisfaction) of XP-om were included as outcome (impact of agile usage) measures in the *a priori* framework and the overall construct was named as *agile usage effectiveness*. However, there are some important differences between XP-om measures and the outcome measures specified in the current study. In XP-om, productivity is measured using metrics such as lines of code per month (KLOEC/PM) and user stories per month, and quality is measured using metrics such as number of test defects/KLOEC. In the current study, quality refers to outcomes such as improved quality in defect management, reduction in the number of defects, and improved quality of the delivered product. Similarly productivity refers to outcomes such as lead time, development time, and faster delivery. This is because the focus of this research is to investigate any overall improvements in systems development as a consequence of sustained usage of AMs (XP, Scrum, XP + Scrum etc..) rather than to understand the impact of the depth of usage of practices of a specific agile method such as XP (which is the focus of the XP-EF framework). The adapted version of the framework as applicable to this study is shown in Figure 2.8.

2.5. Post-Adoptive Usage

The system usage construct in general has occupied a central role in IS research (Barkin & Dickson, 1977; Burton-Jones & Straub, 2006), where both its antecedents (Venkatesh, Morris, Davis, & Davis, 2003), and its impact on individual performance (Doll & Torkzadeh, 1998) have been studied. Though ‘usage’ generally refers to ‘system usage’, in the field of IS success research, success, effectiveness, or impact on outcomes is considered to be dependent on the quality of the implementation process (Ishman, 1998). Based on the reasoning that examining the process of developing an information system is equally important to examining the use of

the actual system, researchers such as Ishman (1998) have used the same measures for studying both the process and product usage. Since agile methods, an IS process innovation is a systems development methodology that falls into the broader domain of information systems (Seddon, Staples, Patnayakuni, & Bowtell, 1999), this study draws from the theoretical foundations of IS usage to derive measures for both ‘agile usage’ (this section) and ‘agile usage effectiveness’ (section 2.6). However, attempt was always made to review the extant agile literature first, and then relevant literature from the broader IS domain (e.g. systems development methodology, innovation diffusion, and implementation) was reviewed.

Innovation diffusion research explicitly distinguishes between initial usage of the innovation and continued sustained usage (Agarwal & Prasad, 1997; Rogers, 2003). Based on the six-stage innovation assimilation model (see section 2.4.2), usage can be broadly classified into two broad facets: *adoptive* and *post-adoptive usage*. Initial or adoptive usage of an innovation may not always be sufficient to fully derive the desired benefits and improvements in systems development (Agarwal & Prasad, 1997). Individual users need to institutionalise the innovation as part of regular work behaviours; this type of usage has been variously referred to as post-adoptive (Hsieh & Robert, 2006) or sustained usage (Zaltman, Duncan, & Holbeck, 1973) (Agarwal & Prasad, 1997). Post-adoptive usage behaviour, in general refers to an individual user’s beliefs and actions relating to the extent and depth of an innovation’s usage beyond their initial simplistic adoption (Hsieh & Robert, 2006). In the field of IS, it is defined as

myriad of feature adoption decisions, feature use behaviours and feature extension behaviours made by an individual user after an information technology application has been installed, made accessible to the user and applied by the user in accomplishing his/her work activities (Jasperson, Carter, & Zmud, 2005, p. 531).

According to Jasperson’s three-stage post-adoptive model, in stage one, an organisation makes a decision to adopt an IS innovation which might be voluntary or mandatory (Jasperson et al., 2005). After adoption, in stage two, individual users make decision to adopt the innovation which could also be either voluntary or mandatory. In stage three, users choose to extend, explore, and use one or more of the innovation’s features. In the context of agile methods, stage one could involve decision made by either the organisation/IS unit or individual team (voluntary or mandatory). For example, at Intel Shannon, developers willingly committed to the usage of agile methods which grew bottom-up rather than mandated by management (Fitzgerald, Hartnett, & Conboy, 2006). In some organisations, it is common for individual

teams to adopt agile methods by stealth, and after a period of time the decision is made and openly announced at the organisation level – in some cases, this occurs after the top management has seen specific evidence of benefits/improvements of using agile methods over a period of time (Senapathi & Srinivasan, 2012). In stage two, the IS unit or individual team/s make formal or explicit commitment to use an agile method (such as Scrum). In stage three, the individual or the team actively chooses to continuously use, extend, or integrate with other practices. For example, after committing to use an agile method XP in stage two, the team might decide to use pair programming (an agile practice) only in some specific situations (for example, the team only pair on some complex tasks) and not as a routine during the entire development process (Pikkarainen et al., 2007). Once the team reaches stage 3 (equivalent to *routinisation* and *infusion* stages of the implementation model), individuals might have gained experience in using the pair programming practice, and it might not only become a routine but users may discover additional effective ways (for example, pair rotation) to apply the practice thereby engaging in feature-extension behaviour (Cooper & Zmud, 1990; Kwon & Zmud, 1987; Pikkarainen et al., 2007) An adapted version of Jasperson’s post-adoptive model of innovation use that reflects an agile context is shown in Figure 2.9.

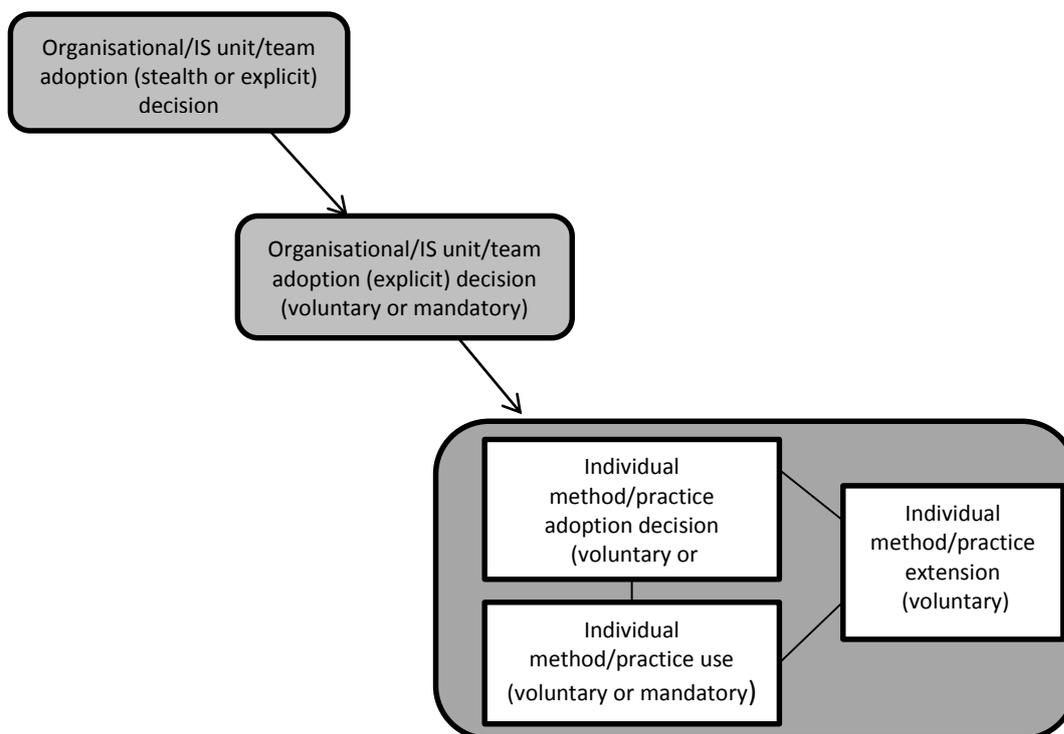


Figure 2.9: Three stage post-adoptive usage model (adapted from (Jasperson et al., 2005))

Prior studies have given more attention to examining factors that impact initial adoption and use (i.e., stages one and two) rather than those that influence post-adoptive stages (stage three)

(Karahanna et al., 1999). A rich body of knowledge about the concept of adoption and initial usage exists in information systems research (Hsieh & Robert, 2006), where IT/IS usage is identified as a key dependent variable (DeLone & McLean, 1992). More recently research into post-adoptive usage has been receiving greater attention (Jasperson et al., 2005) including agile methods (Mangalaraj et al., 2009a; Wang et al., 2012). These studies focus on the phenomenon of post-adoptive or sustained usage rather than initial adoption and use. The current study, too, seeks to contribute to this emerging body of post-adoptive usage literature, i.e. to study sustained usage of agile methods. Accordingly, the next section provides the theoretical background for conceptualising *sustained agile usage*.

2.5.1. Sustained Agile Usage

There are a number of conceptual issues concerning the use of systems development methods (Iivari & Maansaari, 1998):

- Firstly, agile method use is often superficially judged as *used* or *not used*, whereas the actual implementation can be partial and inconsistent, and so categorizing a method as *used* or *not used* may be overly simplistic (Conboy & Fitzgerald, 2010).
- Secondly, the richness and scope of method use suggests that there are a number of different roles involved as users of systems development methods. In the context of AM, they include developers, Scrum Masters, Business Analysts, Project Managers, etc.
- Thirdly, the explicitness of method use may vary from explicit use of specific practice to its implicit use as an influential determinant of the way of working. In the latter case an agile method may have been learned by stealth adoption by a team and the way of working may be a combination of the agile method and traditional systems development practices.
- Fourth, a method may serve several roles in the development process. For example, it is questionable to what extent methods form constitutive rules (e.g., adherence to specific agile method such as XP) and to what extent they embed project planning and execution rules (e.g., daily stand-up meetings, sprint planning meetings).

The above issues highlight the richness of the concept of method usage in general and agile methodologies in particular. Therefore, in the current study these issues were taken into consideration during the development of the proposed research framework. Key questions

relating to complexity of the concept of method usage were raised, for example, how can method ‘usage’ be conceptualised? How can ‘use’ or ‘usage’ be measured? Does ‘usage’ relate to ‘method’ use at a higher level such as XP, Scrum or to the individual practice level?

The usage of SDMs is a versatile concept which is difficult to define and measure (Iivari & Huisman, 2007). Iivari & Huisman (2002) use the term ‘deployment’ to refer to post-adoptive or sustained usage, and define it as *Use* followed by *Acceptance* where :

(i) Use is measured using two measures

(a) *frequency of use* – frequency of application of SDM knowledge, and

(b) *intensity of use* – maximum usage or depth of use of possible listed practices/methods, and

(ii) Acceptance is studied from two perspectives, their *impact on improvements in systems development* (quality and productivity of development process) and the *perceived support* it provides.

In their next study, Huisman & Iivari (Iivari & Huisman, 2007) conceptualise SDM deployment using three aspects: methodology support, methodology use, and methodology impact, where the dimensions of methodology support are based on Henderson & Cooperider’s (Henderson & Cooperider, 1990) three functional facets: production technology, coordination technology, and organisational technology. The dimensions of methodology support were found to have a direct impact on individual users’ capacity to generate planning and design decisions, artefacts, and processes, i.e. the focus was limited and specific to tool support (e.g. CASE) rather than methodologies in general. Therefore, while methodology support was not deemed relevant (Iivari & Huisman, 2007), the other two dimensions (methodology use and methodology impact) are of particular interest to the current study. Methodology use was based on the post-adoptive usage measures specified by McChesney & Glass (McChesney & Glass, 1993): i) *horizontal usage*; describes the percentage of developers, projects, etc. regions using the methodology, i.e., extent of use and ii) *vertical usage*: describes intensity of method usage.

In the context of agile methods, *agile deployment* is defined as the process that occurs within the organisation when the agile methods are actually put to use in development (Pikkarainen, Salo, Kuusela, & Abrahamsson, 2012): i) it starts when agile methods are first introduced to development teams and ii) ends when agile methods become more regular and routinised, used

by a large number of projects, and becomes integrated as a part of the organisational process model. So, ‘end of deployment’ according to this definition implies ‘deployment’, i.e. extent and intensity of use followed by acceptance, as suggested by Huisman & Iivari (2002) and ‘sustained usage’ as used in the current study. Stavru (2012) conceptualise agile deployment using two constructs: *current usage*: the extent to which an agile method is strictly adhered to, and *future use intention*: willingness to increase the extent of use agile methods for future use.

In summary, post-adoptive or sustained usage, as a key measure of successful implementation of a systems development methodology in organisations has been studied by using different terminologies (table 2.6) by focusing on the later stages of innovation assimilation model, i.e. acceptance, routinisation, and infusion. Due to the current study’s broader focus on agile usage, the conceptualisation of sustained agile usage is mainly influenced by the works of Huisman & Iivari (Huisman & Iivari, 2002; Iivari & Huisman, 2007) and Wang et al (Wang et al., 2012). While Huisman & Iivari’s studies provide the theoretical background needed from a systems development methodology perspective in general (including agile methods), Wang et al provide the necessary background for agile post-adoptive usage stages, in particular.

Table 2.6: Terminologies used for sustained usage

Kwon & Zmud (1987)	Acceptance -> Use -> Incorporation
Cooper & Zmud (1990)	Acceptance -> Routinisation -> Infusion
Iivari (1996)	Usage -> Methodology Impact
McChesney & Glass (1993)	Usage -> Acceptance -> Incorporation
Huisman & Iivari (2002)	Use -> Acceptance
Huisman & Iivari (2007)	Support -> Use -> Impact

In more recent years, other studies (Mangalaraj et al., 2009a; Wang et al., 2012) have tried to conceptualise the later stages of agile assimilation. By drawing from a sound theoretical base, they have contributed to a better understanding of post-adoptive use of agile methods by developing interesting concepts and theory through logical reasoning. For example, Mangalaraj et al. (2009a) studied the acceptance of XP agile method, as a post-adoptive stage of assimilation to determine the factors that either facilitate or hinder acceptance of agile methods. Wang et al. (2012) conducted an exploratory study and applied the post-adoptive stages to four ISD teams that used agile methods (XP, Scrum or a combination of both). Based on their

findings, Wang et al. adapted the concepts of acceptance, routinisation, and infusion stages to ASD. While Mangalaraj et al. examined agile acceptance at the method level, and used acceptance in a broad sense without differentiating it from the other two post-stages, i.e., routinisation, and infusion (Wang et al., 2012), Wang et al' study focused on the individual practices of an agile method based on the rationale that it is necessary to examine agile methods at the practice level given the diversity of the agile practices even within a single agile method.

While findings from the above studies provide rich insights and may be used to draw specific implications, one has to be cautious when generalising such findings beyond the study setting/context (Walsham, 1995; Wang et al., 2012). In highlighting specific implications for future research, the authors' (Mangalaraj et al., 2009a; Wang et al., 2012) propose some specific research ideas on how to address some of the limitations in their studies:

- (i) examine the barriers and facilitators of agile assimilation and the effectiveness of agile assimilation,
- (ii) contribute to understanding the association between sustained usage and success or effectiveness, and
- (iii) adopt a quantitative approach by means of a large-scale survey which could be used to determine the levels of agile method usage across the ISD community.

This study was initiated in response to this call and therefore is an attempt to contribute to this growing body of agile literature. In particular, it investigates (i) the key factors that impact sustained agile usage and (ii) the relationship between sustained agile usage and agile usage effectiveness. The next section reviews the literature on post-adoptive assimilation stages, and adapts/maps them to sustained usage of AMs.

2.5.1.1. Acceptance

While *acceptance* in general refers responding in the affirmative, and receiving with consent (Saga & Zmud, 1994), in the context of AMs, it can be seen as “the act of using agile practices willingly”. In IS, *acceptance* is viewed as a multifaceted construct comprising of actions, intentions, and attitudes: three variables are used to represent it: *attitude toward use, intentions to use, and frequency of use* (Saga & Zmud, 1994). It reflects users' commitment to use the system (Hsieh & Robert, 2006). In agile methods, individual users do not strictly adhere to the textbook or prescribed version of the practice but rather customise and adapt them to suit the requirements of the context (Wang et al., 2012). Based on this understanding, Wang et al.

define acceptance of an agile practice as “a commitment to using an agile practice, either “by the book”, or in some tailored fashion” (Wang et al., 2012).

2.5.1.2. Routinisation

Routinisation refers to the notion that successful technological innovations, over a period of time, are no longer perceived as being new as they become an organisation’s normal routine (Saga & Zmud, 1994). The term “routine” implies that the innovation’s use mirrors procedures or practices that are regular part of daily life. The construct is represented using three variables: *normal use*, *standardized use*, and *administrative infrastructure development* (Saga & Zmud, 1994). Out of the three variables, “*normal use*”, i.e. *use is perceived as being normal* which is also associated with *frequency of use* of the acceptance stage. This implies that the frequency of use (repetitiveness) influences usage behaviours to become more spontaneous and normal than reflective (Jasperson et al., 2005). In order to understand if an agile method has reached routinisation, it is important to know if its adopted agile practice/s have become a routine part of the development process (Wang et al., 2012). For example, frequency of use of practices such as XP’s planning game (supposed to be used once per iteration) and pair programming (continuously) can be observed. However, for practices such as ‘simple design’ which are more abstract and bear closer resemble to agile principles than concrete practices, it is difficult to measure routinisation (Wang et al., 2012). Wang et al. define routinisation of an agile practice as “the extent to which an agile practice is frequently used, highly embrace and adhere to, and no longer considered as something out of the ordinary” (Wang et al., 2012).

2.5.1.3. Infusion

Through direct experience and learning processes associated with an IS innovation, individuals gain the capability to use it to its full potential, i.e., the infusion stage (Hsieh & Robert, 2006; Saga & Zmud, 1994). *Infusion* refers to the process of embedding an innovation deeply and comprehensively within an individual’s or organisation’s work systems (Saga & Zmud, 1994). *Infusion* is described using three facets (Hsieh & Robert, 2006; Saga & Zmud, 1994):

- 1) Extensive use: extent of use of an innovation to accommodate a more comprehensive set of work tasks.
- 2) Integrated use: using the innovation to establish or enhance work flow linkages among work tasks, and

3) Emergent use: using the innovation beyond its original intended scope.

Related to the concept of infusion is a user's willingness and determination to explore and find new ways of applying the innovation to work tasks (Agarwal & Prasad, 2000; Hsieh & Robert, 2006). In the context of agile practice assimilation, Wang et al introduce two additional indicators of infusion, intensive use and deeply customised use (Wang et al., 2012): Intensive use refers to the use of an agile practice beyond that suggested by the textbook and deeply customised use refers to deep adaptation of an agile practice to suit the needs of the adopting team. For example, they found that one of the XP teams adapted the forty-hour week to align with client working hours – because their clients worked to a split-shift rota, the team alternated between 6 and 10 hour days, or 4 and 12 shifts, instead of the recommended 8 hours per day (Wang et al., 2012).

The table below (table 2.7) adapts Wang et al.'s definitions (which focuses on individual agile practice) to reflect agile method (focus of this research) by mapping it to the IS post-adoptive assimilation stages (Hsieh & Robert, 2006):

Table 2.7: Mapping of Post-adoptive usage behaviours and agile assimilation stages

Stage	Acceptance	Routinisation	Infusion
Description	commitment and willingness to use an agile method, either 'by the book' or in some tailored fashion	The use of agile methods becomes part of the routine and no longer considered as something out of the ordinary	The agile method is used in a comprehensive and sophisticated manner
Possible usage behaviours	<ul style="list-style-type: none"> - Agile adoption - Initial usage 	<ul style="list-style-type: none"> - Routinised use - Sustained/ Continued Use 	<ul style="list-style-type: none"> - extensive use: extent of use - integrative use: agile practices are used to create new workflow linkages among tasks - emergent use: an agile method is used to perform tasks not in the preconceived scope - intensive use: an agile method is used with intensity beyond that suggested by the textbook - deeply customised use: an agile method is adapted at a deep level to suit the need of the adopting nit/team

The findings from Wang et al.'s study help us to gain better understanding of agile assimilation at the individual practice level, i.e., for example, a team reaching deep customisation of the 40-hour agile practice, or well-routinised on-site customer practice for a specific project. While

such findings enhance our understanding of the use of individual agile methods such as XP, the focus on individual methods on the other hand results in fragmented research, and easily misses the commonalities of ‘agile’ methods (Iivari & Iivari, 2011). Because it is intellectually economic to focus on agile methods as a whole (Iivari & Iivari, 2011), this study seeks to cover the totality of agile methods rather than focusing on individual method or practice. It uses the term ‘*agile method or methodology*’ to cover the totality of agile development methods (e.g. XP, Scrum, DSDM, lean, Kanban, agile modelling). There are at least two main reasons for this broad interpretation:

- i) the researcher contends that individual agile practitioners’ may use an agile method such as Scrum effectively by following a set of carefully selected Scrum practices and tailored (may be in combination with other agile practices) to suit the needs of the development environment, but still adhering to the fundamental concepts and principles of the agile manifesto. For example, Fitzgerald found that *a la carte* selection and tailoring of XP and Scrum practices, not only led to committed usage by developers but also led to significant improvements in quality and productivity of systems development (Fitzgerald et al., 2006).
- ii) The difficulty of defining and measuring method usage (Iivari & Huisman, 2007): two types of use can be distinguished, explicit and implicit use. While explicit use refers to the intensity of use of adopted set of agile practices, implicit use refers to the extent of their use after they have been adopted, learnt, and internalized. The conceptualisation of sustained agile usage attempts to cover both explicit and implicit use.

Applying the concepts of continued ‘use’ or ‘usage’ terms used in both the SDM and agile literature to the context of AM, *horizontal* usage refers for example, to the spread of Scrum from one team or project to multiple teams/projects, or from one region to many regions within an organisation and to other departments (for example, business, finance) beyond their original intended scope of use, and *vertical usage* to the maximum intensity of their use i.e., depth of use of specific agile practices. For example, Scrum is made up of three roles (Product Owner, Scrum Master, Team), four ceremonies (Sprint Planning, Daily Scrum, Sprint Reviews, Sprint retrospectives), and three artefacts (Product backlog, Sprint backlog, Burndown chart), and therefore a team which follows all these practices may ideally seem to have achieved maximum Scrum usage. However, Scrum gives a basic set of constraints to drive a process improvement

(Kniberg & Skarin, 2009), and in reality a Scrum team may continue to use some of their predecessor practices such as XP's pair programming that may have been working effectively for their context. Teams gain an understanding of what agile practices work better for them as they start observing how things like quality, and productivity change, which may lead to further adaptations as they start reflecting on and drawing conclusions from the results. Though this is an ongoing and continual improvement process, over a period of time teams gain a better understanding of whether a given set of practices works effectively for their context. The intensity of the use of these practices is what is referred to as '*vertical usage*' in the current study. The important thing is not the agile practices you start with, but the set of practices that you end up with, i.e., the set of agile practices that you derive based on continual learning, improvements, adaptations and change based on a particular context.

In summary, '*horizontal usage*' refers to the extent of use agile methods beyond their original intended scope of use, and '*vertical usage*' represents either one or any combination of usage behaviours specified in the post-adoptive infusion stage (see table 2.7.) The combination of '*vertical usage*' and '*horizontal usage*' is referred as '*Sustained Agile Usage*' which consists of the following constructs:

- 1) horizontal usage – extent of use across the organisation (Huisman & Iivari, 2002; Iivari & Huisman, 2007; McChesney & Glass, 1993)
- 2) vertical usage - maximum intensity (Huisman & Iivari, 2002; Iivari & Huisman, 2007; McChesney & Glass, 1993; Wang et al., 2012)
- 3) routinisation - the use of agile methods encouraged as a normal activity .(Saga & Zmud, 1994; Wang et al., 2012) -

This study is also concerned with the outcomes of sustained agile usage. 'Outcomes' implies benefits or improvements in systems development and is often associated with terms such as "success", "effectiveness", and "benefits". Emphasizing the significance of continued usage over initial usage, Bhattacharjee argues that the ultimate success of an innovation can only be derived from its sustained usage (Bhattacharjee, 2001). If an innovation is continuously sustained and used effectively, it can produce outcomes for the individual and the organisation (Seen, Rouse, & Beaumont, 2007). The next section reviews the theoretical background relevant to the 'outcomes' of SAU.

2.6. Outcomes of Sustained Agile Usage - Agile Usage Effectiveness

In order to understand the value and efficacy of organisational decisions and investments made in innovative methodologies such as agile, it is critical to measure its success or effectiveness (Delone, 2003). One of the well-established and validated IS success frameworks is the DeLone and McLean model which brought some awareness and structure to the dependent variable “success” in IS research (Delone, 2003; DeLone & McLean, 1992). The framework identifies six dimensions of success: *system quality, information quality, use, user satisfaction, individual impact, and organisational impact*. Based on these six dimensions, a number of different measures have been identified in the literature depending on the specific aspect of focus: (DeLone & McLean, 1992) for example, while some have chosen to study system quality, using measures such as ease of use, ease of learning, others have studied information quality using measures such as accuracy, and timeliness. Association between these measures, for example, between usage and individual impact, and information quality and individual impact has also been tested with significant results (Delone, 2003).

Even though use of agile methods as a process may lead to individual and organisational impact, this study does not regard use as a discrete event to be stated (use vs. non-use) as implied by process theories (Iivari, 2005). This is because use alone is not sufficient to ensure benefits or gains in development outcomes (Mohan, Ahlemann, & Kugler, 2013). It has been argued that only when an innovation has been used to its fullest potential, can its benefits or improvements in outcomes be realised (Seddon, 1997). Therefore, “usage” in this study refers to post-adoptive behaviour (see section 2.5.1), i.e., continued or sustained usage, and may be considered an appropriate measure of success or effectiveness (Delone, 2003). However, it is insufficient to say that more use will result in improvements in benefits or outcomes (Delone, 2003). Rather, it is important to (i) consider the extent, quality, intent, and appropriateness of usage, and (ii) develop deeper insights into the important factors that impact usage. DeLone & McLean combine both individual and organisational “impact” measures into a single category called “net benefits” which relate to outcomes resulting from such effective use. Based on this rationale, it is proposed that sustained usage of agile methods is associated with more ‘net benefits’ or ‘improved outcomes in systems development’. The perceived improvement in outcomes is referred to as “*agile usage effectiveness*” in this study. It is based on the reasoning that an agile method that is not used in an effective and sustained manner cannot make any individual or organisational impact, i.e. improvements in development outcomes (Iivari, 2005).

It is believed that analysing the relationship between agile usage and agile usage effectiveness, where effectiveness is measured as the impact of agile usage on systems development outcomes is crucial to understanding sustained usage of AMs in organisations. However, sustained agile usage as a factor affecting agile effectiveness has been omitted from the agile literature. Unless agile practices are used more deeply and widely throughout the organisation, we will not be able to ascertain its impact on systems development activities. Though it might be impossible to specify with certainty what these outcomes are and to what extent they can be achieved, this study is more interested in examining if there are any specific improvements in the overall systems development process as a result of sustained usage of agile practices as perceived by the organisation. To that extent, three effectiveness measures were identified as the core criteria for assessing *agile usage effectiveness* (see section 2.4.3) (McChesney & Glass, 1993) (Huisman & Iivari, 2002; Williams et al., 2004b) :

- 1) improved productivity in the development process,
- 2) improved quality of the development process, and
- 3) customer satisfaction.

The above list of measures is not exhaustive and may include other important measures such as improved employee morale, faster time-to-market, and predictability (Cohn, 2009).

(Khalifa & Verner, 2000) took an interactionist approach positing that impacts from the use of a systems development methodology will influence developers' attitude towards subsequent use of the methodology. In the context of the diffusion of IS process innovations, this means that a developer's use towards future methodology use is affected by how he or she perceives their improved effectiveness when using the methodology (Green & Hevner, 1999). On the contrary, (Iivari, 1996) examined the impacts of CASE usage on perceived impacts, i.e., he examined how using the CASE tool impact developer perceptions of quality and productivity based on the rationale that CASE tools cannot be effective unless they are used, which is the approach proposed by the current study. It is believed that in order to know whether there are any improvements in systems development, the agile practices must be used deeply and extensively. This is because, the innovation adoption theories presume that 'incorporation' cannot happen before they are effectively used and become a normal part of the organisational life, and therefore, it is believed that agile usage and its effectiveness are important for successful 'incorporation' of agile methods in an organisation (Pikkarainen et al., 2007).

2.7. Factors that impact Sustained Agile Usage

This section examines the important factors that impact effective and successful use of systems development methodologies by drawing conceptual and theoretical insights from relevant literature. The identification of a stable and consistent set of factors has both theoretical and practical merit (Agarwal & Prasad, 2000): from a theoretical point of view, it is important that researchers agree upon a parsimonious set of perceived attributes that consistently relate strongly to methodology usage in order to build a cumulative research tradition. From a practical point of view, such a sparse set is desirable due to lower overhead costs associated with data collection and operationalisation of variables (Agarwal & Prasad, 2000).

The choice of sustained agile usage as a surrogate for success of agile methods is consistent with innovation diffusion research (Agarwal & Prasad, 1997). According to this stream of research, there are many predictors of usage, such as individual beliefs or perceptions about innovation, technological, and organisational characteristics (Moore & Benbasat, 1991; Rogers, 2003). As such, understanding the various factors that impact usage has generated much interest in IS research (Agarwal, 2000; Agarwal & Prasad, 1997; Iivari, 1996; Iivari & Maansaari, 1998; Karahanna et al., 1999; Roberts & Hughes, 1996; Venkatesh et al., 2003). Research has also highlighted the difference between factors that impact initial and continued or sustained usage. For example, Agarwal & Prasad (Agarwal & Prasad, 2000) found that different factors affected initial usage and intentions of future usage in their study of World Wide Web usage. Similarly, Karahanna et al. found that different factors affected initial and continued usage of windows (Karahanna et al., 1999).

First, a detailed review of the literature was undertaken to identify the key factors that impact sustained usage of agile methods. Given the lack of theoretical and conceptual support in the field of AM (Abrahamsson et al., 2009; Cohn, 2009; Wang et al., 2012), a review of relevant literature from the domains of information systems, software engineering and agile methods was conducted. The search aimed at identifying English language peer-reviewed empirical studies that focused on factors that influence sustained and effective usage of SDM. It was a broad search process which combined both automated and manual searches to increase coverage. The following electronic databases were selected: ACM Digital library, AIS Electronic Library, ProQuest (ABI/INFORM), IEEE Digital Library, ScienceDirect/Scopus, SpringerLink.

Secondly, another search that specifically focused on agile literature was performed. In addition to the databases used in the general search, all volumes of the two annual global conferences on agile software development: XP² and Agile³ were manually searched. The search included qualitative and quantitative studies, and industrial experience reports, published between 2005 and October 2011. Studies that focused on single agile practices such as pair programming or test-driven development were excluded. Studies conducted in academic settings were excluded. The search included XP, Scrum, and Kanban, the widely used AMs in academic research and practice (Conboy & Fitzgerald, 2010). The search was performed using the following search terms (search terms were adapted to match the individual requirements of each of the search engines on the selected database list):

((*“agile”* OR *Scrum* OR *“extreme programming”* OR *XP* OR *Kanban*) AND (*sustained* OR *success* OR *effectiveness* OR *implementation* OR *us** OR *acceptance* OR *adopt** OR *“success”* OR *“effectiveness”* OR *“success factors”* OR *“effectiveness factors”* OR *“business value”*)).

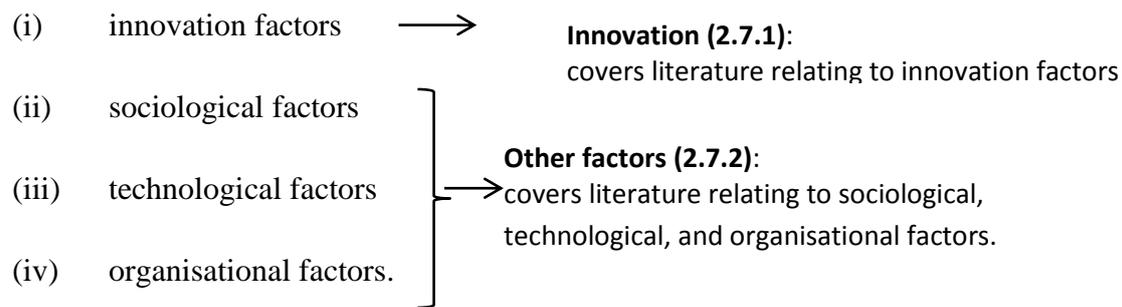
All studies that indicated some form of post-adoptive method practice, i.e., use, acceptance, assimilation, and deployment were included. The quality and suitability of each qualifying study was assessed using the following criteria (Dybå & Dingsøy, 2008):

- 1) that it was an empirical research paper
- 2) the research aims and objectives were clearly stated
- 3) it focused on identifying factors that impact sustained agile usage, and
- 4) it had adequate description of context/setting.

Based on a detailed synthesis of the selected literature on sustained and effective use of systems development methods and AMs, the identification of factors was grouped into four main categories. They are discussed below under two main sections (2.7.1 and 2.7.2):

² Agile Processes in Software Engineering and Extreme Programming – International Conference on Agile Software Development (XP *nnnn*), where *nnnn* is the year of the conference

³ (<http://agilealliance.org>).



2.7.1. Innovation Factors

This stream of literature views individuals' perceptions about innovation characteristics of an innovation as important influencers on usage and acceptance behaviour (Agarwal & Prasad, 1997). One of the main reasons for including this category is because of its recurring theme in innovation adoption and usage models as significant influencers of an innovation's acceptance and use (Agarwal & Prasad, 1997).

In a meta-analysis of seventy-five innovation characteristics studies, *complexity*, *compatibility*, and *relative advantage* were found to consistently influence adoption/implementation of an innovation (Tornatzky & Klein, 1982). Consistent with Tornatzky and Klein's findings, *complexity*, *compatibility*, and *relative advantage* were found to have a significant influence on individual acceptance of 'C' programming language by COBOL/C programmers (Agarwal & Prasad, 2000).

Huisman and Iivari combined IS implementation and DOI theories to develop a conceptual framework to investigate various factors that influence the deployment of systems development methodologies by individual system developers (Huisman & Iivari, 2002). While the influence of *relative advantage*, and *compatibility*, on the deployment of SDMs was supported, the impact of *complexity*, *demonstrability*, and *trialability* were not strongly supported.

Similar to Huisman and Iivari, Mangalaraj and colleagues also combined DOI and IS theories to examine the post-adoptive use of XP agile method in two projects within an organisation (Mangalaraj et al., 2009a). Based on Zmud's IS implementation framework, they classified *compatibility*, *relative advantage*, and *complexity* as technical characteristics of an innovation that influenced XP's acceptance. They found that compatibility of the technology with XP practices had an impact on the acceptance of XP practices. Their use of the term 'acceptance' relates more to the post-adoptive usage phase than initial adoption. The main difference between the two studies is that while Mangalaraj's study used a single-case approach,

Huisman' study provided a statistical validation of their survey conducted with 234 developers from eighty-three organisations.

Riemenschneider et al. (Riemenschneider et al., 2002) found that four variables (*usefulness*, *subjective norm*, *voluntariness* and *compatibility*) significantly influenced an individual's intention to use an innovation. Their findings suggest that significant results in product innovation do not imply significance in process innovation and vice versa. For example, PEOU and Perceived behavioural control which were previously found to be significant in tool studies did not return significant results in methodology study (Riemenschneider et al., 2002). Their findings suggest that as "the behavioural domain changes from tool use to methodology use, there is a reduction in the relevance of how easy or hard the behaviour is to perform and whether one possesses adequate internal or external resources to perform it"(Riemenschneider et al., 2002, p. 1141). It also indicates that there is "an increase in the relevance of subjective normative pressure to perform the behaviour, the perception of a formal mandate and the compatibility of the target behaviour with individuals' current ways of performing their work" (Riemenschneider et al., 2002, p. 1141). Their findings confirm the known differences between methodology and tool usage contexts, i.e. methodology use is more radical and mandatory than tool use. It also suggests that compatibility has higher relevance than complexity or PEOU.

Chan and Thong (Chan & Thong, 2009) developed a framework to examine acceptance of AMs based on a knowledge management perspective. Their framework identified a number of factors (ability-related, motivation-related, and opportunity-related) as influencers of knowledge management outcomes (KMO) (knowledge creation, retention, and transfer), and the impact of KMO in understanding individual acceptance of AMs. The innovation diffusion perspective is added to the framework by showing a direct influence of AM characteristics (PU, PEOU, Perceived Compatibility, Result Demonstrability, and Perceived Maturity) on acceptance of AMs. However, it is not clear whether these factors impact adoption or initial use, or post-adoptive usage as the term 'acceptance' is used in a rather general sense without differentiating whether it relates to adoptive and post-adoptive use.

Grounded in both agile and DOI literature, Bonner et al (Bonner, Teng, & Nerur, 2010) proposed that increased agility leads to developers' perceptions that AMs are less complex (*complexity*), more compatible (*compatibility*), and provide increased benefits (*improved quality, greater productivity, higher morale*). Developers' will be more likely to 'accept' AMs based on their perceptions that increased agility will lead to increased benefits. Similar to Chan

& Thong's study, though the relation of acceptance and usage concepts to post-adoptive or sustained usage is not specifically differentiated, their definition of 'process agility' implies sustained use of AMs rather than initial adoption.

In a more recent study, Mohan et al (Mohan et al., 2013) used a psychoanalysis perspective to conceptualise usage into three distinct constructs: committed, compliant, and resistant use. Using DOI theory, they tested the impact of SDM attributes (relative advantage, complexity, compatibility, and image) on each of the three usage constructs. They found significant results for their proposed hypotheses on the influence of *relative advantage*, *complexity* and *compatibility*, on each of the three constructs. The influence of *image* was not supported.

Two main points are clear from the above discussion: 1) the innovation diffusion frameworks have been applied and adapted in numerous ways in IS research including their recent application in agile context. 2) *relative advantage*, *complexity*, and *compatibility* have been consistently identified as antecedents to both the adoption and continued use of innovations, though the influence of *relative advantage* and *compatibility* are stronger than *complexity*. For example, some studies did not find strong support for *complexity* (Huisman & Iivari, 2002; Riemenschneider et al., 2002). Moreover, while some characteristics such as *trialability* (i.e., being able to trial an innovation on a specific project or for a particular period of time before it is adopted) may influence an innovation's initial rate of adoption, but might not have an equal or similar impact on its continued or sustained use. Based on the evidence from the literature which implies that not all factors will influence sustained usage in the same way they impact initial adoption, only *relative advantage* and *compatibility* were deemed relevant to be included as sub-constructs in the 'innovation' category.

2.7.2. Other factors

Khalifa and Verner examined the impact of both the (i) facilitating conditions (usage factors) and ii) developers' perceived beliefs (product quality and process quality) on the extent of use of two software development approaches: the waterfall model and prototyping (Khalifa & Verner, 2000). Facilitating conditions have been historically defined as objective factors in the environment that facilitate the performance of an act (Gallivan, 2001; Triandis, 1980) – which has been operationalised using three constructs: team size, organisational support, and the innovation's speed of adoption. In their study, extent of use referred to the (a) *degree* or *depth of use* which a methodology is applied at various phases of the development life cycle (e.g., analysis, design, and implementation), and ii) *breadth of use*: its use in development of different

application areas such as decision support systems, expert systems, and transaction processing systems. They found that the overall effect of organisational support and team size significantly influenced the extent of use of prototyping methodology.

Huisman and Iivari (Huisman & Iivari, 2002) studied the various factors that influence the individual deployment of SDMs by identifying five categories of factors: Innovation, Individual, Organisational, Task, and Environmental factors. They studied deployment using two aspects (McChesney & Glass, 1993): i) Use - examined using two dimensions: *frequency of use* – frequency of application of SDM knowledge, and *intensity of use* – maximum of the individual usage of twenty-nine listed methods, and (ii) Acceptance - studied from two perspectives, their *impact on improvements in systems development* (quality and productivity of development process) and the *perceived support* it provides. Their overall results indicated that relative advantage and management support strongly influenced the deployment of SDMs. The model's post-adoptive perspective of an innovation's extent of use and its impact on improvements in systems development is of particular interest to the current study.

Williams, Krebs, and Layman (2004a) developed an ontological framework called the XP Evaluation Framework (XP-EF) to identify factors that influence effective use of agile XP practices. They applied their framework to two cases:

- i) IBM - in their year-long study at IBM, they found that a small team (7-11 members) stabilised and sustained their use of XP practices effectively through two sequential software releases. The experience of the team members was high in terms of their domain expertise, experience, and technical expertise (e.g. programming). Though the team was using waterfall prior to XP, they were using small informal team practices that resembled those of XP. This helped the team to better adapt to and sustain the effective use of agile practices. They found that the team improved productivity and improved their post-release defect density by almost 40% when compared to similar metrics from the previous release. The results also indicated an overall increase in team morale as the team utilised more agile practices, and
- ii) Sabre Airline Solutions - In a longitudinal study, comparisons of two releases (one after initial adoption and the other after two and half years of sustained agile use) of a software product showed a 50% increase in productivity, a 65% improvement in pre-release quality, and a 35% increase improvement in post-release quality. Similar to IBM, the overall experience and expertise of the team members was high,

and the team was experienced in using technical practices such as continuous integration and collective code ownership. The perceived success of the early agile projects and their sustained use led to the spread of agile use throughout the organisation, i.e. it led to over 30 teams with more than 200 people using agile methods.

Though both the above studies have limitations of single case studies conducted in specific contexts, they provide evidence that sustained usage of AMs beyond initial adoption leads to improvements in productivity and quality. They also highlight the significance of sociological (experience, domain and technical expertise) and technological (tools and technical practices) factors on the sustained usage of AMs.

The following two studies investigated success factors in agile projects:

- (i) Based on a confirmatory survey study, Chow & Cao collected data from 109 agile projects from twenty-five countries by classifying factors that impact perceived level of success into five categories: organisational (management commitment, organisational environment, team environment), people (team capability, customer involvement), process (project management and project definition), technical (agile software techniques and delivery strategy), and project (project nature, type, and schedule) (Chow & Cao, 2008). Success was defined by using four aspects: quality (delivering a good working product), scope (meeting all requirements by the customer), timeliness (delivering on time), and cost (within estimated cost and effort). Out of the twelve factors which were grouped under five dimensions (Organisational, People, Process, Technical, and Project), their study found statistical support for three factors: (1) *delivery strategy* - regular delivery of software and delivering most important features first, and (2) *agile software engineering techniques* – e.g. well-defined coding standards, simple design, refactoring, and correct integration testing, both from the technical dimension, and (3) *team capability* from the people dimension. However, contrary to the findings in both the SDM and agile literature, some of the previously validated measures as such management support and commitment (Huisman & Iivari, 2002; Nerur & Mahapatra, 2005) were not supported.
- (ii) Similar to Chow & Cao, Misra & colleagues (Misra, Kumar, & Kumar, 2009b) hypothesised a set of twelve factors that influence success of agile software projects

and classified them into two broad categories: people and organisational. Success was defined using time, cost, and quality. Nine factors (customer satisfaction, customer collaboration, customer commitment, decision time, control, corporate culture, personal characteristics, societal culture, and training and learning) were found to have statistically significant relationships with success.

The combined findings from the above two studies highlight and support the significance of technical characteristics such as *agile tools and techniques* (technological), *personal/sociological characteristics* (sociological) and *organisational culture/structure* (organisational) on the successful use of agile projects. Some notable limitations of these studies (Chow & Cao, 2008; Misra et al., 2009b) are:

- (1) the focus is on practitioners' perceptions on factors that impact project success from an initial use or adoption perspective
- (2) the various factors derived in the two studies are mainly conceptualised from general agile values and principles or cases/reports from proponents of AMs rather than based on strong theoretical foundations and empirically validated scientific research.

While the above limitations could be attributed to the lack of theoretical foundation and sufficient empirical literature in the field of AMs (Conboy, 2009; Mangalaraj et al., 2009a; Wang et al., 2012), it should be noted that relevant theoretical support (e.g. software process improvement) did exist at the time these studies were conducted. For example, as the main focus of Chow & Cao's study was identifying critical success factors (CSFs) in agile software projects, basing the study's methodological design on the conceptual and theoretical foundations of CSF concept research (Bullen & Rockart, 1981; Rockart, 1979) and software process improvement research (Dyba, 2005; Niazi, Wilson, & Zowghi, 2006; Rainer & Hall, 2002), would have contributed to building a more consistent and cumulative tradition of research.

Two studies that specifically focus on post-adoptive use of AMs are: (Mangalaraj et al., 2009b) and (Pikkarainen et al., 2007).

- (1) Pikkarainen et al. (2007) explored the application of innovation adoption theory to the use of agile practices (XP and Scrum), focusing in particular on the later stages of assimilation, i.e. acceptance, routinisation, and infusion, and found that the concepts are largely applicable to the context of AMs. The key findings from the study were:

- a. when agile practices become routinised into the team's development process, there are greater chances of discovering more comprehensive and sophisticated ways of using them, which might lead to improvements in their effective use
- b. deeper level of usage of specific agile practices may be driven by specific needs of the adopting teams
- c. duration of agile use does not have a proportional effect on their assimilation stages which suggest that time may not be an appropriate indicator in the evaluation of sustained usage of AMs.

(2) Drawing from the theories of IS implementation and DOI, Mangalaraj et al. (2009a) , developed a conceptual framework that identified 'acceptance' as a post-adoptive phase. The factors that influence acceptance of AMs were classified into five categories: (1) Individual factors (attitude, technical knowledge) (2) Team factors (team management, team leadership) (3) Technological factors (compatibility, tool support) (4) Task related factors (application type, project size) and (5) Environmental factors (budget and schedule constraint, time constraint). Using a case study approach they applied the framework to investigate the acceptance of XP practices by two teams within the same organisation. They found all the five factors influenced the acceptance of XP practices – while some (knowledge, tool support) facilitated sustained use of XP, others (e.g. strict budgetary and time constraints) were found to be barriers for their sustained use.

In summary, the above two studies highlight the significance of post-adoptive or sustained usage in enriching our understanding of downstream phases of innovations such as AMs (Wang et al., 2012). While Pikkarainen et al's focused on the later post-adoptive stages, i.e. acceptance, routinisation and infusion contending the need to examine AMs at the practice level, Mangalaraj et al. (2009) examined agile acceptance at the method level in order to determine the factors that either facilitate or impede their acceptance. Pikkarainen et al., focused on the assimilation of XP/Scrum practices using three case studies, and Mangalaraj et al., investigated the acceptance of XP practices across different teams within the same organisation.

By interviewing thirteen agile software development practitioners from seven organisations in Malaysia, Asnawi et al. highlighted the significance of social and human aspects on the use of agile methods (Asnawi, Gravell, & Wills, 2011). Drawing from an earlier study (Roberts,

Gibson, Fields, and Rainer (1998)) on traditional SDM implementation, Livermore (2008) found that a number of factors under management's control (training, management involvement, access to external resources, and organisation size) had a significant impact on successful implementation of agile methods. In another study that examined the factors that influenced agile adoption including the benefits and challenges associated with it, organisational resistance and lack of management support were identified as key challenges that influenced effective implementation (Vijayasathy & Turk, 2008b). Cram (2012) examined the implications of aligning the organisational values embedded in a systems development method such as agile with the organisational values of project team members. They found that where alignment between the project teams and their development approach was high, perceptions of the systems development process were associated with satisfaction and enthusiasm; where alignment was low, perceptions were associated with frustration and discontent.

Overhage and Schlauderer (2012) identified a set of factors to investigate the long-term acceptance of Scrum (use > five years) in a German insurance company. Using five interviews and a survey of fifty developers within the company, their findings provide some general support that developers perceived Scrum's characteristics' (e.g. time-to-market, transparency, and process complexity) to be better than in traditional projects. However, though the authors use innovation diffusion theories to support their claim of focusing on 'sustainability' and 'long-term acceptance', there is no conceptualisation or measurement of 'acceptance' as a post-adoptive phase. Therefore, the study appears to be incomplete and the findings inconclusive.

In a survey of software development professionals, Vijayasathy and Turk (2012) found that subjective norm and training significantly influenced the use of agile methods. Using a dialectic method, they found that perceived benefits emerged as significant predictor of agile usage only when users faced hindrances to the use of agile methods.

Based on a multi-case study of nine projects, Strode, Huff, and Tretiakov (2009b), investigated the relationships between different aspects of organisational culture factors on the effective use of agile methods. The following factors (see table 2.8) showed statistically significant correlations with agile method usage, i.e. the greater the presence of these factors, the higher was their agile method usage as measured by the extent of use of specific agile method practices and techniques used on the projects.

Table 2.8: Organisational factors that correlate significantly with agile method usage.

Source: (Strode, Huff, & Tretiakov, 2009a)

1	The organisation values feedback and learning. Social interaction in the organisation is trustful, collaborative, and competent. The project manager acts as a facilitator. The management style is that of leadership and collaboration.
2	The organisation values teamwork is flexible and participative and encourages social interaction.
3	The organisation enables empowerment of people.
4	The organisation is results oriented.
5	The leadership in the organisation is entrepreneurial, innovative, and risk taking.
6	The organisation is based on loyalty and mutual trust and commitment.

In another study that investigated the relationship between organisational factors and traditional SDM usage, a positive relationship was found between hierarchical culture and SDM usage (Iivari & Huisman, 2007). The combined findings of the studies on organisational factors suggest that while hierarchical culture might support traditional SDM usage, low formality culture might positively impact effective usage of AMs (Strode et al., 2009b).

The summary of the extracted factors from the findings of the review is shown in Table 2.9: factors that were specifically identified as critical to sustained usage are shown as X and those that implied the impact of factors are shown as X*. Due to the limited number of empirical studies in agile literature, studies that did not explicitly focus on post-adoptive AM (e.g. initial use or adoption perspective (Chow & Cao, 2008; Misra et al., 2009b)) and those that implied their actual use and practice were also included. In the 'organisational' category, studies included a wide range of factors such as management support, training, organisational values, culture, structure – all these were grouped into one category factor as 'Organisational support'. Not all studies identified 'effectiveness' measures as an outcome of sustained usage.

Table 2.9: Factors that impact sustained agile usage⁴

Study	Focus	Relative advantage	Compatibility	Complexity	Experience	Technical competence	Attitude	Agile technical practices	Tool Support	Organisational support	Outcomes
Agarwal & Prasad (2000)	SPI	X	X	X							
Khalifa & Verner (2000)	SDM									X	
Huisman & Iivari (2002)	SDM	X	X								Improved quality and productivity
Riemenschneider et al. (2002)	SDM	X		X							
Williams et al. (2004)	Agile (XP)				X	X	X	X	X		Improved quality, productivity, higher morale, customer satisfaction
Iivari & Huisman (2007)	SDM									X	Improved quality and productivity
Livermore (2008)	Agile									X	
Chow & Cao (2008)	Agile							X*			Quality, Scope, Timeliness, Cost
Vijayarathy & Turk (2008)	Agile									X*	
Misra et al. (2009)	Agile					X*	X*			X*	Time, cost, Quality
Mangalaraj et al. (2009)	Agile (XP)	X	X	X		X	X		X		
Strode et al. (2009)	Agile									X	
Bonner et al. (2010)	Agile		X	X							Improved quality, productivity, higher morale
Vijayarathy & Turk (2012)	Agile	X									
Mohan et al. (2013)	Scrum	X	X	X							

2.8. Research Model

An initial formulation of the key factors influencing sustained agile usage is shown as *a priori* research model which identifies a set of key factors that influence SAU, i.e., nine critical factors (two innovation, three sociological, two technological, and two organisational). It also proposes the relationship between the SAU and agile usage effectiveness. The proposed

⁴ X – factors that directly influence SAU X* - factors that imply influence

sustained agile usage model is set out in Figure 2.10: (1) Innovation factors (*relative advantage, compatibility*) (2) Sociological factors (*attitude, experience, technical competence*) (3) Technological factors (*agile practices, tool support*) and (4) Organisational factors (*top management support, methodology champion*).

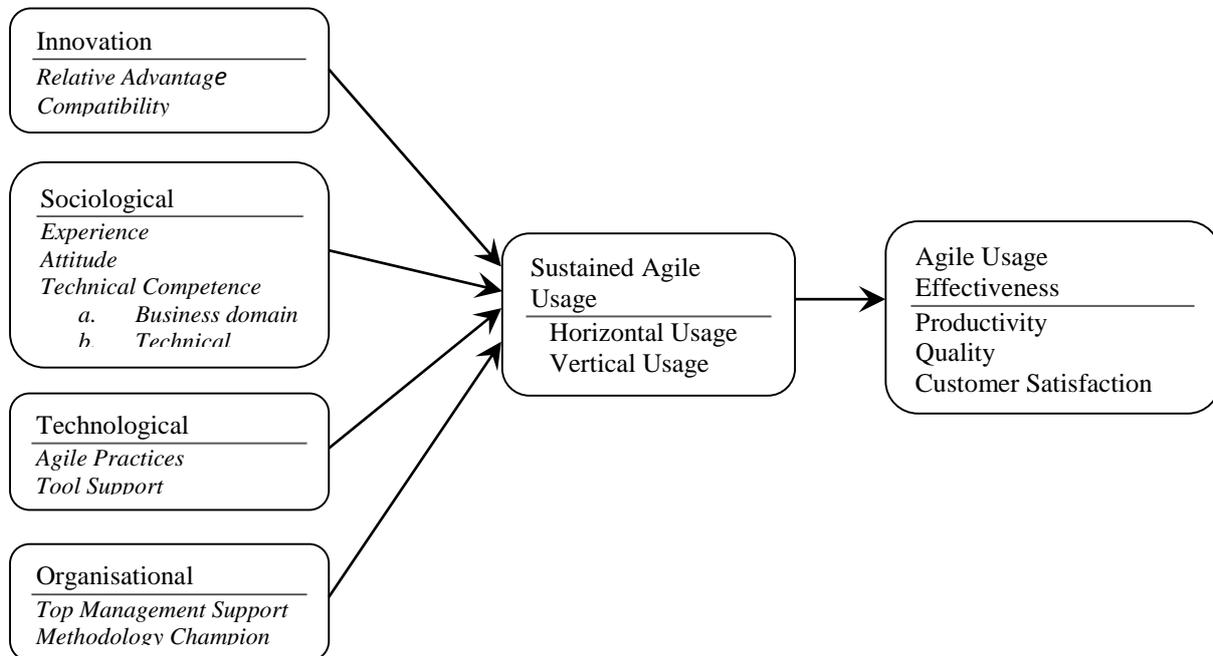


Figure 2.10: The Research Model: Sustained Agile Usage Model (CF1)

2.8.1. Innovation Factors

Relative advantage is defined as by Rogers (Rogers, 2003) as “...*the degree to which the innovation is perceived better than its precursor*”. An organisation can successfully move to post-adoptive phases only after an innovation consistently offers specific improvements in comparison to its predecessor. There is empirical evidence to suggest that relative advantage is a significant factor in predicting the usage of SDMs (Hardgrave, Davis, & Riemenschneider, 2003; Huisman & Iivari, 2002) as well as evidence at the organisational level (Iivari, 1996). Other studies that have validated the effect of this attribute on the use of an innovation include software process engineering innovations (Fichman & Kemerer, 1993), programming languages (Agarwal & Prasad, 2000), and acceptance of AM (Chan & Thong, 2009).

“*Compatibility* refers to *the degree to which an innovation is perceived as being consistent with the existing practices, values, [and] past experiences...*” (Rogers, 2003, p23). In terms of post-implementation stages it is described as the fit between an innovation and a particular context (McChesney & Glass, 1993), which implies that the chosen agile practices must match the

context in order to be effective and successfully integrated into the organisation. Since the adoption of agile methods represents a major shift in the paradigm of systems development (Rajlich, 2006), it entails major alterations to work practices, investment in tools that support and facilitate rapid iterative development, versioning/configuration management, refactoring and other agile techniques (Nerur & Mahapatra, 2005). For example, (Mangalaraj et al., 2009b) found that the use of multiple languages such as C, Java, C++, and Motif, in a large legacy project caused serious challenges to the adoption of XP practices such as code ownership, refactoring, and automated testing. There is sufficient evidence for the significance of compatibility in a number of empirical studies on traditional SDMs (Hardgrave et al., 2003; Huisman & Iivari, 2002; Iivari, 1996), and it is also identified as a significant predictor of the acceptance of AMs (Chan & Thong, 2009).

2.8.2. Sociological factors

The selected sociological factors include *attitude* – the practitioner/team’s positive or negative salient beliefs about the consequences of continuing to use an innovation (Karahanna, 1999) and *experience* - a high level of practitioner/team experience will contribute to increased productivity, and *technical competence* (i.e., *domain expertise*, a practitioner/team with a high level of expertise may not be subject to the learning curve associated with an unfamiliar domain, and *language expertise*, practitioner/team with high level of expertise may not be subject to the learning curve associated with learning an unfamiliar programming language) (Agarwal & Prasad, 2000; Williams et al., 2004c).

Past research suggests that high levels of technical knowledge within an organisational unit will strongly influence the effective use of an innovation (Rai & Howard, 1994). Sociological factors have also been found to affect post-adoptive phases of assimilation rather than earlier stages since they influence employees’ willingness and ability to adapt to changes in newer practices and adopt the values associated with an innovation. Therefore higher levels of attributes such as personal innovativeness, personal resilience, and tolerance of ambiguity may facilitate diffusion whereas lower levels of these attributes may constrain diffusion (Gallivan, 2001). Throughout the agile literature, technical competency (individual and average team competence) has been repeatedly emphasised as a critical factor to project success (Cockburn & Highsmith, 2001; Highsmith, 2002b).

2.8.3. Technological factors

Technological factors include *agile development practices*, and *tool support (use of Project Management tools such as VersionOne, RallyDev, tools for automated testing)*. Recording *agile practices* may provide insight into which hybrid practices may lead to more effective outcomes (Williams et al., 2004c). This outcome is because there is often a substantial difference between the ‘vanilla’ textbook version and the actual “method-in-action” used in practice because most prescribed agile practices are tailored to meet the contextual needs of software development (Fitzgerald, 1997; Pikkarainen et al., 2007). For example, Pikkarainen et al., (Pikkarainen et al., 2007) found that different XP practices reached different levels of assimilation during different periods of usage, and practices that addressed specific needs of the adopting team reached deeper assimilation levels.

While the significance of *tool support* in the adoption of software process innovations in general has been recognised (Green & Hevner, 1999), their importance in facilitating acceptance of agile practices in terms of providing support to specific XP practices like refactoring, continuous integration, and test-driven development is also documented (Mangalaraj et al., 2009b). For example, (Mangalaraj et al., 2009b) found that the use of software tools such as IntelliJ (IDE vendor that supports refactoring) and CruiseControl (continuous integration engine that supports test driven development) greatly helped in speeding up XP practices such as refactoring and test-driven development.

2.8.4. Organisational factors:

Organisational factors include Top Management Support (TMS) and Methodology Champion (MC). TMS refers to ongoing, continual support and encouragement of the top management executives in the adoption and implementation of innovations (Sultan & Chan, 2000), which has emerged as a key factor affecting implementation success in IS innovation and the systems development methodology literature (Huisman & Iivari, 2002). Active support and direct involvement of top management is capable of enabling a smoother transition to adaptive practices such as agile ones. For example, Roberts et al. (1998); (Roberts & Hughes, 1996) found that lack of management support was one of the biggest obstacles in implementing SDM, while (Iivari, 1996) reported significant relationships between CASE usage and management support both at the individual and organisational level. In the context of AM, Vijayasaraty and Turk (2008a) found lack of management support to be one of the biggest obstacles in the successful implementation of AMs.

MC: Successful adoption of AMs implies changes to the organisational culture, form and processes, which require significant changes in the systems development methods, values, and the learning of new practices. While traditionally MCs are predominantly viewed as playing a critical role in the introduction of new innovations in organisations (Premkumar & Potter, 1995), they are also characterized as bearers of persuasive and evaluative information about an innovation (Beath, 1991). According to Beath, MCs not only promote the users' vision of using an innovation, but also uses a variety of other influences (social, political, etc.) to eliminate barriers to successful diffusion and implementation (Beath, 1991). In the context of AM, MCs play a significant role in encouraging and facilitating the ongoing usage of agile practices, which include responsibilities such as convincing management, pushing through implementation hurdles, mentoring, and ensuring that agile practices are correctly adhered to by team members (Pikkarainen et al., 2007).

2.9. Research Scope

2.9.1. Focus of Investigation

Sustained or continued usage effectiveness of IS-related innovations may be studied at an individual (Ishman, 1998) or organisational level (Iivari, 1996). As discussed in section 2.3.1, AMs can be classified as a contingent organisational innovation, where the secondary adoption could be authority-based, optional, or consensus-based. Though there can be strong dependencies between organisational and individual decisions to adopt and use an IS innovation such as agile, these two types of decisions are distinct from each other. While the initial adoption decision of an innovation is usually made at the organisational level, its continued or post-adoptive usage is mainly decided by individuals or teams involved in the development process (Khalifa & Verner, 2000). An organisation's decision to adopt an innovation cannot be considered as an individual user's acceptance (Hardgrave et al., 2003) or commitment to use the innovation.

Prior studies in SDMs have suggested that individuals choose not to continue to use an innovation even after the decision has been made at the organisational level (Orlikowski, 1993). In the context of software process innovations, it is believed that the innovation should be adopted at the individual level in order to be effective (Green & Hevner, 1999). It is believed that in the case of post-adoptive use of an innovation it is the individual user who decides to continue to use an innovation based on a number of factors such as attitude, willingness to learn

and change, and their experience based on its initial use. If the use of AM is made mandatory against the willingness of individual practitioners, it might have a negative impact on the work morale which in turn could have an effect on their long-term or sustained use. Prior studies have highlighted the need for understanding agile usage and implementation at the team level (Mangalaraj et al., 2009a; Wang et al., 2012). Therefore, to add the existing body of knowledge which consists of few early studies on post-adoptive stages of agile use at the *team* level, this study focuses on the *individual* level, i.e., the question of ‘why’ or why individual agile practitioners’ ‘do’ or ‘do not’ sustain the use of AMs.

Agile methods as a research domain comprises a number of key research themes and theoretical perspectives (Dingsøyr et al., 2012). In an examination of five special issues published on agile development between 2003 and 2011, three important points were highlighted: 1) XP and Scrum were the most common methods researched, 2) most studies focused on furthering our understanding of agile concepts, 3) dominant topics researched include adoption and/or adaptation of agile, reconciliation of the tension between agile and plan-driven development, and evaluation of adoption issues in environments that were not inherently conducive to agile (Dingsøyr et al., 2012). The lack of research on post-adoption use of AMs, and in particular, lack of empirical research on their actual and effective use beyond the adoption phase has been stressed by many authors. And, because some methods (XP and Scrum) have received more attention than the others, the current body of knowledge has resulted in fragmented research, and shared aims, values, and strengths of ‘agile’ methods are starting to be missing out (Iivari & Iivari, 2011). Therefore, as discussed in section 2.5.1.3, this study seeks to cover the totality of AMs rather than focusing on individual methods such as XP and Scrum. The more general phenomenon of sustained or continued usage of agile method will be investigated, i.e. any SDM methodology which falls under the umbrella of AMs (XP, Scrum, DSDM) will be considered as the case, i.e. agile methodology as the primary object of investigation.

2.10. Research Design

2.10.1. Epistemological foundations of the study

In order to conduct any valid research, it is important to know the underlying philosophical assumptions on which the research is based (Myers, 2009). The most relevant philosophical assumptions are those that relate to the underlying epistemology which guides the research (Myers, 2009). Epistemology is defined as the theory of knowledge regarding its methods,

validity, and scope (Soanes & Stevenson, 2004). It refers to the underlying assumptions about how knowledge can be obtained in any research (Hirschheim, 1992). Based on the underlying research epistemology, there are three main categories: positivist, interpretive, and critical (Orlikowski & Baroudi, 1991).

Positivist research assumes an objective social reality which can be described using measurable properties, and is independent of the researchers' instruments, subjective opinions, and moral judgements (Myers, 2009). The primary purpose of positivist studies is to test theory, in an attempt to increase the predictive understanding of phenomena (Myers, 2009). Theories are generally based on the existence of *a priori* fixed constructs and relationships within phenomena which are typically investigated with structured instrumentation (Orlikowski & Baroudi, 1991).

Interpretive research assumes that social reality can only be described through social constructions such as language, shared meanings, and instruments (Myers, 2009). The primary purpose is to understand the deeper structure of the phenomenon by focusing on the complexity of human sense-making as the situation emerges (Kaplan & Maxwell, 1994; Myers, 2009). Therefore, interpretive research asserts that reality cannot be understood independent of social factors (including the researchers) that make sense of that reality (Orlikowski & Baroudi, 1991).

Lastly, critical research assumes that reality is historically constituted and people can consciously act to change their social and economic conditions (Myers, 2009; Orlikowski & Baroudi, 1991). However, critical researchers believe that human ability to do so is constrained by various forms of social, cultural, and political domination as well as natural laws and resource limitations (Klein & Myers, 1999). Thus, the main task of critical research is to critique the existing social systems by bringing the supposedly restrictive and alienating conditions of the status quo to light (Myers, 2009).

While the three epistemologies discussed above are philosophically distinct, these distinctions has not always been clear and straightforward in the practice of IS research (Lee, 1989). There is considerable disagreement as to whether these philosophical perspectives are necessarily opposed or can be accommodated within a single study (Myers, 2009). In agreement with Lee (Lee, 1991), though the current study attempts to integrate different philosophical perspectives' using a mixed method approach (discussed next), the study primarily employs a positivist view to addressing the research questions. This is because the main driving question of this research:

“How can organisations sustain the use of agile methods?” seeks a generalisable result that can be applied to a wide range of organisations that use AMs.

Though the value of combining different research methods in a single study has been recognised in the IS literature for quite a long time (Gable, 1994a; Lee, 1991), their application in IS studies has been rather slow. Currently, there is considerable literature that provides guidance and support on the conduct of mixed method research designs (Gable, 1994a; Lee, 1991; Orlikowski & Baroudi, 1991; Venkatesh et al., 2013).

Important observations in the context of the current study such as rapid and widespread adoption of AMs (Wang et al., 2012), and the lack of evidence on their actual usage, penetration, and effectiveness (Lee & Xia, 2010; Vijayasarathy & Turk, 2012) led to the relationships proposed in the two main research questions (questions 2 and 3 in table 1.1) formulated in this thesis. In order to adopt a rigorous and adequate theory-building process (Eisenhardt, 1989), a mixed method research design that included research methods appropriate to include both inductive and deductive reasoning was sought. Deductive logic involves arguing from the general (e.g. theory, conceptual framework) to the particular (e.g. data) and inductive logic involves arguing from the particular to the general (Teddlie, 2009). Mixed method (MM) research uses both deductive and inductive logic in a distinctive sequence described as the inductive-research research cycle which involves both inductive and deductive reasoning processes (Teddlie, 2009) – see Figure 2.11. MM design strategies provide a powerful mechanism for research in areas such as AM which either lack strong theoretical foundations or in which existing theories and findings are insufficient to explain or offer significant insights into a phenomenon of interest (Venkatesh et al., 2013).

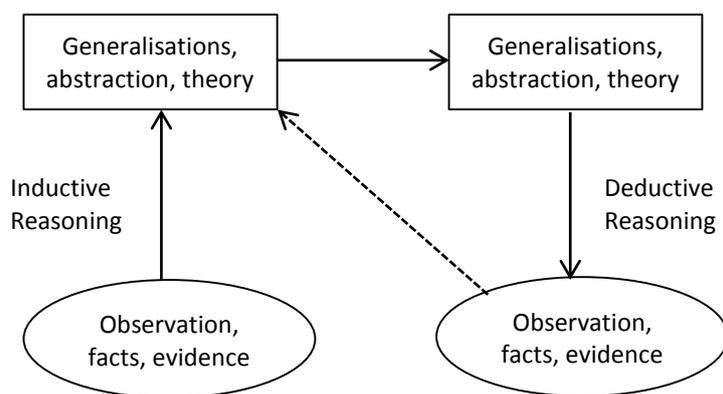


Figure 2.11: Mixed method research design. Source: (Teddlie, 2009)

Venkatesh et al. (2013) identify seven purposes for conducting MM research:

- 1) complementarity – gain complementary views about the same phenomena or relationships
- 2) completeness – obtain a complete picture of a phenomenon
- 3) developmental – questions from one strand emerge from the inferences of a previous one, or one strand provides hypotheses to be tested in the next one
- 4) expansion – explain or expand upon the understanding obtained in a previous strand of study
- 5) corroboration/confirmation – assess the credibility of inferences obtained from one approach
- 6) compensation – enable to compensate for the weaknesses of one approach by using the other, and
- 7) diversity – obtain divergent views of the same phenomenon.

The purpose of this study is ‘developmental’, and the MM design employed is the sequential combination of (a) the qualitative phase (e.g. case study, semi-structured interviews): used to review and refine the constructs and relationships proposed in the initial *a priori* model, and develop hypotheses based on the final refined model and (b) a quantitative study to test the hypotheses. The methods in the qualitative phase are employed to explore and discover the concepts and issues relating to sustained usage of AMs as well as to facilitate inductive reasoning to build theory and formulate hypotheses. In the quantitative phase, a *survey* is used to facilitate hypothesis testing and theory confirmation. The combination of the two phases can

also be seen as illustration of an integrated use of case study and survey method as suggested by Gable (Gable, 1994a). This design approach is analogous to Lee’s (Lee, 1991) proposition on integrating positivist and interpretive approaches as discussed in chapter 1. Figure 2.12 shows how the two strands of research are brought into an overall research context that includes *conceptual study* as a model building exercise, as well as the use of *case study* approach to test the literature-based *a priori* model to produce the first validated version of the model which in turn provides the theoretical foundation for the *semi-structured interviews* and *focus group* phase. The overall design is divided into five distinct phases which is reflected in the structure of this thesis (see chapter 1). Each of the five phases is briefly introduced below:

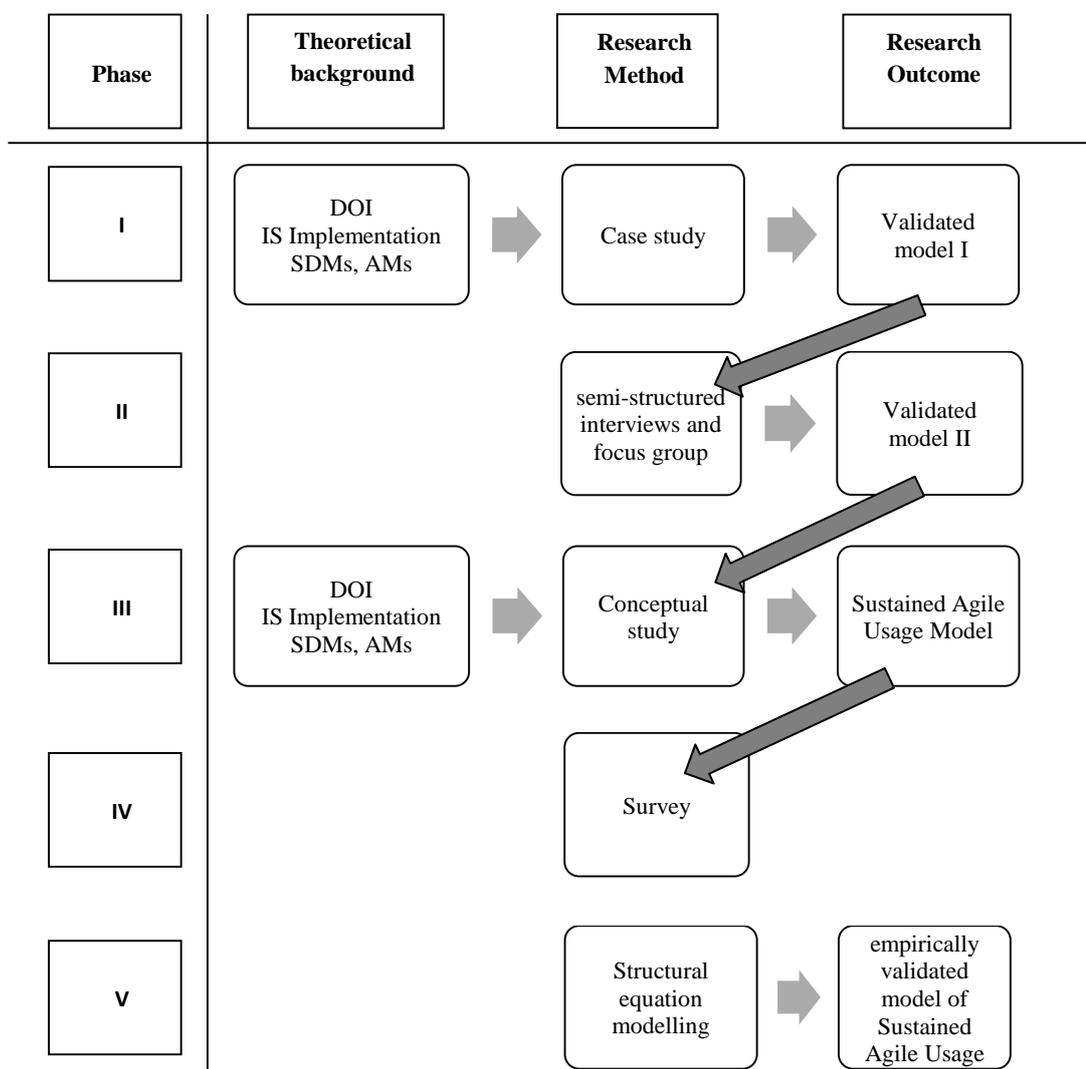


Figure 2.12: Overall Research Design

Phase 1: Case study

Case research is useful when a phenomenon is new, broad, and complex, an in-depth investigation is needed, and when a phenomenon cannot be studied outside the context in which it occurs (Benbasat et al., 1987). It is particularly appropriate in areas where research and theory are in their early formative stages (Benbasat et al., 1987). Though AMs have been used in organisations for more than a decade, research in the areas of their post-adoption use, and effectiveness is in its early formative stages. Therefore, case study method was employed as one of the main research approaches in the current study. The main purpose of using the case study approach was to test the proposed *a priori* research model CF1 (conceptual framework – see Figure 2.10) and provide theoretical explanations that account for the various factors that impact agile usage and agile effectiveness. A pilot case study (CF1) was followed by an in-depth case study (CF2). As discussed in chapter 1 (section 1.4), the structured-case framework was applied, where each research cycle followed three stages (1) Conceptual framework -> (2) plan-collect-analyse-reflect -> (3) literature-based scrutiny (described in 1.4.1.1). Cross-comparison of the two cases was conducted to draw insights on the various factors relating to sustained usage of AM.

Phase II: Semi-structured Interviews and Focus group

In phase two, the validated model from phase 1 is subjected to further empirical investigation. The investigation is carried out in the form of a series of semi-structured interviews and a focus group with actual users and practitioners of AM. The main goal is to gain further understanding of sustained usage in organisations from practitioners' point of view, to unearth additional predictor constructs or variables that might influence agile usage, or avoid inadvertent exclusion of variables in the proposed model. The outcome of this phase is further refinement and re-specification of the model.

Phase III: Model Building

The findings from phases one and two are combined in the development of the final research model of agile usage. The findings from both the phases are integrated with theories in the extant literature and prior empirical findings on the sustained usage of AMs. The final model specifies all the constructs, and relationships between dependent and independent variables.

Phase IV: Survey

To conduct deductive reasoning a survey is employed to facilitate hypothesis testing and theory confirmation. The final model of SAU is operationalised in a web-based survey instrument to test and measure the hypothesised constructs and relationships. The main objective of this phase is to devise a valid and reliable, measurement appropriate for empirically testing the proposed SAU model. It comprises of construct and scale development, development of the survey instrument, a series of preliminary and pilot tests, and the actual conduct of the survey.

Phase V: Structural Equation Modelling

The data collected from the survey phase is subjected to statistical analysis by means of Partial Least Squares Structural Equation Modelling. The main objective is to validate the devised measurements for the specified constructs, and empirically test the hypothesised relationships between the constructs. The outcome is an empirically validated model of SAU.

2.11. Conclusions

This chapter reviewed the literature that serves as background to support the legitimacy of the research questions and objectives of this study. The areas of the literature reviewed are summarised in table 2.1.

The research design adopted in the present study follows the sequential mixed method research (Teddlie, 2009; Venkatesh et al., 2013). It uses an integrated approach by combining qualitative and quantitative research methods embodied in a positivistic view to addressing the research questions. As discussed in chapter 1, it follows the three levels of understanding proposed by Lee (Lee, 1991). First, by using a combination of a case study, interviews, and a focus group, *subjective understanding* about the various factors that either hinder or facilitate the sustained usage of AM is gained by investigating the subjective perceptions of agile practitioners. Second, based on the *interpretive understanding* of the data collected in phase 1, the proposed model is further refined and re-specified. Finally, *objective understanding* is generated by subjecting the model to a statistical validation using a survey.

Chapter 3. Case Study Design

In this research, a pilot case study was followed by a complete case study. This chapter describes the overall design that was followed for the case study method. The main purpose of using the case study approach was to test the proposed *a priori* research model and provide theoretical explanations that account for the various factors that impact sustained agile usage. First, background and nature of the case research method is provided followed by the rationale for using case study method. The overall case study design is discussed next. This is followed by a description of the case selection, data collection, and data analysis procedures.

3.1. Background and the nature of Case Study research

A case study is defined as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (Yin, 1994, p. 13). Yin’s definition is too broad to be applied in business disciplines such as information systems where a ‘case study’ is always synonymous with a study of some business aspect of an organisation (Myers, 2009). This organisational focus distinguishes case study research in business from case study research in other fields, where it is defined as follows:

case study research in business uses empirical evidence from one or more organisations where an attempt is made to study the subject matter in context. Multiples sources of evidence are used, although most of the evidence comes from interviews and documents. (Myers, 2009, p. 76)

Case study research supports all types of philosophical perspectives, i.e. positivist, interpretivist, or critical (Dubé & Paré, 2003). Case studies can be *exploratory*, *descriptive* or *explanatory* (Yin, 1994):

exploratory studies are mainly used to answer “what” questions where the goal is to develop relevant hypotheses and propositions for further inquiry;

explanatory studies are used to answer “how” and “why” questions where the goal is to determine whether there are any causal relationships between variables or events;

descriptive studies are mainly used to answer “what” questions in the form of “how many” or “how much” where the goal is to provide a rich description of the phenomenon being studied.

Case study research is useful when a phenomenon is new, broad, and complex, an in-depth investigation is needed, and when a phenomenon cannot be studied outside the context in which it occurs (Benbasat et al., 1987). It is particularly appropriate in areas where research and theory are in their early formative stages (Benbasat et al., 1987).

Case study research has been widely accepted in the IS discipline for more than three decades (Benbasat et al., 1987; Klein & Myers, 1999; Lee, 1989; Orlikowski & Baroudi, 1991). Case research allows the researcher to study an IS phenomenon as perceived by IS practitioners, investigate actual state of practice and generate theories based on the findings and analysis of such practice, understand the nature and complexity of real-life processes, and appropriately carry out research in areas in which little previous research exists (Benbasat et al., 1987). When asked to give one reason for the popularity of the case study methodology in IS, one Harvard professor noted that “*whereas traditional MIS systems were simply a subfunction of an organisation, the newer MISs could potentially lead to the restructuring of the entire organisation, with the firm in its entirety becoming an MIS*” (Yin, 1993, p. 44). In agreement with this viewpoint, case study method was adopted in the current study to unleash the various factors and the dynamic and changing conditions (Pare, 2001) under which contemporary systems development methodologies such as agile could potentially lead to the restructuring of entire organisations in their attempt to becoming agile organisations.

3.2. Rationale behind the choice of the case study method

Although many benefits from the use of AM relating to improvements in systems development outcomes such as productivity and quality have been claimed, research evidence supporting proponents’ claims is lacking (Erickson et al., 2005; Lee & Xia, 2010). There is very limited empirical evidence on their actual usage, penetration, and rigorous examination of ‘if, how, and why’ AM are effective (Begel & Nagappan, 2007; Lee & Xia, 2010; Vijayasarathy & Turk, 2012). This research looked for evidence of effectiveness of AMs as an outcome of continued or sustained usage of AMs in organisations.

Though AMs have been used in organisations for more than a decade, the field suffers from lack of strong theoretical foundations. In particular, research in the areas of their post-adoption

use, and effectiveness is in its early formative stages. And, as the main research questions driving this study contains “How?” (*How can organisations sustain the use agile methods?*) and “What?” (*What are the factors that impact sustained agile usage?*) questions, the study falls into both exploratory/explanatory categories, which are precisely the criteria identified as best suited to employ a case study approach. The following questions (source - Benbasat et al. (1987)) were asked to decide on the appropriateness of the case strategy:

- “Can the phenomenon of interest be studied outside its natural setting?” (No)
- “Must the study focus on contemporary events?” (Yes)
- “Is control or manipulation of subjects or events necessary?” (No)
- “Does the phenomenon of interest enjoy an established theoretical base?” (No – the field of AMs suffers from lack of strong theoretical and conceptual foundation;) (Conboy, 2009; Wang et al., 2012)

The main objectives of the case study phase, in relation to the overall study design (section 2.10, Chapter 2) were to:

2. test the proposed *a priori* model: are all constructs and relationships correctly captured? Is there any inadvertent exclusion of any important constructs? Any redundant constructs?
3. aid in the iterative development of the research model (using the structured-case methodology)
4. aid in the design of the subsequent survey: obtain sufficient evidence from the cases for the proposed relationships before deriving the hypotheses
5. support meta-analysis of data: to combine analysis from case studies with findings from other phases (e.g. semi-structured interviews) and survey analysis to support triangulation and meta-analysis.

While the cases presented in this research conform to Yin’s definition, i.e. (i) enable investigation of a contemporary phenomenon in a real-life setting (R. K. Yin, 1994), and particularly appropriate for the study’s topic of SAU, where theory and research are still in their formative stages (Eisenhardt, 1989), and (ii) facilitated the testing of a well-formulated theoretical model, i.e., the *a priori* SAU model, the main reason for using case study method was to use empirical evidence from relevant organisations in an attempt to study the phenomenon of interest, i.e. SAU in context by using multiples sources of evidence such as interviews and documents (Myers, 2009).

3.3. Case Study Design

Case study method seeks an in-depth investigation of the interaction between the phenomenon of interest and context. Conducting good case research is difficult and presents the researcher with unique challenges (Dubé & Paré, 2003; Yin, 1994). The following sections describe how important attributes for conducting rigorous case research such as (i) stating clear research questions, (ii) specifying criteria for selecting cases, (iii) providing information about data collection methods, and (iv) clearly elucidating the data analysis process were applied in the current study (Dubé & Paré, 2003).

3.3.1. Theory testing

The process of building theory from case study research starts with the initial definition of research question followed by *a priori* identification of constructs from the extant literature (Eisenhardt, 1989). In this study, theory building was conducted at an earlier phase, where *a priori* constructs were identified through a synthesised literature review (discussed in Chapter 2). Any additional or tentative themes emerging from the case study data were constantly compared with those derived from the literature, i.e. the *a priori* model. The pilot case study served as the primary test ground for testing the *a priori* model, the results of which provided further guidelines to complete the main case study as per the recommended guidelines. While such conceptualisations have been criticised for denying relevant theoretical interpretations from the data (Ahrens & Dent, 1998), Eisenhardt (Eisenhardt, 1989) argues that such a process of deriving a theoretical model by constant comparison across cases, evidence, and literature has the potential to generate less biased theory. Thus, the study adopts a positivist philosophical perspective which aims to increase the predictive understanding of the phenomenon under investigation (Orlikowski & Baroudi, 1991).

3.3.2. Unit of Analysis and Case selection

Unit of analysis is related to the fundamental problem of defining what the case is, and must be related to the way the initial research questions have been defined (Yin, 1994). However, most published articles in IS do not clearly specify the unit of analysis (Benbasat et al., 1987; Markus, 1989). The specification of the unit of analysis is critical if we want to understand how the case study relates to the broader body of knowledge (Dubé & Paré, 2003). It is even more critical with explanatory and exploratory case studies, as the practical significance of the findings for theory rests on the appropriate unit of analysis (Dubé & Paré, 2003; Markus, 1989):

In an exploratory study, a clear specification of the unit of analysis helps define the boundaries of a theory, which in turn set the limitations in applying the theory. In an explanatory study, a clear definition confirms that the unit of analysis under study is consistent with the boundaries of the theory being tested. Due to the dual nature (exploratory and explanatory – see section 1.3) of the current study, both the above aspects in defining the unit of analysis apply. As the study's focus of investigation is the sustained usage of AM, *agile systems development methodology* was selected as the unit of analysis, i.e. individual agile methodologies used within organisations were sought as cases. The objective was to investigate and reveal information relating to (a) different stakeholders' perceptions on various factors that either facilitated or hindered the sustained usage of the agile methodology, (b) outcomes before and after implementation of agile methodology in the organisation.

Building theories from case studies relies on 'theoretical sampling' as opposed to 'statistical sampling'. In theoretical sampling, cases are chosen which are more likely to replicate or extend the theory. The use of multiple-case design in building or testing the *a priori* theoretical model is recognised in the literature (Eisenhardt, 1989; Yin, 1994). Multiple-case designs are preferred over single-case designs as the evidence from multiple cases is considered more compelling. Multiple-case designs must follow a replication rather than sampling logic. Two main criteria are used when selecting potential cases (Yin, 1994): literal replication – similar outcomes are predicted, and theoretical replication – contradictory outcomes are predicted. Since the main objective of this study was to develop a rich, theoretical framework for understanding SAU, an exploratory literal replication approach was used. The following criteria were used to select the cases:

- i) The organisation had been conducting systems development for a range of different applications using one of the main agile methodologies (e.g. Scrum, XP)
- ii) The organisation had been using agile methodologies for at least 2 years
- iii) Support and overall interest from the organisation and the sponsorship received (e.g. willingness to participate), and key stakeholders (developers, Scrum Master, etc.,) were available for interviews
- iv) Medium to large scale organisations which were either within the geographic proximity to the researcher's location or where there was easy access to relevant resources and key informants from the organisation

Taking into consideration the resource constraints, opportunities, feasibility issues, and the overall mixed method design of the study, two cases were selected. In addition to the criteria for selection discussed above, the first case, BBCW was selected and treated as the pilot case for two main reasons:

- (i) it had empirical evidence of achieving specific improvements in systems development outcomes as a result of sustained usage of AMs (Middleton & Joyce, 2010a), and
- (ii) the researcher had access to key informants who were supportive, passionate and interested in the research topic.

BBCW is a wholly owned subsidiary of British Broadcasting Corporation (BBC) which operates under the BBC Charter and Agreement. The second case, Statistics New Zealand (Stats NZ) is a government organisation and New Zealand's national statistical office which provides statistical information needed in a wide range of areas. The two organisations were selected by paying attention to theoretical relevance which ensures that the substantive area addressed, i.e. the sustained usage of AMs was similar (Eisenhardt, 1989). Thus, both the organisations had adopted AMs during 2005/2006 and sustained their use in most of their systems development operations until 2009/2010 during which time data was collected for this study.

3.3.3. Data Collection

Case study research relies on multiple sources of evidence and typically combines multiple data collection methods. Yin (2003) identifies six sources of commonly used evidence in case research: documentation, archival records, interviews, direct observation, participant observation, and physical artefacts. In this study, the primary source of data was semi-structured interviews with key stakeholders in both cases. Other evidence included direct observation of daily stand-up meetings (Stats NZ only), relevant documentation, published articles and reports, informal personal communications (email and telephone), and publicly available information such as websites. All secondary evidence was used to augment and corroborate interview data. A total of twenty (BBCW – 3, Stats NZ – 17) interviews were conducted. Though BBCW had a smaller number of interviews in comparison to Stats NZ, it provided considerable insight into the basic issues being studied, and it satisfied the theoretical relevance which ensured that the substantive area addressed, i.e. the SAU was similar. Besides,

it had empirical evidence of achieving specific improvements in systems development as a result of sustained agile usage of AMs. An interview guide/protocol was used to elicit information on the agile practices used in various projects, and to test the factors and measure the outcomes of the usage model. Interviewees were selected based on their primary role in a given agile project using a specific agile methodology, for example, Scrum. The interviewees' opinions on each of the constructs were sought to validate the model's constructs. They were also given the opportunity to openly discuss and identify any other relevant constructs or measures based on both their current and previous experiences. Different stakeholders such as developers, business analysts, project managers, Scrum Masters (SMs), and IT service delivery managers were targeted for the interviews to capture different perspectives relating to sustained usage of AMs. Ethical guidelines were followed and informed consent was obtained by all participants (see Appendix F for all supporting documentation). The duration of the interviews ranged from thirty to sixty minutes. All interviews were electronically recorded and transcribed. Detailed discussion on the interview process and the conduct of the interviews are presented in Chapters 4 and 5

3.3.4. Quality of Research Design

The quality of case research is typically evaluated using four main criteria (Yin, 2009):

- Construct validity: identifying correct operational measures for the concepts being studied
- Internal validity: seeking to establish causality
- External validity: defining the domain to which a study's findings can be generalised
- Reliability: demonstrating that the study's procedures (e.g. data collection) can be repeated, with the same results.

Based on the above criteria, Dubé and Paré (2003) provide a framework for evaluating the quality of positivist case study research in IS. This framework is used to evaluate this study's case study design (see Chapter 4, section 4.11)

3.3.5. Data analysis

The basic goal of data analysis is to gain a logical and coherent understanding of the collected data (Kaplan & Maxwell, 1994). Based on the work of Miles and Huberman (1994), Pare (2001) divide the data analysis stage into three distinct stages: *early steps in data analysis*, *within-case analysis*, and *cross-case analysis*.

3.3.5.1. Early steps in Data Analysis

Miles and Huberman (1994) suggest a series of methods to assist with analysing and reflecting on existing data and generating strategies for refining the process of further data collection: contact summary sheet, document summary form, reflective and marginal marks, case analysis meeting, coding, and interim case summary. In the current study, two methods were used during the early phases of data analysis.

Field Notes: During data collection (e.g. conducting interviews) brief field notes were created. This was done in addition to recording the interviews, and at the end of each day, summaries were created which included information such as “ideas” that were generated, a list of ‘to-do’ items for subsequent data collection efforts, descriptions of the context of the conversations, meetings, etc. The field notes were reviewed frequently and any important issues or conflicting answers were immediately identified. Such issues were clarified with key informants from each organisation and any additional information that was missing was sought.

Coding: Codes help in assigning units of meaning to the descriptive or inferential information compiled during a study (Miles & Huberman, 1994). There are several approaches to creating a coding scheme that serves as a template for organising the data - a coding scheme allows the investigator to see the logical link between the theoretical model and the codes (Pare, 2001). One approach is to rely on predefined or *a priori* codes based on prior research, i.e. the proposed research framework, which was the approach followed in the current study. Based on the *a priori* framework, the coding scheme was divided into three broad categories: (1) factors with four sub-categories - *innovation*, *sociological*, *technological*, and *organisational* (2) sustained agile usage, and (3) agile usage effectiveness. The actual coding was conducted as described below:

- (i) Code data under corresponding predefined constructs (*a priori model*) in the coding scheme
- (ii) Identify or inductively develop any potential new constructs (e.g. using in-vivo coding)
- (iii) Further analyse the coded data to validate its relevance, categorization, etc.,

3.3.5.2. Within-Case Data Analysis

There are three main types of data analysis techniques (Yin, 1994): pattern-matching, explanation-building, and time-series analysis. Pattern-matching is one of the most desirable strategies for case-analysis ((Trochim, 1989) cited in (Pare, 2001)) which compares an empirical based pattern with the predicted one, i.e. the *a priori model*. Internal validity is enhanced when patterns coincide (Pare, 2001). Pattern-matching was used in the current study to analyse the findings, both within each case and also across cases. The main purpose was to validate the *a priori* constructs and to gain insights on the proposed hypotheses/relationships between the various constructs to aid in the subsequent phases of the study (e.g. survey). NVivo⁵ version 10 was used to support the data analysis process. Chapter 4 describes the data analysis process in greater detail.

3.3.5.3. Cross-Case Analysis

Cross-case analysis technique applies to the analysis of multiple cases (at least two cases), and can be performed whether the individual case studies have been previously conducted as independent research studies or as a predesigned part of the same study (Yin, 2009). In the current study, the first case study (BBCW) was an extension to a previously conducted independent study (Middleton & Joyce, 2010a). Findings from this study was compared and examined with the findings of Stats NZ using the *a priori* framework. In terms of this research, though BBCW is a smaller case (e.g. data collection – number of interviews, etc for this research), but the whole case itself is a large one, i.e. extension of a previous study, i.e. Middleton & Joyce (2010). According to Yin (2003), cross-case comparison can be performed whether the individual case studies have previously been conducted as independent research studies (authored by different persons) or as a predesigned part of the same study. In either situation, the technique treats each individual case study as a separate study. In this way, the technique does not differ from other research syntheses-aggregating finding across a series of individual case studies. Therefore, the entire collection of data from both cases was analysed which enabled the study to draw cross-case conclusions.

3.3.6. Case Report

Reporting a case study is the most important aspect from the reader (user)'s perspective, and therefore should provide clear explanations of study's findings and its implications (Pare,

⁵ <http://www.qsrinternational.com/>

2001). In addition to optimal qualities of a case report (see Figure 3.1), the report should also present implications for research and recommendations for practice.

- accessibility and clarity (e.g., no technical jargon, assumptions explicitly stated)
- conceptual structure (i.e. themes)
- coherence (e.g., effective interpretation of the context)
- sufficient raw data are presented
- quotations are used effectively data, analytical framework, and interpretations and results must be separated
- headings, figures, tables, are used effectively

Figure 3.1: Optimal qualities of a case report (adapted from (Pare, 2001))

Yin (Yin, 2009) identifies four formats for writing case reports, out of which two are applicable to the current study:

- (i) classic single-case study – a single narrative is used to describe and analyse the case. This format was used to write up the findings of the first case study (BBCW) and reported in the form of a conference paper at the 12th International Conference on Agile Software Development, XP 2011 (Senapathi, Middleton, & Evans, 2011).
- (ii) multiple-case report – in addition to individual case narratives, the report will also contain a section on cross-case analysis and results. It will consist of multiple narratives, covering each of the cases separately, usually presented as separate sections. This format was used to write up the findings of both the cases (BBCW and Stats NZ) and also the cross-case analysis. This report was submitted to the Agile 2011 international conference (Senapathi & Srinivasan, 2012), which received very good reviews. An extended and revised version of this paper was submitted to the journal, *Journal of Systems and Software*. It was one of the five papers which were accepted out of twenty-one submissions – this was seen as an indication of the quality and increased confidence in the adequacy and rigor of the chosen case study approach.

3.4. Conclusion

This chapter described the overall design that was followed for the case study method. First, background and nature of the case research method was provided followed by the rationale for

using case study method in this research. The overall case study design was discussed next. Later, application of rigorous case research attributes such as identifying clear research questions, specifying criteria for selecting cases, providing specific information about data collection methods, and clearly elucidating the data analysis process was described.

Chapter 4. Case Study Phase

The case study approach is a significant phase in the overall research design of this study. In chapter 3, the overall design of the case study method was presented. This chapter presents the conduct and findings of two case studies, BBC Worldwide (BBCW) and Statistics NZ (Stats NZ). First, the background and context, research method, and findings and analysis of the application of the *a priori* framework (i.e. the research model) to the pilot case study, i.e. BBCW are provided. Based on the insights learnt and reflections from the pilot case, several changes were made to the case design. The application of these procedures to the second case study, i.e. Statistics NZ (Stats NZ), along with a discussion of findings and analysis is presented next. This is followed by a description of the cross-case analysis, i.e. how the model was used to inform analysis of post-adoptive usage of AMs in two organisations, i.e. BBCW and Stats NZ is discussed. The overall conduct of the case study approach is then evaluated using the case research design quality criteria proposed by Dubé and Paré (2003).

4.1. Sustained Agile Usage Model – Phase 1

The initial conceptual framework (CF1) (*a priori* framework) derived from the literature (Chapter 2) is used to guide the first research cycle, i.e. the design and conduct of the first case study, BBC Worldwide. The outcome of this cycle is used to inform the design and conduct of the second case study, Statistics NZ cycle (CF2), i.e. the. According to the structured-case framework, the research model represents the beginning of research cycle 1 (i.e. CF1), i.e. application of the *a priori* model to the BBCW case (Figure 4.1). The *a priori* model discussed in (Chapter 2, Figure 2.10) is presented in Figure 4.2 again for convenience.

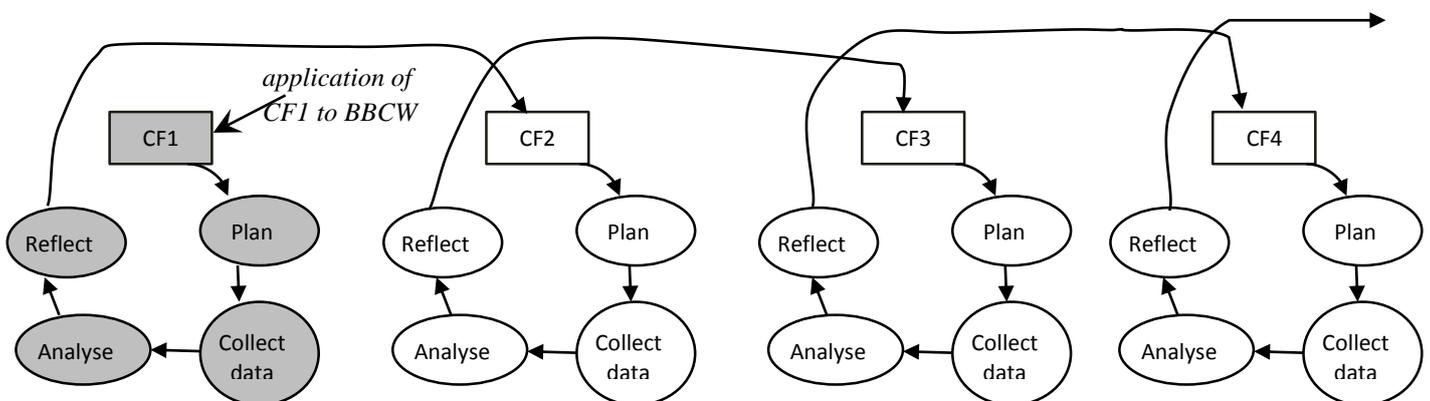


Figure 4.1: Structured-case framework (Carroll & Swatman, 2000)

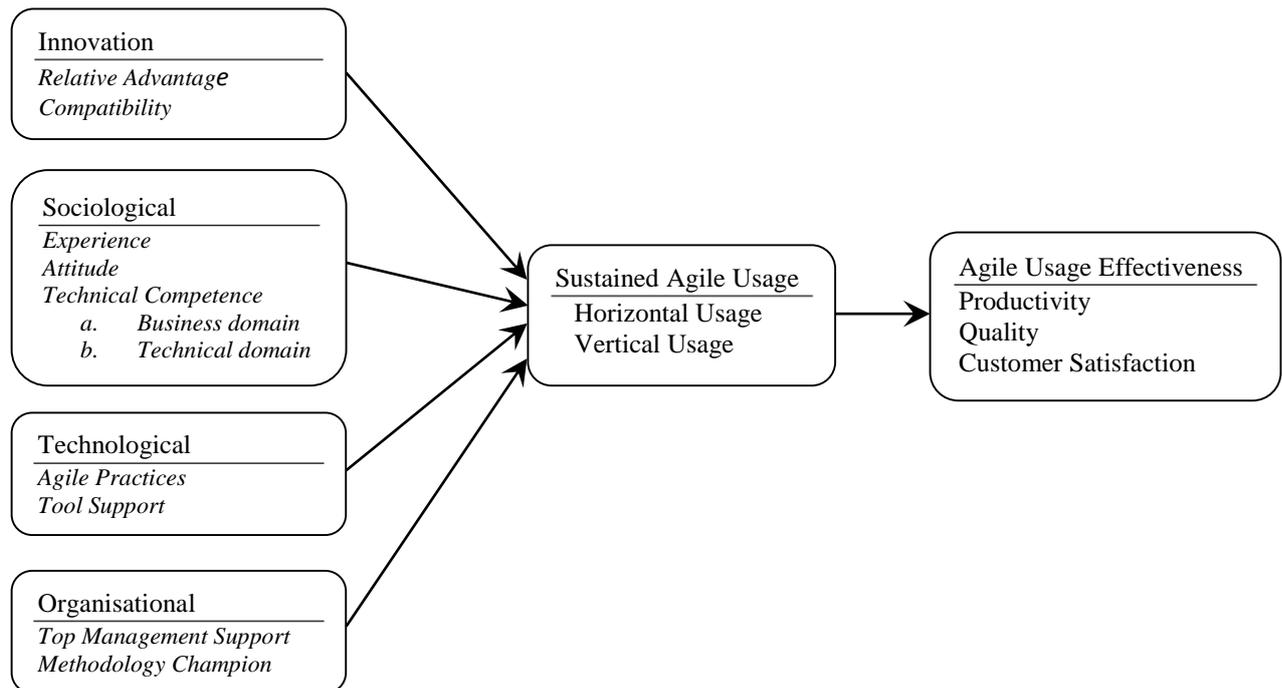


Figure 4.2: Sustained Agile Usage Model (CF1)

4.2. BBC Worldwide

4.2.1. Background and Context

BBCW is the main commercial arm and a wholly owned subsidiary of the British Broadcasting Corporation (BBC). Its mission is to create, acquire, develop and exploit media content and brands around the world in order to maximise the value of the BBC's assets for the benefit of the UK license payer. BBCW generated profits of £103 million (US\$ 147 million) on revenues of £1.004 bn. (US\$ 1.4 bn) (BBCWorldwide, 2010). BBC Worldwide Limited invests in, commercialises, and showcases content from the BBC in many countries around the world. The development teams are based in London, United Kingdom. In terms of software development, BBCW was using formal practices based on the waterfall methodology until 2005. The use of traditional methods had created a disciplined process approach to development, but the rapid time-to-market pressures led BBCW to consider AMs. Further, BBCW encouraged innovation and sought to rigorously assess new methods and practices that could meet their needs. Over a period of about three years (2005 -2008), BBCW had been deploying a range of AMs, predominantly Scrum and XP practices, Scrum for project planning and tracking, and XP for improving the product, i.e. the technical engineering aspects of software development. At the time of data collection for the current study, i.e. 2010, the adoption of agile methods at BBCW had grown organically over a period of 5 years. And,

contrary to the conventional wisdom that agile methods work effectively only when implemented in its complete form (Fitzgerald et al., 2006), the combination of XP, Scrum, and Kanban were found to be quite compatible.

In 2007, a group of technically competent practitioners who were passionate about the use of AMs started experimenting with lean principles of software development, Kanban in particular. As a result Kanban was implemented in BBCW in April 2008. Kanban is a lean approach to software development. It is based on the principles of lean thinking and has been shown to have the potential to at least double the productivity of both manufacturing and service organisations (Middleton & Joyce, 2010a). The core properties of Kanban are: a) visualise the workflow: split the work into items and use named columns visually (on a wall for example) to illustrate where each item is in the workflow, b) limit WIP: assign explicit limits to how many items may be in progress at each workflow state, and c) measure the lead time: optimise the process to make lead time as small and predictable as possible (Kniberg & Skarin, 2009).

In an earlier study, Middleton and Joyce (2010b) conducted a detailed investigation of the performance of one of the most mature software development teams at BBCW, i.e. the Digi-Hub team which was using Kanban. It was made up of nine staff comprising Project Manager, Business Analyst, Software Architect, Tester, Lead Developer, three Developers and a Support Developer. It was working on a mix of developing new software and software maintenance. The technology used was C#, .NET, MS SQL Server, and legacy Connected Service Framework (CSF) code. The governance structure consisted of Business Board (Strategy & Budget), Project Board (Detail & authorise specific work), Product Owner (reconcile Business & Customer wants), Users requesting work (Sign off work completed), End users (200 - 300 people). End users are internal to BBC Worldwide, and the digital assets created were ultimately used by millions of people (Middleton & Joyce, 2010a). Stricter identification of the business benefits was required before agile projects were authorised. The deployment of lean started with one team (Digi-Hub) which had to work within their existing framework. However, the team had discretion in not only to manage their own work, but also to try influence other parts of the organisation (Middleton & Joyce, 2010b). Evidence of effective agile usage showed that over the 12 month period (October 2008 to October 2009), lead time to deliver software improved by 37%, consistency of delivery rose by 47%, and defects reported by customers fell by 24%. As this study reported specific evidence of performance improvements as a consequence of continued use of AMs, it was deemed an appropriate case to be used as a pilot case in the current study. In fact, it was an appropriate example of a critical case which met the

conditions for testing a well-formulated theory (i.e., the proposed *a priori* research model), the outcomes of which could result in confirming, challenging, or extending the theory (Yin, 1994). Therefore, the main goal of conducting this case was twofold: (1) to test the research model in an attempt to identify additional predictor constructs or variables that might influence SAU, or avoid inadvertent exclusion of variables in the proposed model, and (ii) gain a better understanding of how AMs were actually used in practice beyond the adoption stage.

4.2.2. Research method

An exploratory methodology was adopted as it is considered appropriate in new and evolving fields such as AMs (Yin, 1994). AMs are only recently receiving attention from the academic community, and very little is currently known about how they are used beyond their adoption stage. Exploratory case research is also considered most appropriate when there is a need to consider the complicated relationship between people, ideas, and organisations (Travers, 2001). As the deployment of AM in BBCW was strongly championed by the grass-roots software developer community and in particular by a specific mature team, Digi-Hub, such an exploratory focus was deemed necessary.

Data collection involved a series of formal and informal personal interviews (including Skype interview), conducted over a 1-year period (Nov 2010 - Nov 2011) with three members of the software development team who were responsible for agile deployment at BBCW. In all, interviews were conducted with three different individuals, with some interviewed on several occasions: (1) Development Manager, (2) Lead Developer, and (3) Agile Coach. This was facilitated by the fact that interviews with the Development Manager and Agile Coach could be arranged in Auckland where the researcher studied and worked. Interview with the lead developer, who resided in London, was conducted using Skype. The duration of the interviews ranged between 1.5 – 2 hour duration, and informal interviews and email communications/discussions were used to clarify issues as they emerged. To address the ethical issues relating to conduct of interviews such as i) confidentiality of the interviewees and of the data, and ii) informed consent of the interviewees, ethical clearance was obtained prior to conducting the interviews ([Patton, 1990](#)). The participants had a minimum of two years' experience of working with agile methods, and their overall experience ranged from two to five years.

All interviews were recorded, and subsequently transcribed, proof-read and annotated. The questions during the interviews were largely open-ended, allowing respondents freedom to

convey their experiences and views ([Oppenheim, 1992](#); [Yin, 2003](#)), and expression of the socially complex contexts that typically underpin software development. Where participants suggested new factors beyond those identified in the model, they were asked to provide supporting evidence or examples to supplement their point, thus allowing the researchers in the analysis of the data to distinguish between opinions and actual practice. A semi-structured format was used to conduct the interviews which encouraged the interviewees to openly discuss their experiences and attitudes relevant to the research problem. Such an approach facilitates refocusing as the research progresses, in that responses to certain questions can stimulate new awareness and interest in some specific issues which may then require further additional probing (Trauth & O'Connor, 1991). Thus, a detailed interview protocol was not developed at this stage, but rather a guide was used to aid the interview process.

The next section presents the findings from the study by mapping it to the main categories in the proposed *a priori* model.

4.2.2.1. Innovation factors

Prior to 2009, BBCW had been using Scrum methodology combined with some XP practices. The Digi-Hub team was delivering enterprise messaging systems, which was very complex, poorly designed with very large and complex legacy code base. It was difficult for the team to accurately gauge the time required for completing a specific task. This was because a given piece of work would become bigger and bigger and there was ongoing reprioritization. Therefore, the team found it difficult to adhere to Scrum's time-boxed iterations. Moreover, they were not receiving timely feedback from customers and so there were a number of big projects that were not successful. It was about the same time (i.e. 2009) that Kanban as a lean approach to software development was gaining popularity. Since the team was already using Scrum and given Kanban's flexibility in allowing other practices in conjunction with its core properties, provided a perfect context for a senior team such as Digi-Hub to implement Kanban practices in combination with their existing Scrum and XP practices (e.g. daily stand-up meetings, retrospectives, pair programming). The specific advantages of using Kanban over its precursor Scrum practices were i) limiting the work-in-progress, i.e., stopping context-switching and getting efficiency out of visualising the process and gaining an understanding of the whole process, ii) reducing batch size, i.e., by reducing the size of units of work going through the pipeline which resulted in reduction of overheads including changes in requirements and iii) '*granularity of visualisation*'; "...in Scrum you don't get the granularity

of visualisation, Kanban is very granular, and what really happens is once you start visualising your work, the whole team gets a collective understanding of how they build software” (AC). No major issues relating to compatibility were identified.

4.2.2.2. Sociological factors

The core part of the team was not only highly experienced but also technically competent in software development, and had previously used XP and Scrum practices for at least two years. Though the team was not familiar with the business domain, it was very experienced with the technology domain in terms of using Microsoft Stack, Web services, user interfaces etc. It was perceived that it was much easier for people with higher levels of technical expertise to learn a new business domain as reflected in this statement by the lead developer, *“if you have technical expertise, you can usually understand new business domains quickly”*

The team’s attributes of positive attitude, willingness to change, high motivation, and personal innovativeness appeared to have an influence on their ability to adapt to changes in agile practices. For example, though Kanban was implemented at a time (2008) when there was limited literature, the team worked together by learning from each other, which ensured that the strengths and expertise of different members were reflected in the choice of their tasks and decisions (for example, some members of the team were very strong on test-driven development) and had a common understanding of what the team thought good practices were. Though the members were not mandated to use Kanban practices, they themselves became very interested in and motivated by Kanban and started practicing what they learnt from books, attending Kanban meetings etc., In addition, the high levels of experience of the team’s project manager and agile coaches (who placed great emphasis on incorporating appropriate technical practices in addition to adherence to specific agile practices) also had an influence on the fast and deep assimilation of agile practices.

4.2.2.3. Technological factors

The team was previously a Scrum team which used two-weekly sprint time-boxed iterations, retrospectives, planning meetings etc., but when it moved to Kanban in 2008 it incorporated Kanban properties without making major changes to some of the existing XP/Scrum practices that were already working well such as daily meetings, refactoring and test-driven developments. Although the team had a number of engineering practices in place such as test-driven development, automated acceptance testing, source control, bug tracking software, and

decoupling, their use improved and consolidated during the assimilation stages (Middleton & Joyce, 2010b). In terms of Kanban practices, the team highlighted the need for deeply implementing all the core properties along with the support of necessary tools as the lead developer noted, “...we visualized our workflow, limited WIP, we used models, collected data to manage and measure flow, i.e., we had all the five properties from David Anderson’s book, and we had some of the emergent properties as well”. Though the term Kanban originates from the Japanese meaning equivalent of ‘signboard’ or ‘billboard’, Kanban in software and systems development usually refers to the method formulated by David J. Anderson (Anderson, 2010b).

A number of technical tools such as Cucumber (behavior driven development tool) for automated testing, TeamCity for continuous integration were used, and a lot of data collected from the Kanban board in conjunction with other internal systems for logging hours etc., were fed into project management practices. The team enjoyed autonomy in their choice of tasks, relevant tools, and making decisions relating to breaking a high level problem into smaller modules. Thus, deeper implementation of the core practices with an emphasis on optimising the existing practices was found to have an impact on SAU.

4.2.2.4. Organisational factors

When BBCW moved to Kanban in 2008 the governance structure was: Business Board (strategy & budget), Project Board (detail & authorise specific work), Product Owner (reconcile business & customer wants), Users requesting work (sign off work completed), and End users (two – three hundred people). Agile teams received very strong support from the Project Board, the Product Owner, IT management and knowledgeable colleagues, and benefited from hearing world renowned speakers such as Martin Fowler, Craig Larman, David Anderson, etc., who gave talks at BBCW. However, support at the business board level was not as strong due to a lack of understanding of the changes in methodological and technical practices.

The MC played a critical role in liaising between the management and the agile teams. The MC was not only working with the corporate levels of management to educate them but was also involved in coaching other teams and providing one-on-one coaching. The MC coached the teams in ways that enabled them to find self-organising behaviours. The team believed that the MC played a key role as a skilled facilitator especially in handling difficult issues, and one that enabled the teams to challenge their perceptions of what they were really capable of rather than simply answering or solving their issues, as noted by the AC, “...rather than giving the

answer straight away, it's more allowing them to arrive at the solution that should be there". MC was perceived as the key driver who was responsible for creating a community interest in BBCW.

4.2.2.5. Sustained Agile Usage

Horizontal usage of AMs at BBCW increased consistently after the implementation of Kanban. Before Kanban was introduced almost half (fifty percent) of the projects were using Scrum, but when Kanban was implemented usage eventually increased to almost eighty percent. Kanban usage continued to spread widely as other teams also started implementing Kanban. Use of Kanban spread into the BBC from BBCW, the spread being referred to as the '*Kanban flu*'. The number of staff working on Kanban projects also increased steadily in almost exactly the same proportion as the number of projects described above.

Vertical usage was also found to play a significant role on sustained and effective usage which is best reflected in words of the lead developer "*...the depth of adoption maps to an exponential curve of success – I think if you just do a couple of practices **of a method** [emphasis added] you are not going to get much benefit. If you do a lot of them and they are deeply engrained you are likely to be more successful*". In addition, the focus on reducing technical debt by allowing time for making improvements was also found to have an impact on overall effectiveness and increased future productivity (Middleton & Joyce, 2010b).

4.2.2.6. Agile Usage Effectiveness

Usage effectiveness was analysed using three main factors: improved quality of the development process, improved productivity during the development process, and customer satisfaction. Specific improvements were recorded based on the data collected between October 2008 and October 2009 (for a detailed investigation and specific discussion of relevant results and findings, please refer to (Middleton & Joyce, 2010b)).

The *quality* of the development process improved. This improvement was measured by the number of live defects (live defects are the bugs reported by customers during a week plus the bugs still open for investigation). The numbers of live defects reported by customers fell by twenty-four percent, i.e., bugs were being fixed more quickly and the mean numbers of bugs open each week also declined slightly.

Three measures were used to gauge improvements in *productivity*. i) Lead time: the total elapsed time from when a customer requests software to when the finished software is released to the customer. It tracks how quickly software is delivered to customers. Lead time to deliver software improved by thirty-seven percent, and consistency of delivery rose by forty-seven percent. ii) Development time: sum of the time estimates of stories or tasks completed. It gives insight into the efficiency of development. Development time was recorded in working days. A variation in delivery times reduced by seventy-eight percent from 30.5 to 6.8, and the mean time to develop fewer and smaller software features declined by seventy-three percent from 9.2 to 2.5 working days. iii) Release Frequency (RF) is defined as the number of items released to customers per month. RF increased by a factor of eight from two from November 2007 to sixteen in October 2009.

It was believed that a lot of the team's behaviour was driven by focusing on customer needs and satisfaction. The lead developer stated, "...*that's driving a lot of your behaviour as well, so, if you are focusing on what the customer receives, then a lot of these practices will start to make more sense – breaking work into smaller units means more frequent feedback from customers which is reflected back into requirements of un started work*". Breaking the work into smaller units enabled more regular feedback from the customer, which further enabled teams to deliver new functionalities faster with more predictability, which in turn made their customers happier. Consistent and ongoing collaboration with the customer was perceived to have a positive impact on overall customer satisfaction.

4.3. Discussion

In summary, findings from the BBCW case confirmed that the proposed *a priori* model could be utilised to understand the various factors i.e. (1) Innovation factors (*relative advantage, compatibility*) (2) Sociological factors (*experience, attitude, technical competence (business domain, technical domain)*) (3) Technological factors (*agile practices, tool support*) (4) Organisational factors (*top management support, methodology champion*) that influence SAU. Support for most factors and for the impact of SAU (measured by horizontal and vertical usage), in turn, on *agile usage effectiveness* (specific improvements in development outcomes) was found.

Innovation factors (*relative advantage, compatibility*) highlight that real evidence and awareness of the relative benefits of using AMs has a significant influence on their sustained

usage. The practitioners' high levels of experience, technical knowledge and competence, and their willingness to learn also had a significant impact on SAU. The emphasis on deeply adopting all the core properties/practices of Kanban where the change was driven by optimising the existing process without making major changes to existing workflow, job titles, roles and responsibilities, etc., played a critical role. The methodology champion's role in actively and vigorously promoting his vision for deploying Kanban and using a variety of influence processes to experiment with and implement the various practices had a significant impact on the overall success of the change process. And given that the methodology champion who acted as the key driver for the entire initiative left BBCW in 2011, the question at the time for BBCW was, "will the initiative continue to survive and sustain?" SAU experience at BBCW has been positive mainly due to the efforts of a team of motivated agile practitioners' strongly supported by a passionate champion/coach rather than support from the top management. Though evidence of improvements in development outcomes provided justification for the management to continue using AMs and their usage not only spread to other software development teams, but also to other areas such as SAP teams, product development teams, and business, the need for broader strategic changes at the organisational level was deemed critical for longer term SAU. For example, the focus on continuous improvement and emphasis on improving the system - "*it is about making the system that people work in more productive as opposed to the people working in the system. That's really the key difference- a lot of managers focus on people, whereas continuous improvement is always more effective when you focus on the system.*" (lead developer), highlights the significance of the need for the entire system (e.g. organisation structure, culture, development models and strategies) to change/adapt in order to support SAU and development.

4.3.1. Reflection

The evidence from the findings of BBCW case study suggests that the proposed research model can be used to understand the sustained and effective usage of AMs in organisations. Deliberate reflection on the research design, findings and analysis of the BBCW case revealed a number of important points and limitations to be taken into consideration in the next research cycle, i.e. CF2 as discussed below:

- i) Another key concept that emerged during analysis was the influence of *budget and schedule constraints* on the sustained and effective usage of AM. It was identified that restrictions on budget and schedule (time) has a significant impact on the

application of engineering practices such as reducing technical debt, use of appropriate tools such as testing environments, automated deployment, etc., In particular, such restrictions were perceived to have an impact on SAU in the long run, which in turn was perceived to have an impact on outcome measures such as quality. Another study that studied the post-adoptive usage of XP practices (Mangalaraj et al., 2009b) also supports this concept, where it was found that projects with relatively less restriction on budget and delivery schedule afforded a lot of flexibility to the team and enabled a deeper adoption of XP practices compared to other teams that had strict schedule and budgetary constraints. Though these findings provided initial support for including this factor in the research model, further validation was deemed necessary. Moreover, the findings relate to the perceptions of specific teams within single-site case studies. For example, while the current study involved a single pilot case (mainly based on interviews with a single team), the XP case study (Mangalaraj et al., 2009a) was based on a single site (multiple teams) but focused only on XP practices. It was decided to seek additional justification in order to further validate the significance of this finding: (a) internal justification – through further iterations between the data and the tentative findings (b) external justification – to discuss the proposed change with experts or practitioners in the industry, and/or a panel of IS researchers.

- ii) On further reviewing the analysed data, it appeared that the interviewees interpreted the role of MC as that of an Agile Coach (AC). As discussed in Chapter 2, the role of MC relates to responsibilities such as using a variety of influences (social, political, etc.) to eliminate barriers to successful deployment of AMs at the organisational level such as convincing management, pushing through implementation hurdles, and mentoring. However, as BBCW had employed an agile coach, it appeared that the interviewees might have misinterpreted the researcher's question relating to MC as AC. The differences between MC and AC could have been made clearer to the interviewees. At the time of BBCW data collection, the concept of *coaching* and the use of the AC role had just started. And, in organisations such as BBCW which mainly worked on a project or team basis, there was no recognised role for MC at the organisational level. However, by 2011, some resources on coaching in software development started appearing in the practitioner community. For example, Davies (2011) identified some key

differences between a coach and other roles such as MC, team leader, and project manager. While the two roles are not incompatible, the difference is that roles such as MC, project manager have a wider set of project and organisational specific responsibilities such as reporting progress, performance appraisals etc., whereas the sole focus of an AC is on process improvement without the additional responsibilities such as project deliverables (Davies, 2011). Secondly, a coach is usually a transitory role (typically someone external to the organisation) not tied into project duration or to a specific organisation, whereas MC is typically an internal organisational role with broader responsibilities. This point was noted to be applied in future refinements/iterations of the model.

- iii) One of the main limitations of the BBCW case was that all three participants were from similar or related roles (Development manager, lead developer, and AC) that had a stronger technical and software development expertise requirement, which might have had an impact on the findings. For example, all three interviewees were very passionate and strong advocates of AMs. And, all three of them belonged to the Digi-Hub team, which was perceived as one of the high performing teams at BBCW, though there was a mixture of medium to high levels of experience and expertise among the members. However, due to constraints relating to the distance of the location (i.e. London), it was difficult to arrange interviews with a wider range of staff members. The findings might have been different if participants from other roles such as Business Analyst, Project Manager, Scrum Master, etc., were included. The importance of identifying the appropriate set of roles and perspectives to be included in an investigation is documented in the literature (Seddon et al., 1999). As the focus of investigation is the post-adoption or sustained usage of AMs, which consists of decisions and perceptions relating to its implementation, conduct, and sustainability, a wide range of roles qualify to influence or impact such usage. In particular, the following roles were identified and classified as ‘agile practitioners’, i.e. roles which played a critical part in the sustained usage of AMs: Business Analyst, Developer, Tester, Scrum Master, IT Delivery Manager, Project Manager, CIO, and AC.
- iv) Though a guide was used to facilitate the conduct of the interview process at BBCW, a detailed case study protocol (CSP) was missing. A CSP was deemed necessary not only to structure and guide the conduct (Yin, 1994) of the consequent

case study (i.e. BBCW), but also to evaluate issues and policies relating to the phenomenon of interest i.e. SAU (Stake, 1995). Though most approaches to case study conduct are quite similar at a high level, they are different in terms of their underlying philosophical assumptions (Brereton, Kitchenham, Budgen, & Li, 2008). For example, while both Eisenhardt (Eisenhardt, 1989) (who is concerned with using case studies to develop theories) and Stake (Stake, 1995) (concerned with program evaluation) take an interpretive approach to case study research, Yin (Yin, 1994) takes a slightly more positivist approach. Given the mixed mode research design of the current study, a CSP incorporating ideas from all the above was developed. It consists of the following sections (See Appendix A):

- a. Research Objectives
 - i. Research questions
 - ii. Purpose
 - iii. Unit of analysis
 - iv. Research model and key constructs)
- b. Case Study Design
 - i. Multiple-case design
 - ii. Population
 - iii. Sample selection
 - iv. Data management issues
- c. Data Analysis

The conduct of the interviews was guided by the semi-structured interview guide which consists of two sections (see Appendix B): section A was designed to understand the context of the organisation where AMs were used and section B identified the potentially important constructs to be incorporated in the SAU model. Findings from the pilot case and the extant literature were incorporated into the interview design to test and validate the significance of the various constructs and relationships identified at the time.

- v) The analysis of the pilot case data also revealed that there was not sufficient data to reflect the core themes that would enable meaningful conclusions. In addition to the open-ended format and the interview guide that was used to guide the semi-structured interviews in BBCW, it was deemed necessary to explicitly measure the *a priori* constructs specified in the model. When such measurement confirms the relevance of the *a priori* constructs to the study context, they can be treated as triangulated measures on which the emerging theory can be grounded (Eisenhardt, 1989).

4.4. Sustained Agile Usage Model – Phase 2

The previous sections presented details on how the first case study (BBCW) was conducted, along with findings, analyses, and reflection. The initial evidence suggests that the proposed research model can be utilised to understand the sustained usage of AMs in organisations. The study's overall design incorporated strategies to iteratively clarify and validate emerging concepts in each research cycle, and so, the research cycles produce a series of conceptual frameworks CF1, CF2....CFn where CFn represents the latest version of the framework developed (Carroll & Swatman, 2000) (see Chapter 1, section 1.4.1.1). At the end of research cycle 1 (CF1), though there were no changes made to the research model, several changes regarding design and conduct of the next research cycle (i.e. CF2) were taken into consideration - as discussed above (section 4.3). Using Carroll & Swatman's structured-case, the current study's research enters cycle 2 (i.e. CF2), i.e. application of the model to Stats NZ case (see Figure 4.3). Appendices A and B includes copies of all documentation (case study protocol, interview guide) that were developed and used to guide the conduct of the second case study. The case study design was also reviewed by case study research experts, when the researcher participated at the following conferences: International conference on agile software development (XP2010), IFIP TC8 Doctoral Consortium (IFIP 2010), and the Australasian Conference on Information Systems (ACIS 2011).

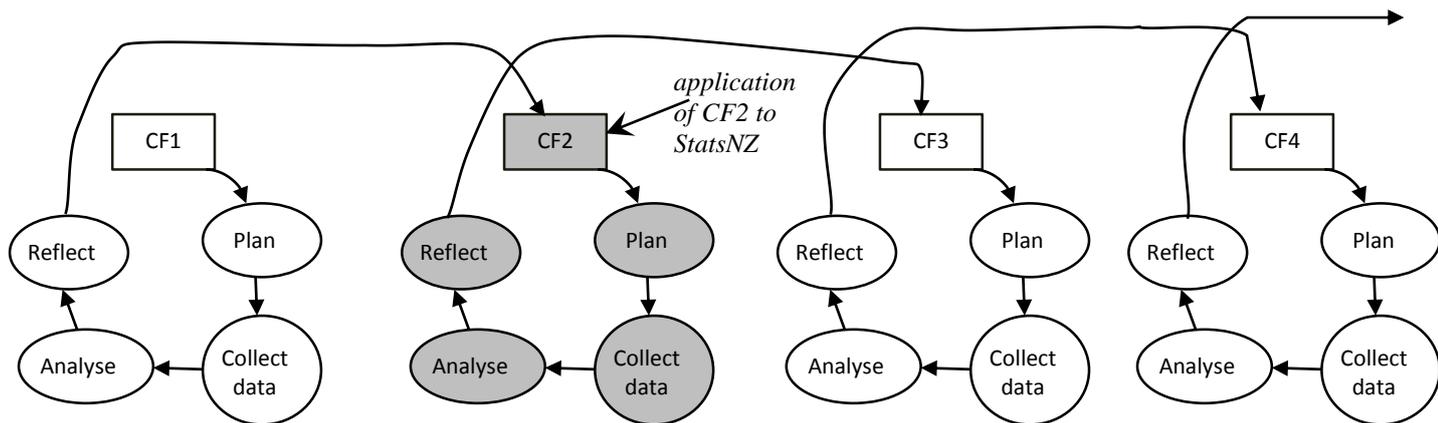


Figure 4.3: Structured-case framework (Carroll & Swatman, 2000)

4.5. Statistics NZ

This section presents the background and context of the organisation, followed by a discussion of the findings using the model elements i.e. factors, SAU and agile usage effectiveness. Though several changes were made to the design and conduct of case study, no changes were made to the model at the end of research cycle 1, i.e. case study 1.

The proposed research model (conceptual framework 1, CF2) is presented in Figure 4.4 again for convenience.

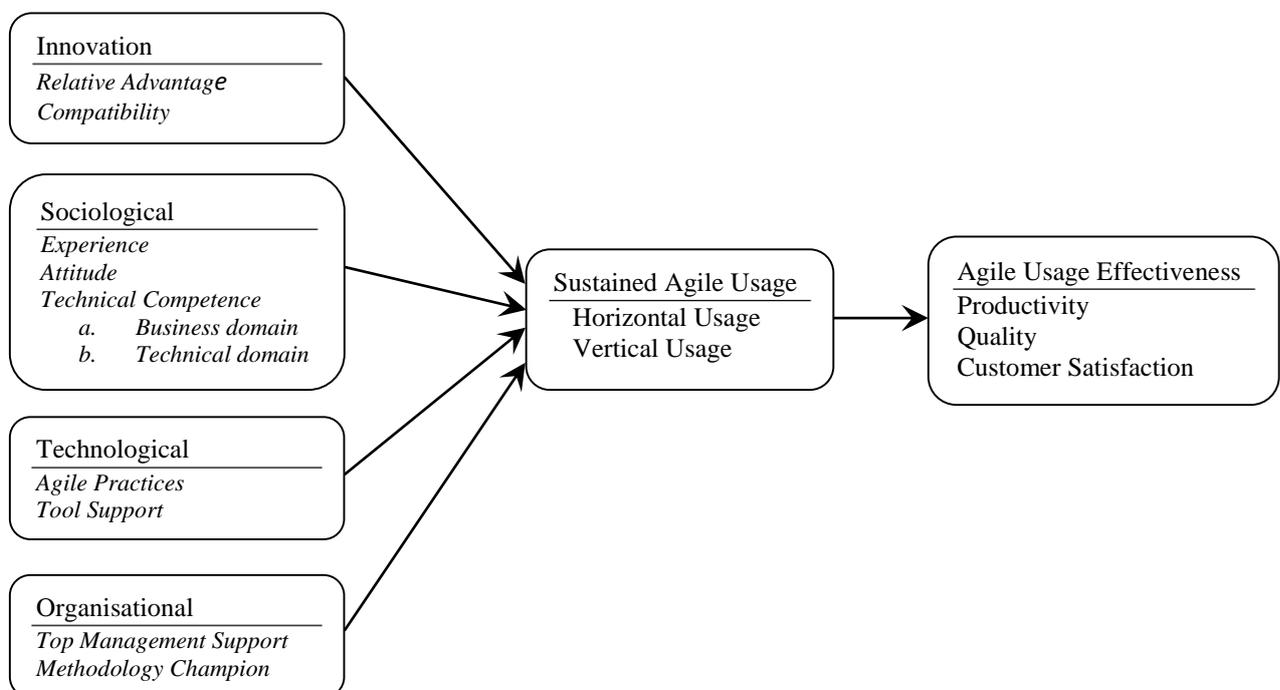


Figure 4.4: Sustained Agile Usage Model (CF2)

4.5.1. Background and Context

Stats NZ is a government organisation which is New Zealand's national statistical agency and the major source of official statistics. The Programme of Official Social Statistics (POSS) aims to provide a coherent set of official social and population statistics to meet the key information needs of both the government and the community. The POSS is made up of a suite of social surveys which comprises a range of statistical data collections such as the five yearly Census of Population and Dwellings, household economic survey, and New Zealand health survey.

In terms of systems and software development, Stats NZ had been formally assessed at Level 1 on the Capability Maturity Model (CMM) in 2004. In order to improve this rating and to bring some discipline in the development process, the software development life cycle (SDLC) was introduced in 2004. Though the SDLC process was regularly reviewed and updated in 2006 and 2008, with better templates, tools and training, some complex issues remained unsolved (Street & Jug, 2011):

- (a) It was hard to depict the iterations with the SDLC process. It was perceived as a rigid process which lacked shared ownership, less team collaboration and co-operation, which was seen to affect the morale of employees.
- (b) It was difficult to complete the requirements for a given solution as the analysis became far too detailed, and therefore the owner was not willing to approve the solution. As a result, project elaboration appeared to take much longer time and became very expensive.
- (c) The morale of developers became low as they felt that they were not consulted enough during the requirements phase, and there was friction between developers and business analysts.
- (d) As requirements and priorities were often discussed with business users only at the start and completion stage of development, it was very difficult to incorporate new findings and requirements which emerged as a result of better understanding of the problem.
- (e) The business started losing confidence in the capabilities of the IS department to effectively deliver a full solution on time. As a result support and co-operation from the business was diminishing which had an impact on employee morale in the IS department, i.e. their morale was low.

4.6. Agile Implementation

Stats NZ has about two hundred and twelve members in the IS department distributed across three locations: Christchurch (CH), Wellington (WL) and Auckland (AK). WL is the main center where all projects originate, from where they are assigned to different teams - projects and teams are cross-sectional across three regions. The original advocate of AM in Stats NZ was the development section manager in applications development and support division, CH, who saw AM as an approach that had the potential to help Statistics NZ address its systems/software development issues and to contribute to a more collaborative approach between IS staff and the rest of the business (Street & Jug, 2011). He encouraged IT Development teams to use Scrum. Scrum is an iterative and incremental development methodology that emphasizes a set of project management values and practices with its distinctive emphasis on self-organising teams, daily team measurement, and avoidance of following predefined steps (Larman, 2009). Some key practices include a daily stand-up meeting, fixed time-boxed iterations, and a demonstration to external stakeholders at the end of every iteration.

The first project was the introduction of Selective Editing into Overseas Trade, which had to be completed within a very short timeframe, to a very tight budget. This project was adopted in Christchurch in 2007, which was delivered successfully and to the satisfaction of the Business Unit (Business Indicators) and started Stats NZ down the agile path. Later it was introduced into more low-risk, small to medium size projects in both Wellington and Auckland. People started enjoying the new ways of working together as a team, self-organising nature of teams, and there was a big improvement in the morale of the employees. This motivated the testers and business analysts (who were initially not supportive of agile) to undertake formal training and were later incorporated into the Scrum teams. Some agile enthusiasts started working with other colleagues in both IT Solutions group (internal team) and business units which led to progressive and successful implementation of AMs and practices project by project. As a result, some important projects (Census 2011, Better Economic Statistics (BEST⁶) and Business ToolBox⁷) were implemented using AM and the use of AM continued to spread in all the three regions. The key factors that contributed to the benefits across these three agile projects were (Street & Jug, 2011):

⁶ Scope – development of new processing platform for micro-economic statistics

⁷ An interactive web toolset for small businesses (<http://www.stats.govt.nz/businesstoolbox>)

- (1) Commitment by all project teams to the use of AM
- (2) Regular participation of the Product Owner
- (3) Improvements in teams' focus and efficiency
- (4) Visibility of project scope and improved stakeholder engagement
- (5) Productivity improvements
- (6) Quality improvements
- (7) Improved team motivation and employee morale

The above benefits were also accompanied by a number of challenges relating to Stats NZ's organisational structure, alignment of AM with corporate business planning processes, and the deployment process. To address these challenges, Stats NZ implemented Agile Systems Development Cycle (ASDLC) in 2010.

ASDLC was first proposed by Ambler (Altheide & Johnson, 1994). It consists of six phases (see Figure 4.5):

- Iteration -1 -> rationale for business case, opportunity, just enough feasibility analysis
- Iteration 0/Warm up – initial support and funding, model the scope of the system with stakeholder involvement, team building, model an initial architecture, setting up the environment, and initial estimation.
- Construction – collaborate closely with stakeholders, implement functionality in priority order, analysis and design, deliver software regularly, and testing.
- Release/End game – transition the system into production, final testing and acceptance testing, and deployment.
- Production – maintenance and support.
- Retirement – removal of a system release from production.

Though ASDLC looks similar to a traditional SDLC, it is mainly built on the core agile values of high collaboration, iterative and incremental development where there is constant involvement of stakeholders. For example, developers work closely with stakeholders to understand their needs, pair together to implement and test their solution, and quick stakeholder feedback is sought on the solution (Altheide & Johnson, 1994).

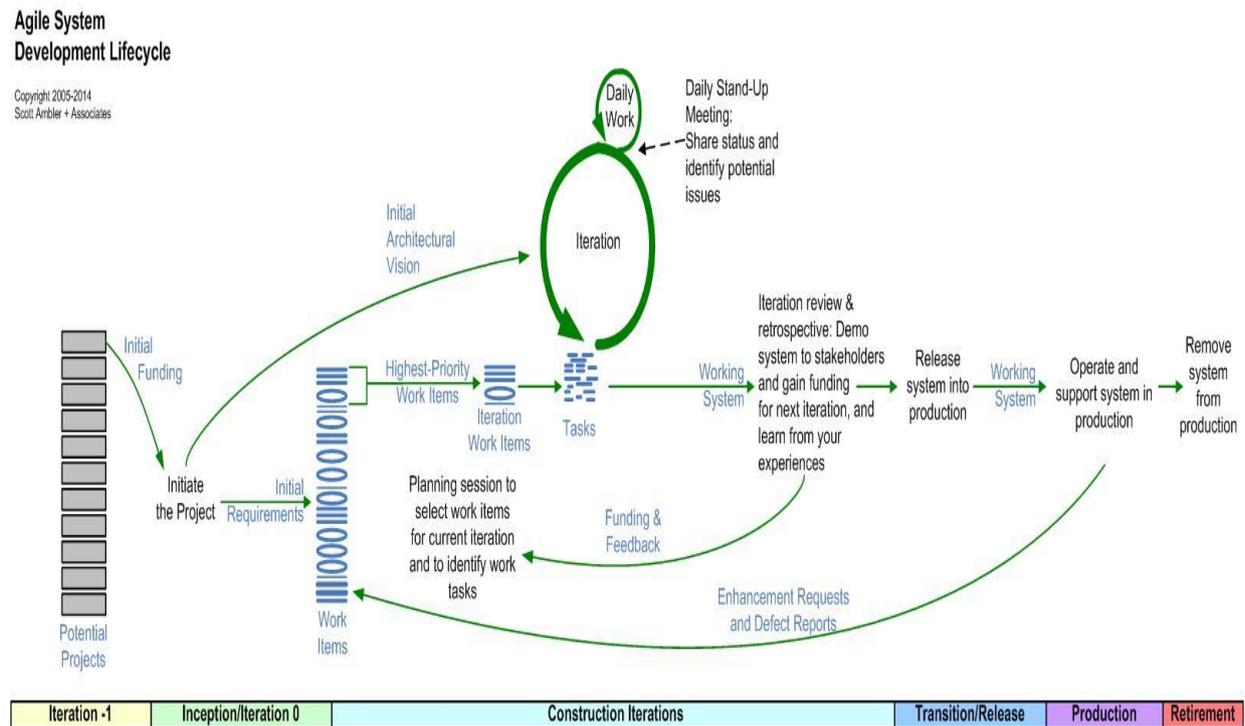


Figure 4.5: Agile System Development Life Cycle (ASDLC) – Ambler(2005)

Stats NZ, which had many potential projects active at any given point of time, some in planning, some in development, and some in production, therefore needed a development process that addressed the full development cycle, i.e. the Scrum construction process had to be tailored to reflect and support the way in which agile process was utilised, and to facilitate alignment with other corporate processes such as business planning and project management methodologies. As a result, a group of agile enthusiasts led by the IT Delivery manager at CH developed a customized version of ASDLC in an attempt to bring together the best of both agile and SDLC to address the needs and challenges that Stats NZ was facing with the ongoing use of AM. The ASDLC outlines all the initiation and planning phases, key roles, schedule and order of execution, and intended outcomes. It also incorporates the business planning process. ASDLC was implemented across the whole of IS solutions group in early 2010 where all groups were encouraged to take ownership of the process. By 2011, ASDLC became the primary method for delivery of systems. Most teams were cross-functional Scrum teams – 4 teams in CH, 3 teams in WL, and one team in AK, in which developers, testers, business analysts, architects, methodologists, and subject matter experts worked together.

4.7. Research Method

The overall case study design that was adopted across both cases (BBCW and Stats NZ) is described in detail in Chapter 3. An in-depth case study approach was adopted. Though one of the often-cited limitations of the case study approach is its lack of generalizability, the ‘thick descriptions’ provided by the case study were considered much more valuable than generalizability of results (Fitzgerald et al., 2006; Yin, 1994).

The case study protocol (see Appendix A) provides guidelines on the design, conduct, and analysis of the study. ‘Semi-structured interviews’ were the main data collection method employed. Other evidence (e.g. observations of daily-stand up meetings, documents and published articles relevant to the study) was mainly used to corroborate interview data, and as input to data analysis. Detailed information and justification for the use of semi-structured interviews as a way of conducting qualitative research in IS are presented in Chapter 5.

Interviews were guided by both the CSP and the interview guide. They commenced with an open discussion on SAU and their impact on agile usage effectiveness. The individual constructs of the CF were subsequently introduced and the participants’ opinions on the overall relevance and significance of each of these constructs were sought. Interviews were conducted with a range of different roles and stakeholders (e.g. developers, Scrum Masters, business analysts, testers). Most participants were involved in more than one project at any given point of time. A senior IS staff member from Christchurch acted as the main point of contact between the researcher and Stats NZ, who assisted with the identification of the interviewees. A contact list of all participants was developed. Interviewees were selected based on their primary role within the agile initiatives and their assumed capacity to provide relevant information.

All potential participants were initially nominated by the key contact person at Stats NZ. Their contact details were provided to the researcher. Each potential participant was later contacted by the researcher seeking their support in the study. The key contact person then made arrangements (i.e. time, venue) to conduct the interviews with the participants who agreed. Data collection involved a series of formal and informal personal interviews, conducted over a 2-year period (2010 – 2012). Interviews were conducted in person to interview participants in Auckland (AK) and Wellington (WL). Christchurch (CH) interviewees were interviewed in the Wellington office via videoconferencing. In all, interviews were conducted with seventeen different individual agile practitioners, with some interviewed on more than one occasion (see table 7.1).

Table 4.1: Profile of Interview Participants

Location	Role
Auckland (AK)	Developer (3)
	Tester (1)
Wellington (WL)	Business Analyst/Scrum Master (2)
	Project Manager (1)
	Developer (2)
	Development Manager (1)
	ITDM (1)
Christchurch (CH)	CIO (1)
	ITDM (1)
	Project Manager (1)
	Developer (3)

All interviews were electronically recorded using Livescribe Smartpen⁸, and later transcribed. Informed consent was obtained by all participants as per the University's ethical guidelines and requirements. The Smartpen's notebook was used to create field notes during the conduct of the interviews. Field notes were primarily used to (see section 3.3.5.1 for more details) keep track of any emerging themes, ideas, or concepts and as a log of tasks "completed" and "to-do" to aid in subsequent data collection efforts. Data was coded using NVivo tool.

As the interviews were conducted over a reasonably long period of time, i.e. two years, Stats NZ employees interviewed during the earlier stages of the study were contacted again to offer any new or updated information on the sustained use of AMs at Stats NZ. This enabled to maintain consistency with those interviewed during the later stages of the study (Silverman, 1998). Thus, the study adhered to recognised best practices regarding any longitudinal research, although no comparison of participants' perceptions was made over time.

4.8. Findings

Though a number of different themes and concepts emerged from the data collected, the findings are presented under the categories/constructs identified in the *a priori* model for better organisation, consistency, and readability. Other key findings are discussed in the discussion section.

⁸ <http://www.livescribe.com/en-nz/smartpen/>

4.8.1. Innovation factors

Prior to 2007, Stats NZ was using waterfall methodology which was supposedly overlaid on top of Rational Unified Process (RUP), but in reality they were not actually following RUP and had an incorrect understanding of the different phases. For example, elaboration was viewed as design, construction as building, and transition as testing. The teams spent the majority of their time on the requirement gathering phase and encountered problems in predicting the time needed for various tasks, which in turn affected their delivery schedules. The morale of the teams was observed to be very low, as the IT Delivery Manager (ITDM), CH, described

“...we decided to trial it, particularly because of the low morale, low measures of success we were having in delivery, and once we trialed it, the developer’s level of morale just leaped, and that’s what made us continue with it. We could see it really changed their work enthusiasm.

These conditions set the stage for Scrum to be introduced as a viable methodology in some low-risk, small projects, and based on the positive feedback from these projects its usage scaled up to other projects over a period of time. And as discussed in section 4.6, specific benefits were reported by practitioners involved in three major agile projects (Census 2011, BESt⁹ and Business ToolBox¹⁰) in comparison with the predecessor methodology.

Though there were no major *compatibility* issues in terms of using specific Scrum practices, incompatibility issues were reported in other areas such as resourcing. For example, there were cross-functional teams, and therefore trying to manage cross-functional resources for the duration of the project early on was difficult and incompatible with the existing resourcing model. From a waterfall perspective, resources would become available in a waterfall sense, i.e., testers would be available in the testing phase, and their resourcing was done at an individual level rather than at a team level which resulted in some constraints. There was resistance from business analysts as they struggled to understand their identity in the agile process or the agile framework. This was because while there was a lot of information about how developers, testers etc., would sit within the agile framework, there were not many guidelines about product engineers or people who liaise between the project stakeholders and the development team. Business analysts expected recognition for their role because the

⁹ Scope – development of new processing platform for micro-economic statistics

¹⁰ An interactive web toolset for small businesses (<http://www.stats.govt.nz/businesstoolbox>)

business rules at Stats NZ were detailed and complex and had many dependencies between them.

4.8.2. Sociological factors

Most team members were experienced (more than ten years) in a variety of roles such as business analysis, testing and development but had no specific experience with Scrum when it was first adopted. Over a period of time, the teams gained experience by learning from each other and applying it on a project by project basis. Most teams had knowledge of the business domain; almost all members in the IS department were internal employees and had been working there for at least five years.

In terms of technical expertise, teams included a mix of different competency levels. One of the project managers said,

“...when we put them together as a Scrum team, there would be a mixture of these different experience and competency levels, for example, so that we could have a senior person helping a junior” .

However, most teams had moderate to high levels of expertise in terms of programming languages, tools and technologies etc. Initially, there was only one Scrum Master who looked after all the Scrum teams, but over a period of time more members were given the opportunity to take the SM role on a rotational basis. According to the MC, this resulted in them gaining a breadth of experience rather than the depth required to mentor other SMs;

“But over time we learnt that they’ve got a breadth of experience, but not really depth. So I’m finding it hard at the moment to find Scrum Masters that can mentor other Scrum Masters. So we’ve got lots of Scrum Masters or lots of people who have had a go at the Scrum Master role, but we don’t have anybody who has built up the experience and built up the patterns and that knowledge of what does a particular dynamic in the team look like, and how to put that back on track, or how to encourage that to be able to come back on track” .

Most Scrum teams perceived themselves as self-organising, but in reality they were not autonomous, and were finding it hard to move away from formalised roles. This was because there were two streams of management to which the staff members reported, one was the SM

of the Scrum team and the other a manager role, for example, a business analyst (BA) who reports to a BA manager, and a tester who reports to a test manager, and so on.

There were some notable differences in practitioners' attitude regarding the use of AM across the three regions. For example, while Christchurch members displayed a more positive attitude, feeling of 'oneness' or 'belonging', and higher motivation, Auckland employees displayed lower levels of motivation and lack of 'willingness to learn', lack of commitment to using agile practices. IS staff members in WL were larger in number than the other two regions, and may be as a consequence, a mixture of both positive and negative attitudes were observed. The following statements illustrate this:

(1) Project manager, CH stated that team members who work together was the key factor for success in agile projects,

“a handful of quite like-minded individuals that thought a particular way, and because of them projects experience success and began to snowball, ...the type of people I guess, a team that kinds of works together, so that's the composition of the team is really critical....and that's been the case in a lot of projects I was involved in...”

(2) a senior business analyst in WL highlighted the need for learning from each other and contributing to the team as a whole,

“so the knowledge is not of one person and the other person can sort of support the less experienced ones, or newer persons. And though we had customized training with SEI for the whole BA team, only when you actually do it you learn, and then share that with each other ...” and

(3) when questioned about the importance of commitment and willingness to learn an Auckland developer stated,

“my job is to develop and their job [manager] is to organize.... from my point of view because as far as I am happy, why I have to change? If manager thinks there is better way to do this, that's all right, they can try. But my task actually is to just do my job...and I think the system [agile] its' more benefit for managers I think because for them it's much easier to monitor progress...”

As the last statement above illustrates, AK practitioners, in general displayed lower levels of motivation and negative attitude towards using agile compared to the other two regions and the

general perception was that agile “ was a push from the top so we had to kind of use that” (Developer, AK). As some key members of their teams (e.g. product owners, business analysts, architect) were based in WL, AK teams felt isolated from the other two regions. Challenges and issues (for example, conducting daily stand-ups, lack of visibility of boards) associated with cross-location were also highlighted.

4.8.3. Technological factors

Though the teams were initially required to use all the Scrum practices ‘out-of-the box’, eventually they adapted the practices to suit the requirements of individual teams. There were variations in Scrum practices between the teams. Some experienced teams used all the practices well, some evolved from the initial stages and struggled to incorporate some of their own practices, while few others continued to hold onto some waterfall techniques.

Team Foundation Server (TFS) was mentioned by most interviewees and was the only main tool that was used extensively by all Scrum teams. While BAs perceived TFS to be highly compatible with their existing practices, some developers felt that it was not used effectively - one AK developer complained that it was largely just used as source control,

“we are not really taking advantage of the application life cycle management of TFS... teams have attempted to use it but not with an agile template, so it’s all a bit again very customized and not necessarily the most appropriate or efficient way to do it”.

Engineering practices such as automated testing or continuous deployment were not used, and may be as a consequence there was minimal awareness of specific tools that support such practices.

4.8.4. Organisational factors

Top Management Support: Although the first few Scrum teams had some support from their immediate managers such as project or development managers, there was no support or commitment from management for a considerable period of time after agile was adopted. During the initial period of adoption, teams were not confident of gaining support from management until they were able to demonstrate the benefits of using agile methods. The MC described this situation:

“...we had to do it by stealth in that sense which led to it being quite a difficult process bringing in change, especially when the organisation wasn’t supporting change. But

looking back in hindsight, it would have been almost a hundred percent, or a ten-fold easier if we had senior executive team on board who were quite comfortable with what we were trying to do, how we were trying to do it and what the return on investment was going to be. That would have helped us to smooth down all of those issues; isolation, resourcing issues, resistance to change, and would have helped smooth all of that stuff out. And, arguably probably even provided a faster transition as well”.

The MC (the sole person who championed agile use in Stats NZ) played a very crucial role in both the initial and later phases of agile use. He pioneered the use of agile in Stats NZ by taking on a number of effective roles and implementing strategies, including the role of an agile coach. He was involved in a variety of roles such as trainer, mentor, coaching other teams/SMs and enabling them to work independently on their respective projects. As the management required evidence of good results before Scrum could be formally adopted, the MC played a critical role in using appropriate strategies for the diffusion of agile practices in Stats NZ. He was also instrumental in facilitating agile use in other branches and also coaching, for example, one analyst in Wellington reported, “...*though he was based in Christchurch, he was always available and willing to come over to Wellington... he did not direct us in any way, just presenting facts and answer any queries...*”. He was described using many terms such as a “crusader”, “maverick” by various interviewees - ,

“he was also a coach in a way; he had the coach role. He just fashioned his job and he just went and did the stuff. So he was a bit of a maverick in the pack” (Developer, WL)

4.8.5. Sustained Agile Usage

Horizontal usage of agile practices at Stats NZ increased after the implementation of Scrum on a regional basis. Scrum was first introduced in the Christchurch office in 2007. As it was very different from their previous methodology (waterfall), it was initially introduced in a few low risk, small to medium sized projects, which allowed the teams to evaluate the process. And based on some good positive feedback from the initial projects, Scrum usage scaled up to other projects. The methodology champion stated,

“...so with all the positive information that we had compared to previous projects using more of a waterfall approach we had some real data there that we really were encouraged as a team to take it on and it sort of snowballed from there”.

And after about a year it spread to the other two regions, i.e., Wellington and Auckland. Overall, the combined horizontal usage from all the three regions continued to increase with almost eighty percent of all small projects and all larger programs of work (those over two years) using Scrum practices quite successfully, and in the words of a BA “...almost every new project that starts now uses Scrum”

In terms of vertical usage, all the core properties of Scrum were implemented in the initial projects. According to one BA,

“it was better to do by the book. I don’t know whether we did it by the nth degree, at least we followed the process fully, yes, all the practices, definitely”. The MC added, *“they’ve followed them quite diligently and have been doing that for two and half years, so it’d be quite sustainable to do that”*.

And, over a period of time, Scrum usage evolved, where different teams and projects were using their own variations of Scrum – some of these (e.g. CH) were based on reflection, adaptation and learning, while others (e.g. AK) practiced their own interpretations without much guided coaching or monitoring.

In summary, while horizontal usage increased, there were different variations of vertical usage across the three regions.

4.8.6. Agile Usage Effectiveness

Two particular themes were found to relate to quality which is best reflected in the words of the ITDM (CH) and SM (WL) respectively:

- 1) improved quality of the delivered product

“...the reason why we are delivering better quality is simply that the user is more involved and so they are prioritizing daily at stand-ups, and definitely every three weeks at the sprint planning meetings by identifying what is more important to them and then the end product is that we are delivering better quality than we were before”, and

- 2) improved quality in defect management,

“..we are closing the defects a lot quicker than we were previously which suggest that we are finding issues early, which is great. In some instances we are actually finding more defects which is a great indicator because it means we are spending time in the right

places. And so if our rate of closing those defects is the same as the rate we're opening them for a majority of the projects then we know we've got the right rhythm; we're finding stuff, we're correcting it and that's a great quality measure in its own".

Productivity: Velocity measured in terms of story points per sprint was used to measure improvements in *productivity* and was believed to provide a basis for improving the accuracy and reliability of planning projects. One WL developer stated that there were

"...some instances where teams were reaching a fever-pitch in their productivity. And we were getting to a point where we were finishing projects early and it allowed us time to sit back and look at other aspects such as testing, where we were discovering new areas that we could do to look at improving the project without being under pressure".

Customer Satisfaction: One of the main motivations for adopting AM in Stats NZ was to improve their relationships with clients. The agile approach to collaborating with the client throughout the development process showed specific improvements in quality, regular and faster delivery, and played a critical role in improving their customer satisfaction as noted by their ITDM (CH)

"...their engagement has been phenomenal – they've really just got on board, and really enjoyed working closely with the teams. They feel a lot more, not necessarily in control of the project, but having some real, direct influence on the success of the project. They feel they can contribute with valuable decisions, really understanding what those issues are when technical issues pop-up, and being able to talk freely with the development team...the quality of that decision making as well; seeing that visibility of some of the engineering problems we've come up against for example, has really helped them to understand what does it mean when we ask for a particular functionality, because they've seen a lot more of how those decisions can impact the team directly, and how that can have a direct impact on the success of the project, it's helped them really understand what software engineering is all about which is pretty good".

4.9. Discussion

The study findings confirm the efficacy of the proposed research model in understanding sustained usage of AMs in organisations. Insights drawn are discussed in the following sections

4.9.1. Innovation

While most interviewees expressed awareness of the relative advantage of AMs in comparison with their predecessor SDLC/waterfall method, there was no evidence of any specific and effective strategies to track or validate the benefits, i.e. improvement outcomes/metrics of sustained agile use. The rationale for the need to stabilise their ongoing and continued usage was not clear. Agile practices such as test-driven development or continuous integration were not used, and therefore many were not aware of the different tools that supported specific agile practices. TFS was the only tool that was used. Though specific compatibility issues in terms of tools and technologies used were not identified, major compatibility issues relating to sociological, organisational culture, structure, and technological factors were identified – these are discussed under the remaining categories below.

4.9.2. Sociological

A number of factors relating to the conduct of systems development such as structure, project characteristics (complexity, duration), and cross-sectional teams mandated the use of AM in most projects by the end of 2008. Staff in each of the three regions had different experiences and perceptions on the impact of various factors on agile use. These differences could be attributed to the fact that the whole agile initiative was pioneered by one key person in CH who led a group of technically competent and motivated staff in some initial, low-cost projects. Therefore, CH first envisioned agile as a practical solution to address the problems associated with systems development at Stats NZ and adopted agile in a stealth manner. Later, it was introduced in both WL and AK. While WL responded positively to the change, AK staff struggled to understand the rationale for agile at Stats NZ.

CH had more positive perceptions on the use of AM, i.e., they displayed higher morale, positive attitude and motivation, and higher levels of agile knowledge compared to the other two regions (AK and WL). WL had a wider range of roles (BAs, Product Owners, ITDMs) and larger number of IS staff compared to both AK and CH - this was reflected in a range of different levels of attitude, experience, and agile knowledge of WL staff. AK had only four developers and two testers – staff generally displayed negative attitude and lower commitment to the use of AM. They perceived that AM were not suitable for some of the projects at Stats NZ, and was used just for the “sake of using agile” without evaluating its appropriateness. The AK team complained that the rationale for using agile at Stats NZ was not clear, and lacked a well-defined process,

“trying to understand exactly what we were supposed to do, how we were supposed to be doing it... things like not understanding what the daily stand-ups was for, and having daily stand-ups that were taking like an hour, as opposed to only 15 minutes, so. Yeah, so there was, not everybody was on the same idea of what we were supposed to be doing. It’s more that there wasn’t really like an example of how it’s been done successfully before us. It’s everybody reading what various interpretations of the methodology are, and their own interpretations and we didn’t really have anybody who knew that this is the process.”

As AK members were a small cross-located group distant from the other two core regions (all the main decision-making, development, and business activities happened in WL and CH), they did not have the opportunity to observe/learn from other agile teams. For example, when daily-stand up meetings was conducted at WL, AK staff participated via telephone who felt that they could not keep up with the rhythm of the agile process with the rest of the team. They felt isolated from both WL and CH. Though the MC (CH) regularly visited AK and WL to conduct agile meetings and workshops, it was perceived as one-off induction or update sessions aimed at describing key agile practices in a rather general manner. The significance of positive and right attitude on sustaining AM was highlighted by a senior developer, who played a key role in implementing agile at Stats NZ,

“..you do need people with the right attitude. Some people have the attitude – just do my work and you know if I have done my story that’s it. It’s not, “does anyone else need a hand now, can I help you with this..?” so you need that, you’ve got to have inclusiveness, it’s an unselfishness and it’s that emotional intelligent awareness isn’t it, about what everyone else is doing”.

In summary, a number of phrases related to sociological characteristics such as “proactive”, “inclusiveness”, “unselfishness”, “emotional intelligent awareness”, “empowerment”, “involvement”, “part of the process and part of the decision making”, “agile mentality”, were identified as critical for sustained agile usage.

Most staff had medium to high levels of general technical competence and experience in SDM. However, experience in AM varied across the three regions. In CH, there was a general perception that agile supported only high performing teams,

“I think that agile’s a tool that will enable a high performing team or a skilled team to perform at a high level; so it’s probably less about the tool and more about the making of the team; the team needs to have a clear sort of focus or vision that they need to be part of ...” (Project Manager, CH).

Such focus was reflected in the team composition of CH teams – most of whom were technically talented, motivated, and had an average of five years of agile experience. On the contrary, many new employees in WL had no experience in agile. Lead developer in WL stated,

“we have new project managers coming on that don’t know agile. You’ve got testers coming in, BAs that have never done agile... and now we are on the fringes or those that are less dynamic... and to make it sustainable you sort of need these people who are living and breathing it”.

AK had the lowest level of agile experience compared to CH and WL. While it is recommended that an agile team consists of higher levels of all the required skills, the findings confirm that there will always be a mixture of skills and expertise, and the required skills can only be built over time by actively supporting and learning from each other. Staff were encouraged to attend regular training sessions and workshops on agile, Business Analysis, etc.

“we got people in and did some courses and I sent my senior developers off on Scrum Master courses at that stage, but there is no corporate training programme around Scrum” (lead developer, WL).

An agile community weekly practice was set up (both in WL and CH) in which staff was encouraged to discuss issues related to practice of AM. As this was optional, the turnout at these meeting was normally very low. There were no dedicated roles or in-place coaching strategies or mechanisms that facilitated or monitored effective use of AM across various agile teams,

“and we don’t have any dedicated roles. One of the BA’s who’s into that space has just been given about .4 to do some coaching and setting up and helping like that, but we’ve never had any formal positions around the agile Scrum, it’s never been recognised, you just had to do it as part of your day job and things like that” (Developer, WL).

There was no internal training that facilitated the effective use of AM to cater to the contextual requirements of Stats NZ in general and each region in particular. For example, AK teams

needed more on-site coaching and training on Scrum practices compared to WL and CH, i.e. on-site coaching/mentoring by an agile specialist for the duration of a complete sprint, would have enabled AK members to better understand the process and evaluate the relative benefits of using AM, and improved their morale and motivation. Though the significance of the role of an ‘AC’ in facilitating the effective use of AM has been strongly advocated in the practitioner community (no empirical evidence to support this view exists in the extant literature to the best of researcher’s knowledge), it appears that it is yet not widely implemented in organisations (Davies, 2011) such as Stats NZ. Testers and BAs struggled to understand the value of their roles and suitability in the whole agile framework. Probably a more specific/tailored approach to address the needs of individual roles, and a consistent process-oriented approach in all three regions would have helped alleviate these issues.

4.9.3. Technological

In terms of agile practices, some of the core Scrum practices was not strictly adhered to. For example, for AK and WL teams, conducting daily-stand up meetings across different locations was difficult and challenging. As a result, some agile teams had daily-stand up meetings only twice a week, and in some cases they were held only once a week. Moreover, as members’ belonged to more than one project at any given point of time, it was difficult to meet the sprint goals – because someone would be called off to do some other urgent work. As a result, unfinished user stories had to be reprioritised for the next sprint. As another example, the ineffective use of sprint retrospective meetings is illustrated in the following statement,

“I don’t really think it worked very well. People didn’t seem to really want to look at it objectively. It seems like we would just be going through the motions trying to think up stuff to go in each of the improvements, or what went well and what didn’t work, just for the sake of having stuff in there; where it wasn’t really... I don’t think it was really used how it’s intended to be used.”(Developer, AK).

As the rationale for using AM was not clear, in particular to AK teams, Scrum practices such as regular sprint meetings, daily stand-ups were perceived as time consuming activities. Cross-location of teams and allocation of members in multiple projects was perceived as the main factors that hindered the effective use of agile practices. Two main strategies would have helped resolve this issue: (i) form co-located teams (ii) support cross-located teams with sophisticated collaboration tools. For Stats NZ, since co-locating teams were not a viable

solution, investing in appropriate tools that supported effective use of agile practices in cross-located teams would have alleviated the issue by a large extent.

Most developers were aware of the importance of agile practices such as continuous integration, but were not practiced

“we don’t use continuous integration...it’s been quite a struggle. I think because we are not doing continuous integration there’s less benefit out of doing test-driven development. So, I think we had get a lot more benefit if we’re doing continuous integration and test-driven development” (developer, CH).

And, TFS, the only widely mentioned tool was not being used effectively – in particular, there was no effective and proper integration of everything in TFS, i.e. user stories, tasks, etc. People expressed that important software and tools were not upgraded as fast as commercial firms, for example TFS was always lagging behind the contemporaneous version. One senior developer stated,

“upgrade to TFS 2010 – it’s been discussed for about a year and a half, but this work, I know it’s been scheduled for next year , but the tool is out there about two or three years ago. As far as I know, Stats NZ is always behind about three years”.

Therefore, though main agile practices were followed, their use was not well supported by identification and use of appropriate practices and tools. For example, Middleton and Joyce (2010a) found that the Kanban approach to software development worked better when it was supported by appropriate tools and practices such as (i) good source control software to manage different versions of the software product (ii) bug tracking software (iii) well automated release and deployment processes for software, and (iv) automated unit and coverage testing that reduces live bugs. Agile is not a substitute for good systems development tools and practices, but provides a framework that enables teams to self-manage and contribute to improvements in outcomes (Middleton & Joyce, 2010a).

In summary, core practices of Scrum were are not adhered to on a continual and consistent basis, and because some of these practices did not become a routine part of the development process, teams might missed opportunities of exploring or reaching the full potential of more comprehensive and sophisticated phases of sustained agile usage. For example, Wang et al. (2012) found that teams with increased and routinised agile usage were able to effectively practice sophisticated and deep customisation of agile practices compared to other teams which

were in their early phases of agile use. So, even though some project managers and management perceived that Stats NZ was using AM extensively in almost all their projects, in reality, their adherence to core practices, engineering practices, and the intensity of agile use was not only low but also varied largely between teams.

4.9.4. Organisational

Stats NZ underwent a major transformation change with the introduction of agile. Though people have generally responded well to this change, a number of issues at the organisational level have hindered the sustained usage of AM in Stats NZ.

It is widely agreed that ASD represents a radical change which requires strong management support and constant involvement. In Stats NZ, though the agile initiative was driven bottom up, there was lack of commitment and support from management. Management was perceived as the last to come on board,

they kind of don't practice it themselves; they are not prepared to give too much; like sort out the deployment process or change the structure" (Developer, CH).

Lack of commitment and involvement of top executives was repeatedly identified as the key factor that hindered sustained usage at Stats NZ,

"the CIO, the chief statistician, they're aware, they're certainly aware, and they also talk about Stats NZ being an agile organisation, but he means something different. He means that responsive to change and that sort of thing. And our CIO he knows about Scrum and all of that, but they're not actually doing much to support the sustainability".

After the MC left the organisation in 2012, no dedicated roles were created to facilitate or champion the ongoing and effective use of AM –

"we have no people dedicated to Scrum or agile....there's no champion. There's no champion responsible for that and that's what you need. I think you need that...(Development Manager, WL).

One developer summed it as, "we have actually got this far without corporate support,...., yes they have let us do it, they have not come round and said, "No", but there's not the support structure really. And it's been done through people". Though agile is based on the principles

of iterative and adaptive development, for an organisation such as Stats NZ, a standardized process that defines the use of agile that reflects its organisational policies is imperative. Though ASDLC has been used extensively, a number of challenges still exist. For example, at the elementary level, lack of adherence to a process (e.g. standard Scrum framework/process template¹¹) has had a significant impact on SAU. As a result, a number of various adaptations have crept in. While some projects such as **Census**, and **BES**t developed in CH were trying to adhere to core Scrum practices, WL and AK significantly drifted from core practices. In summary, AM at Stats NZ has morphed into a number of different hybrid versions in which Kanban has also made an entry more recently. And the following issues/inconsistencies were still common in December 2012 (when the data collection ended for this study)

- a) Lack of specific coaching and mentoring to cater to the needs of individual teams and regions.
- b) Lack of or ineffective use of engineering practices and appropriate tools and technologies.
- c) Inconsistent deployment process: Stats NZ has four major deployment process environments: development, test, UAT, and production. This deployment process does not enable or support deployment in iterations as prescribed by the Scrum framework.
- d) Inconsistent funding structure: though most projects are agile, the funding model for business cases is still based on the waterfall model.
- e) Inconsistent project management structure: Stats NZ uses Prince 2 as their project management methodology and is trying to integrate agile with Prince 2. This implies that the sprint durations and sprint release schedules should align with projects reporting periods and reporting milestones. Though effort is ongoing to align these, lot of work is yet to be in done in streamlining management effort. Though the management (CIO) claims that their project management office (PMO) is a strong advocate of the agile framework, developers feel the contrary:

“we have quite a big project management office and Portfolio Managers and Programme Managers, so you’ve got this heavy project management structure, but

¹¹ <https://www.scrum.org/Scrum-Guide>

you've got a non-agile structure.... no one's addressing that thing intellectually I don't think at a management level (Development manager, WL).

Agile in Stats NZ was mainly built by a group of agile enthusiasts and passionate people who were competent and knowledgeable in Scrum. This is well illustrated in the following statements by (i) a senior developer and (ii) the MC respectively:

“(i) because other than it being built by people who've worked with Scrum on a much wider scale than we have, and with input from some of the pioneers of Scrum....Scrum really it comes with process guidance and things that we can reference to see how things are supposed to be done, which is what we've been missing. We've just had to interpret things ourselves, whereas a template is going to have the process described in a bit more detail than we're used to” and,

“(ii) So at the moment it is quite pivotal on my expertise based on what I've done previously; to see those patterns and behavioural traits happening in the team and suggesting changes to put the dynamic right to get back to optimal productivity again. So in small projects it was pretty straight forward, but with large projects we have seen some deficiencies because we haven't got skilled or experienced people”.

Scrum has generally worked well during the initial years probably due to the initial hype and enthusiasm associated with trying something new, and also the strong anchoring support of the methodology champion (MC left Stats NZ in 2012). However, as discussed in the findings above, Stats NZ is currently facing challenges to sustain the use of AM:

“Sustainability is a big issue at the moment” I think this is where the sustainability question is quite important: how do we maintain clear standards? Maintain quality? You talk to a lot of people and they've done some short-term implementations (say a three month implementation), but after about a two and a half year program of work were finding that people are unready to do these disciplines and hitting a particular point where someone says, 'hey, hang on a minute – this would be a better way to do something.' And then addressing the balance and going back to the basic principles again. So there's this period where you have the honeymoon period because it's new and then they get complacent and then they tend to degrade”. (lead developer, WL),

4.10. Cross-case Analysis

The use of multiple-case design in building or testing *a priori* theoretical model is recognised in the literature (Eisenhardt, 1989; Yin, 1994). The first case, BBCW, along with the findings and analysis is described in Chapter 3, and the findings and analysis of the second case, Stats NZ is described in the previous sections (4.5 – 4.9) of this chapter. This section compares the two cases using the SAU model and presents a cross-case analysis of both cases.

While BBCW and Stats NZ both implemented agile practices within their systems development operations, their experiences differed due to variations in the organisational context, usage, and the requirements of key players around the adoption and continued use of agile practices. The structure of Stats NZ can be categorized as a matrix, with hierarchical control of agile use exercised from the organisation's Christchurch branch, while the development work was conducted via project teams operating out of the branches in Wellington and Auckland. BBCW, which owns and administers a number of commercial stations (e.g., BBC World News, BBC Kids) operates in a number of different territories and platforms, and therefore can be categorized as a divisional form with divisions/units having significant autonomy. Therefore, Scrum which prescribes practices such as time-boxed iterations and roles was found to be a perfect fit for Stats NZ's role-orientated, formalised culture. In contrast, for a more autonomous team such as the BBCW's Digi-Hub team which was working on a program with multiples streams where different pieces of work kept coming in, Kanban's properties of splitting the work into pieces, visualizing the workflow, etc., was found to be more suitable in comparison with Scrum's time-boxed iterations which were restrictive and difficult to adhere to.

Table 4.2 summarises the main findings of the cross-case analysis of SAU in the two case studies.

In both cases, *relative advantage* emerged as a key factor influencing agile usage. For example, Stats NZ faced difficulties in requirement prioritization, delays in delivering to the customer, etc., with their previous approach (waterfall/RUP) and faced serious consequences such as decreased employee morale, delivery delays that affected their relationship with the customer. They believed that Scrum brought a radical change to Stats NZ. In contrast, BBCW found Scrum's time-boxed iterations very difficult to adhere to due to the dynamic growth of their individual pieces of work and constant reprioritization by the business. For them, Kanban's properties such as limiting the work-in-progress, reducing batch size and granularity of visualization resulted in a reduction of overheads including changes in requirements. However,

it was surprising that no major compatibility issues were reported in either case, given the fact that such challenges have been reported in other recent studies (Mangalaraj et al., 2009b). Though this clearly calls for further investigation, the findings might be interpreted as either that the teams i) were technically competent enough to adapt to newer practices (BBCW) or ii) the more challenging agile practices such as pair programming, test-driven development were not being used effectively (Stats NZ). Moreover, as previously discussed Stats NZ reported incompatibility issues with their resourcing models, resistance from BAs, and an inability to leverage enough support from the organisation- this hindered the sustained usage of AMs.

In terms of sociological factors, BBCW displayed higher levels of technical competence and positive attitude which could be attributed to the fact that some of the key roles such as lead developer, software coach were hired on a contract basis. It is logical to expect such high levels of competence and performance from practitioners who are normally concerned about career mobility and escalating their marketability in the industry. In contrast, most IS employees in Stats NZ were internal with very little external hiring of experienced IS talent. Some of them had been with Stats NZ for their entire careers. As a result, most of them had very good knowledge of the business domain but lacked the depth of experience needed to sustain the use of agile practices. Employees displayed mixed attitudes, where some of them were very passionate about agile practices few others were not self-motivated and developed an attitude of “us vs. agilists” This could be partly attributed to the paternalistic culture at Stats NZ, where the employees expected the organisation to cater to their training and learning needs. Such cultural norms and mixed attitudes reduce the likelihood of long-term sustainability of agile practices. It also highlights the fact that while differences in individual attributes such as attitude, personal resilience, etc., might not be evident during the initial stages, they will become more prominent during the later stages of organisational assimilation, and therefore might have a serious impact on SAU.

Table 4.2: Cross-Case Comparison of SAU (BBCW and Stats NZ)

	BBCW	Stats NZ
Methodology	Kanban	Scrum
Predecessor	Scrum	Waterfall/RUP
Innovation factors		
<i>Relative advantage</i>	Limiting work-in-progress Reducing batch size Granularity of visualization	Better time management in requirements gathering Improved delivery schedules Higher team morale
<i>Compatibility</i>	Not mentioned	Resistance from BAs Incompatibility with resourcing model
Sociological factors		
<i>Experience</i>	High	Moderate
<i>Attitude</i>	Positive attitude, willingness to learn, and change, highly motivated	Mixed attitudes towards change
<i>Technical Competence</i>	Technical – high Business domain - moderate	Technical – moderate Business domain - high
Technological factors		
<i>Agile practices</i>	Deeper use of all practices	Adaptations of Scrum practices
<i>Tool support</i>	Cucumber for automated testing, TeamCity for continuous integration	Rally project management tool, in-house release management systems, and Visual Studio Team Foundation Server
Organisational factors		
<i>Top Management Support & Methodology Champion</i>	Played a critical role in influencing agile usage	Played a critical role in influencing agile usage
Sustained Agile Usage	Significant increase in both horizontal (80% of projects using Kanban-spread referred to as <i>Kanban flu</i>) and vertical usage (all core properties of Kanban)	Significant increase in both horizontal (almost all projects using Scrum) and vertical usage (derived adaptations of Scrum properties)
Agile usage effectiveness	Specific improvements recorded in improved quality and productivity	Improvements in both quality and productivity Customer engagement and satisfaction seen as having a direct impact on the success of the project

Data analysis highlighted that ‘people’ characteristics such as attitude, motivation, willingness to learn, trust, and respect, were more important than technical knowledge and domain expertise of team members. The findings do not imply that constructs such as technical expertise and attitude have less impact on SAU, rather highlight the significance of sociological characteristics on building technical expertise and team learning.

In both the cases, the management wanted evidence of good results before the teams could continue using agile practices and therefore lot of things had to be done very cautiously during the initial stages of agile implementation. Even after that, there was no major support from or direct involvement of the top management due to a lack of understanding of the changes in technical practices. While it is logical that organisations expect to see specific benefits, it is critical that management needs to understand that contemporary software engineering process innovations such as AMs involve continual learning and improvement based on effective feedback mechanisms over time and improvements are not achieved by merely adopting a new AM. As one project manager in STNZ pointed out,

“...there is not much support from the top management, they know only the theory side of it, and it would be good for them to know the practical side of it, they would get a better understanding of why or why not things are working? We need ongoing support...”

If organisations are not flexible enough to learn and adapt to the changing needs of contemporary practices, it may challenge the teams’ effective use of agile practices and inhibit further diffusion into the organisation.

Despite the fact that Stats NZ had substantially progressed in implementing ASD practices, they followed an approach that was well suited to its formalised culture, and continued to use the training resources and strategies that they were familiar with. Some of these were not particularly relevant to the specific needs of the agile teams as one Project Manager noted,

“...we do attend specialist training on Business Analyst, Project Management, etc., but we need to have specialist training on Scrum – we are keen to learn”.

Stats NZ still overly values the specialist skill and knowledge roles and is finding it difficult to move away from the old formalized roles. On the other hand, in BBCW the teams enjoyed autonomy in terms of being able to make their own decisions in choices and adaptation of tools, use of technical and engineering practices etc. They also enjoyed the benefits of regularly hearing from leading experts and thought leaders on key principles of Kanban implementation which motivated the teams to continually learn from their experiences. Both companies believed that the role of the MC was critical for the successful diffusion of AMs in their organisations. As argued earlier, while the roles that MCs play at various stages of implementation has been well-recognised in the IS literature in general, the findings from this

study in particular highlight the various challenges the role undergoes in the practice of AMs which makes championing crucial to neutralizing the inhibitions, fears, resistance necessary for the effective diffusion of AMs.

Specific evidence of improvements for all three measures were recorded in the case of BBCW (Middleton & Joyce, 2010b), and Stats NZ believed that there were significant improvements in all three measures (though there was no evidence of any formal measurement) and suggested that factors such as increased morale of team members had an indirect but significant influence on their productivity improvements. As their Project Manager explained

“...we are finding that productivity may be higher because people are happier, they have been used for their specialist skills in the right way...and therefore morale has a big impact on productivity”.

Findings from the two cases confirm that all factors in the proposed research model, i.e., (1) Agile innovation factors (*relative advantage, compatibility*) (2) Sociological factors (*experience, attitude, technical competence*) (3) Technological factors (*agile practices, tool support*) and (4) Organisational factors (*TMS, MC*) played a significant influence on the sustained usage of AMs, which in turn had an impact in improvements in systems development outcomes. For example, in terms of vertical usage BBCW implemented all the core properties of Kanban in combination with their predecessor Scrum and XP practices such as daily stand-up meetings, test-driven development, and pair programming without making any major changes to their existing workflow, job titles, roles and responsibilities. As one team (Digi-Hub) began experiencing positive outcomes of using Kanban, its use spread to other teams, divisions, etc., to the business divisions and eventually throughout BBC. In the highly data and business-rule oriented environment of Stats NZ where people were very attached to their roles, recognising the significance of key roles such as BAs and making people in these roles feel they ‘belonged to’ the agile framework was critical. Scrum was first introduced in the Christchurch office, where all the practices were adopted ‘by the book’. As the ITDM explained

“...we were determined at the very start that we should do scrum out of the box, because we knew that we needed to understand how it works first- we said people had to stick with it for at least 6 months...before adapting it. and later they adapted things to something that is more beneficial for them”.

Though deeper use of all Scrum practices had an influence on their effective and sustained use, but over a period of time a number of various adaptations have crept in, and this has had an impact on its long-term sustainability, though the use of Scrum has eventually now spread to all teams, and in the words of the ITDM “...we started out with a handful of projects, and now almost every IT project is done using agile”.

Another key concept that emerged in the findings of BBCW case was the influence of *budget and schedule constraints* on the sustained usage of AMs. It was found that restrictions on budget and schedule (time) influenced effective use of engineering practices such as reducing technical debt, etc., Mangalaraj et al. (2009b) found that projects with relatively less restriction on budget and delivery schedule enabled a team’s deeper adoption of XP practices compared to other teams that had strict schedule and budgetary constraints (see section 4.3.1). As the above findings related to single teams/projects, additional justification was sought in this research cycle (Stats NZ case) to further validate this finding. The influence of *budget and schedule constraints* on sustained usage of AM was discussed with most interviewees. Most of them highlighted the impact of budget/funding on various aspects such as obtaining latest versions of software, new technologies, funding for training etc., but was not perceived to have a negative impact on SAU. On the contrary, it was perceived to have a positive influence on improving the quality of systems development. The following quote by the MC illustrates this viewpoint well:

“In a government funding environment such as ours time constraints are very important anyway. Constraint sounds like a negative word. But having a time constraint is actually quite liberating in terms of making conscious decisions. So with a time constraint we are looking to manage the project by scope. So as we get closer to that time constraint we can start making more detailed decisions about what should or should not be in the product at that particular time. So at the start of the project we are generally quite ambiguous in our decision making in terms of scope and that goes through the whole scope of the project so that by the end we are making almost binary decisions on the scope; what’s in and what’s out of the project. So having a time constraint is quite good because it allows us to improve the quality of our scope decision making. Our financial constraints, they can be a bit of a constraint, especially if we’re talking about number of resources on the project. If we’re quite constrained then we can’t afford additional resourcing, or specialized resourcing on the project, and that can have a negative effect on the project. But again, it can help us understand

pretty early on about the magnitude of the project, 'do we need to look for future funding?' 'Is the project a common sense decision?' 'Should we can the project because we're not going to get it done with this amount of funding?'

The above findings imply that time and budget constraint is more likely to influence individual projects rather than on the overall sustained usage of AMs. In summary, at the end of research cycle 2 (CF2), the following points were noted based on the findings of the two cases (BBCW and Stats NZ):

- time and budget constraint was not deemed as a key factor influencing sustained agile usage and therefore was not included in the research model
- under 'technical competence' (sociological characteristics), there was no need to differentiate between domain and technical expertise
- in addition to 'attitude' (sociological characteristic), a number of other characteristics (willingness to learn and change, commitment, etc.) are critical for the sustained usage of AM. This will be further validated in the next research cycle (CF3).

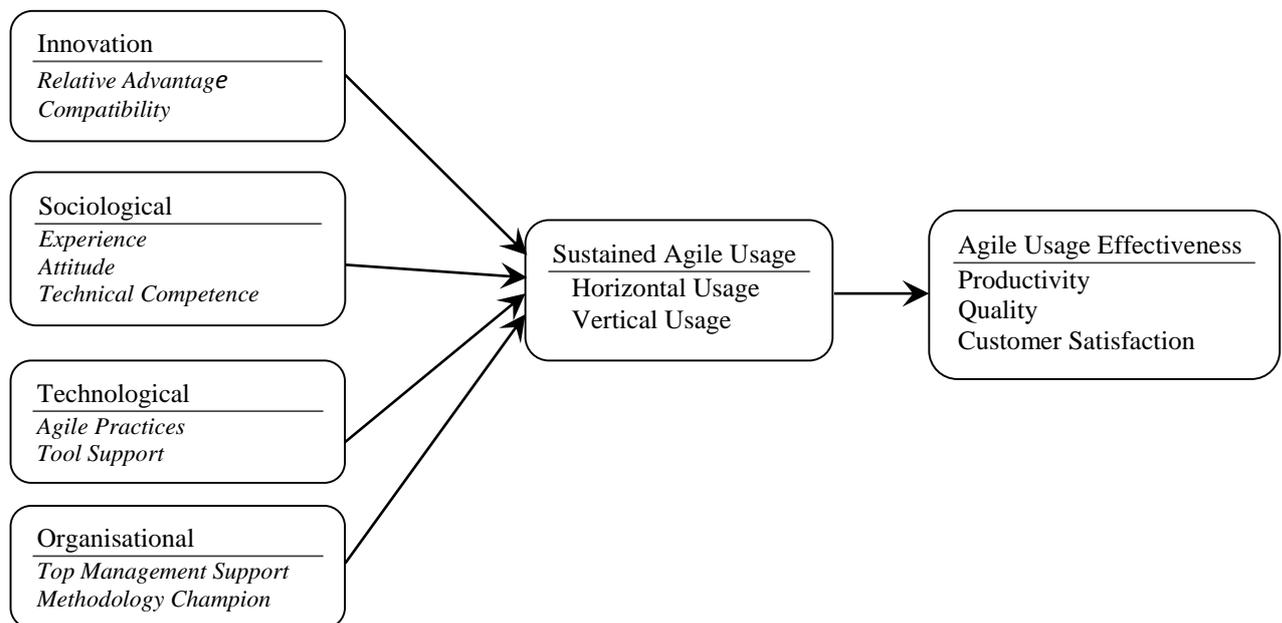


Figure 4.6: Sustained Agile Usage Model (CF3)

The above changes are reflected in the updated research model in Figure 4.6. Applying Carroll & Swatman's framework, the current study's research enters cycle 3 (i.e. application of CF3 to the next phase of research, i.e. Focus Group and Semi-Structured Interviews – Figure 4.7).

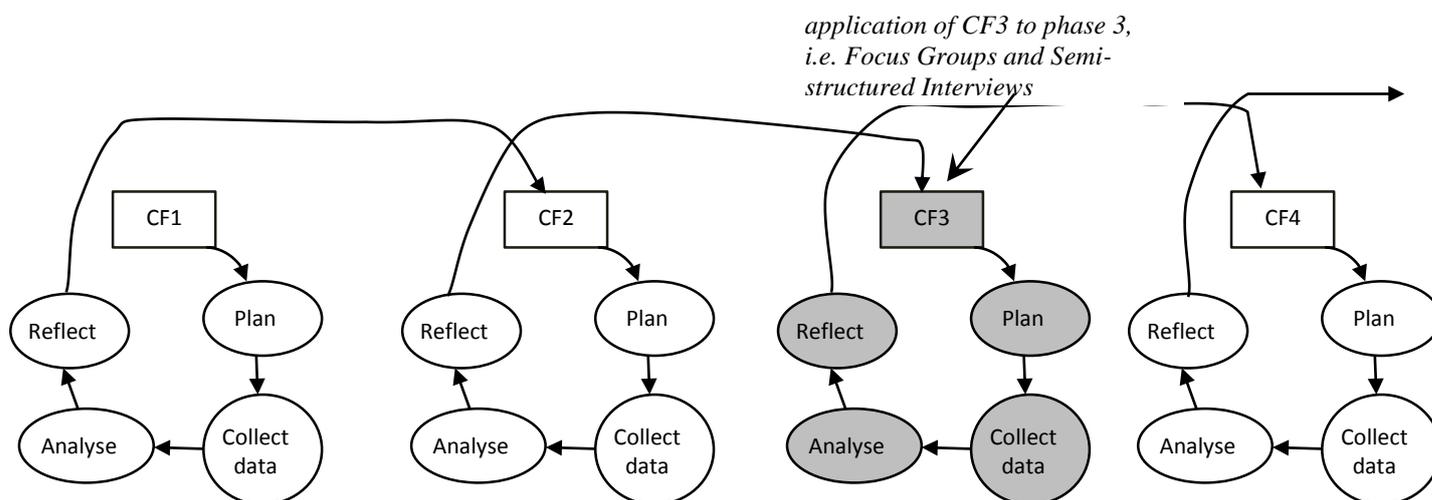


Figure 4.7: Structured-case framework (Carroll & Swatman, 2000)

4.11. Evaluation of the Case Research Process

This section will evaluate the methodological rigor and adherence to the criteria of good positivist case study research practice of the current study by using assessment criteria specified by Dubé and Paré (2003). Tables (4.3 – 4.5) show the findings of this assessment.

Table 4.3: Evaluation of case research process – Research Design

Criteria	Assessment from both cases
Clear research questions	Clear research questions were formulated (see Chapter 1)
<i>a priori</i> specification of constructs and clean theoretical slate	<i>a priori</i> set of constructs were identified (<i>a priori model</i>) to guide the research process
Theory of interest, predictions from theory, and rival theories [internal validity]	Theories of interest: sustained usage of AMs. The study draws from different theoretical backgrounds to develop an integrated model of SAU. The findings from the cases are compared and contrasted with the literature and the model is refined iteratively and to aid in further research phases (e.g. survey – development of hypotheses and predictions)
Multiple-case design	Multiple-case (two cases) design
Nature of single-case design [internal validity] and replication logic in multiple-case design	Both cases follow a literal replication logic
Unit of analysis	Clearly specified
Pilot case	Case one was used as the pilot case
Context of the study	Context: medium to large scale organisations where AMs were one the main SDMs used in their systems development operations. The agile method, its characteristics, practice, organisation context, and various factors that impact its effective usage from the perspective of various practitioners are discussed.
Team-based research and different roles for multiple investigators	N/A

Table 4.4: Evaluation of case research process – Data Collection

Criteria	Assessment from both cases
Elucidation of the data collection process [reliability, validity]	Data sources (predominantly interviews) and how they contribute to the findings are described in detail. The conduct of interviews are described (number of interviews and interviewees, profile of interviewees, transcription use, interview guide, etc.)
Multiple data collection methods and mix of qualitative and quantitative data	The data collected are mainly qualitative
Data triangulation [internal validity]	Data triangulation utilized to some extent
Case study protocol and case study database [reliability]	The case study database and organisation of the material (in NVivo) are discussed in some detail

Table 4.5: Evaluation of case research process – Data Analysis

Criteria	Assessment from both cases
Elucidation of the data analysis	Data collection and analysis carried out in parallel. The process is documented using three stages (Pare, 2001) <i>early steps in data analysis</i> (field notes, coding), <i>within-case analysis</i> (pattern-matching), and <i>cross-case analysis</i>
Field notes, coding, data displays, and flexible process	As above
Logical chain of evidence [reliability, internal validity]	Evidence and sufficient relevant information is provided that should enable the reader to follow the evidence and argument
Empirical testing, explanation building, and time series analysis [internal validity]	Empirical testing is the dominant mode of analysis – this was explicitly discussed (see sections 1.3 and 1.4.1)
Cross-case patterns [internal validity]	Within-case, cross-case analysis, and pattern-matching are utilized
Use of natural controls [internal validity]	Not utilised
Quotes [reliability]	Sufficient relevant quotes are provided to enable the reader to reach an independent judgement regarding the merits of the analysis
Project reviews [reliability]	Case study reports were reviewed by key informants in both organisations. Reports have also been reviewed by international reviewers (papers presented to international conferences and journals), presented at various doctoral consortiums and conferences, and supervisors
Comparison with extant literature [generalizability and internal validity]	Comparison of findings with both conflicting and similar literature have been discussed

4.12. Conclusion

This chapter presented the conduct and findings of two case studies, BBCW and Stats NZ. First, the background and context, research method, and findings and analysis of the pilot case study, i.e. BBCW was presented. This was followed by a discussion of findings and analysis of the second case study, i.e. Stats NZ. Later a cross-case analysis of the two cases (BBCW and Stats NZ) was performed. The overall conduct of the case study approach was then evaluated using the case research design quality criteria proposed by Dubé and Paré (2003).

Chapter 5. Focus Group and Semi-Structured Interviews

This chapter describes the third research phase undertaken in this research. It describes how the SAU model from phase 2, i.e. CF3 is applied to the third phase,(a combination of a focus group and semi-structured interviews) to further explore and gain insights on the adequacy and nature of the theoretically developed constructs of SAU, and to add to the interpretation of the results found by analysing previously collected data. First, a brief introduction to phase 3 and the two data collection methods is presented. This is followed by detailed information on the design and conduct of focus groups. Next, the use of semi-structured interviews as a way of conducting qualitative research in IS is described followed by a description of the design and conduct of the interviews. Combined findings and analysis from both methods are then discussed. Related studies are reviewed to provide justification for the final model along with the development of a set of hypotheses to be tested in the next phase of research, i.e. survey. Next, main conclusions from this phase of the research is presented.

5.1. Sustained Agile Usage Model – Phase 3

The initial *a priori* research model (conceptual framework, CF1), presented in Chapters 1 and 2, was developed by coalescing insights from organisational level Information Systems implementation, traditional innovation diffusion models, and agile methodology literature. It laid out the research territory, guided, and formed the pre-understanding for the first research cycle, i.e. case study 1 (CF1 - BBCW). At the end of the first research cycle (CF1), the new model which was developed as an outcome of reflection, CF2, formed the pre-understanding for the second research cycle (case study 2 – Stats NZ). The updated model based on the analyses and reflection of the first two research cycles (CF3) forms the pre-understanding for the third research cycle (focus group and semi-structured interviews).

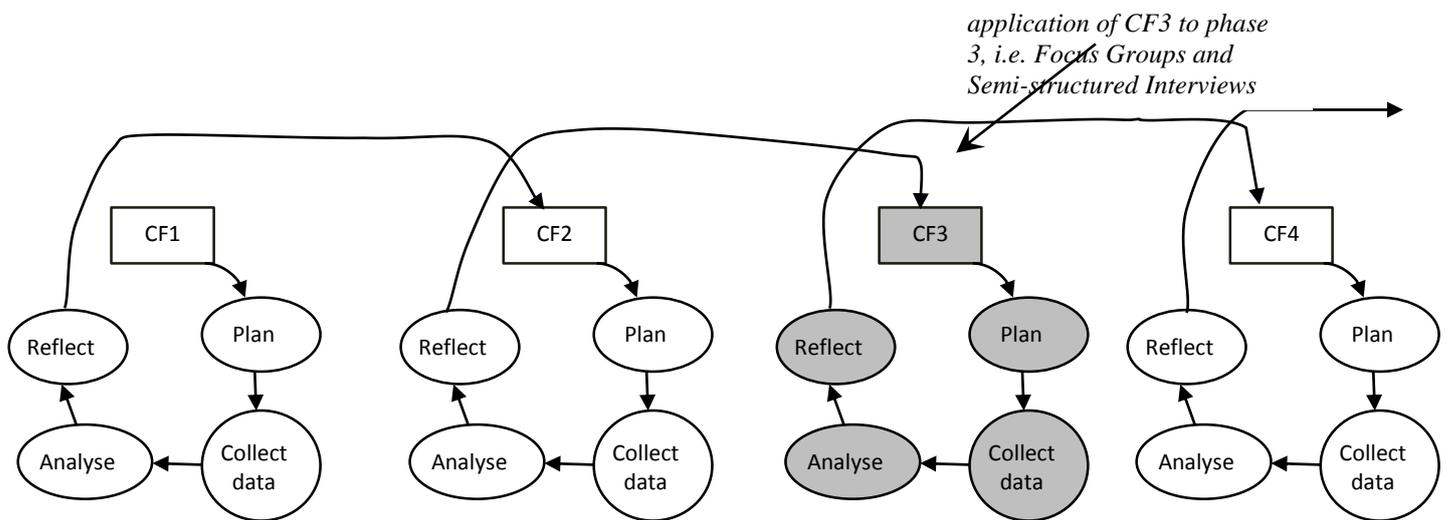


Figure 5.1: Structured-case framework (Carroll & Swatman, 2000)

5.2. Data Collection Methods

When conducting field studies it is important to obtain acceptable and reliable information about the phenomenon under investigation e.g. the phenomenon of SAU in the current study. To gain a better understanding of the various aspects of a phenomenon, it is often best to use multiple data collection methods, and then analyse the resulting data (Lethbridge, Sim, & Singer, 2005).

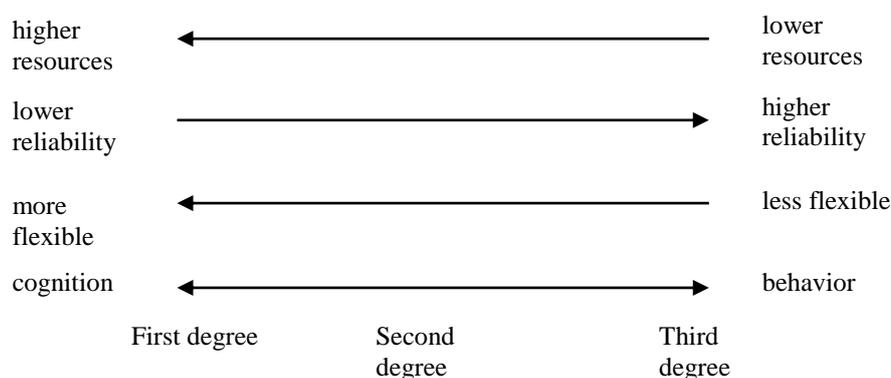
Lethbridge et al. (2005) provide a taxonomy of data collection techniques where each technique is categorized according to the degree of human contact it requires. It gives an understanding of the techniques most suited to each type of field study task:

- First degree contact – requires direct access to a participant population
- Second degree contact – access to participants' environment as they work, without requiring direct interaction with the participants
- Third degree contact – requires access only to work artefacts, such as source code or documentation.

Table 5.1: Taxonomy of Data Collection Techniques (Lethbridge et al., 2005)

Category	Technique
First Degree	Inquisitive techniques <ul style="list-style-type: none"> • Focus Groups • Interviews • Questionnaires Observational techniques <ul style="list-style-type: none"> • Work diaries • Think-aloud protocols • Participant observation
Second Degree	Instrumenting Systems techniques Fly on the wall (Participants taping their work)
Third Degree	Analysis of tool use logs Documentation Analysis Static and Dynamic Analysis of a System

The data collection methods vary in terms of the cost of resources required to collect the data, their reliability, their flexibility, and the phenomenon of investigation (Lethbridge et al., 2005): (i) Cost relates to the effort required to collect the data, the amount of data produced, recording and coding techniques, and the analysis techniques used. (ii) Human participation is often not treated as reliable as they might not often recall past experiences with high degree of accuracy. The relative merits of different methods are shown in Figure 5.2.

**Figure 5.2: Relative merits of data collection methods (Lethbridge et al., 2005)**

Though first degree techniques may be complex and costly in terms of data collection, management and analysis, are considered invaluable because of their flexibility and the depth of investigation that can be conducted on a chosen phenomenon (Lethbridge et al., 2005). Moreover, the selection of the data collection methods must be based on and done in the context of the research goal, objectives and questions. First degree inquisitive techniques such as focus

groups and interviews are suitable for exploratory, descriptive and explanatory research. As the main goal of the current study was to gain a better understanding of the phenomenon of SAU, and the research questions have both exploratory and explanatory elements of research, a combination of focus group and interviews was selected as data collection methods for this phase of research. The objective was to further explore and gain insights on the adequacy and nature of the theoretically developed constructs of SAU, and to add to the interpretation of the results found by analysing previously collected data. Such constant comparison across different types of evidence, cases, and the literature, has the ability to generate less biased theory (Eisenhardt, 1989). The aim is to derive a valid and reliable conceptual model to be later operationalised and tested using a survey instrument.

5.3. Focus Group

5.3.1. Background and introduction

Focus group research is defined as a “research technique that collects data through group interaction on a topic determined by the researcher”. It emerged from the work performed by Paul Lazarsfeld, Robert Merton and colleagues at the Columbia University in the early 1940s as social science researchers were looking for alternatives to data collection methods dominated by interviews (O’heocha, Conboy, & Wang, 2010). Focus groups involve a group of participants and at least one moderator as data is collected via group interaction about a topic provided by the researcher (Morgan, 1997). Participants of a FG both have in common and discuss a specific situation (Merton & Kendall, 1946), with the moderator(s) guiding the direction of the group’s discussions of the particular topics related to this situation with probing, open-ended questions (Wilkinson, 2004).

Focus groups can be used by IS and SE researchers to effectively address a number of research issues such as (Kontio, Lehtola, & Bragge, 2004):

- Identifying relevant research questions;
- Obtaining practitioner feedback on research questions;
- Recognising past experience that can be studied in more detail by other methods;
- Evaluation of potential solutions, based on practitioner or user feedback;
- Collecting lessons learned recommendations; and
- Identifying potential root causes of phenomena.

The issues or research questions can relate to any phase of a research life cycle. According to Kontio et al. (2004), a research life cycle has the following phases:

- In the *informational* phase, the FG can be used to collect characterizing information about the current practices, experience, or problems of systems development/software engineering problems.
- In the *propositional* phase the initial constructs, i.e., models, theories or prototypes, can be subjected to practitioner and user opinions to obtain feedback.
- In the *analytical* phase the user feedback can be used to evaluate the operationalisation of constructs or to test initial feasibility of them.
- In the *evaluative* phase the focus groups can be used to refine research questions, provide some of the empirical feedback, and support the interpretation of empirical data.
- Finally, in the *technology transfer* phase the focus group can help researchers to package their contributions into a form that is more easily deployable by users. In addition, a focus group session can also act as a “sales session” for such research results.

In the current study, the use of the FG method serves to fulfill the some of the purposes specified in middle phases, i.e. propositional, analytical, and evaluative phase. In particular, the FG was used to (i) obtain practitioner feedback on the framework (*propositional*), and (ii) evaluate/validate the proposed SAU model, i.e. identify any additional factors that either facilitate or hinder sustained agile usage (*analytical/evaluative*).

The core theoretical elements of a focus group are: topical focus, group interactions, in-depth data and ‘a humanistic’ character (Stewart, Shamdasani, & Rook, 2007). The topical focus derives from participants having a ‘particular concrete situation’ in common (Merton & Kendall, 1946). In the present study, all participants were expert agile practitioners who shared common understanding of AM usage. Although focus groups are a form of group interview which are often used as a faster way to conveniently collect data from several people, focus groups explicitly use group interaction as part of the method (Golden-Biddle & Locke, 1993). Group interaction is the main attribute of focus groups where discussion allows insights and less accessible data to emerge that may not otherwise emerge in collective or focused interviews (Kidd & Parshall, 2000; Kitzinger, 1997). The analysis of the differences and agreements that emerge from this group interaction are very valuable contributions (Kitzinger, 1997). Therefore, FGs can be considered between face-to-face dyadic interviews and direct

observation: like interviews, FGs allow the researcher to direct attention to specific topics while they also facilitate group discussion as per observation (Drury, Conboy, & Power, 2012).

Focus group technique has many advantages and disadvantages. The advantages are:

- (i) It allows the researcher to obtain substantially more data from a group in a short amount of time than one-to-one interviews (Morgan 1997).
- (ii) The group interaction aspect is especially important where there is not much known about the research topic or the participants require a group discussion to stimulate them to make a contribution (Morgan, 1997).
- (iii) It stimulates reflection and helps in surfacing opinions that might otherwise have not been forthcoming (O'hEocha et al., 2010). Some have termed this “introspective retrospection” (Merton & Kendall, 1946) and others refer to it as participants’ ability to “articulate those normally unarticulated normative assumptions” (Bloor, Frankland, Thomas, & Robson, 2001).
- (iv) In comparison with research conducted in field environments which can be often stressful to the research participants, participants are more likely to be willing participants if they feel comfortable with the researchers and feel they are partners in research that focuses on issues that they consider to be important (Merton, Fisk, & Kendall, 1990).

Limitations of the FG method include (O'hEocha et al., 2010):

- i) group interaction can lead to effects such as conformity of views as dominant characters (Morgan, 1997)
- ii) small group dynamics can confound minority or controversial opinions
- iii) opinions expressed may reflect those of a particular group context rather than a collection of the individuals’ opinions (Stewart et al., 2007)
- iv) more subtle information that might emerge in a more ‘private’ context can be missed

- v) the setting of the topic by the researcher can also influence the range and depth of input gathered and may not reflect topics considered important or interesting to participants (Merton & Kendall, 1946)
- vi) as they do not allow observation of groups in more ‘natural’ contexts, they are primarily restricted to discussions rather than forms of interaction (Morgan, 1997), and
- vii) data collected can be highly subjective as it is confined to participants’ opinions based on their experiences (Sim, 1998).

As most participants in the current study were a targeted group of experienced practitioners who self-selected out of their own interest in the topic area, it is believed that the effect of most of the limitations described above have been minimised. Moreover, as discussed above, the focus group technique was deemed a cost effective and flexible method to obtain experiences from practitioners that might otherwise have been expensive to capture.

While currently the focus group method is widely used in disciplines such as market research, system usability studies, and health service research, very few studies have adopted the approach in IS, and there is no known focus group studies conducted within the domain of ISD in particular (O’heocha et al., 2010). FGs offer many advantages that are specifically relevant to the IS discipline, such as overcoming limited access to data and suitability to unexplored and emerging topics such as agile (O’heocha et al., 2010). Additionally, this FG provided the researchers with an opportunity to explore the varying viewpoints of practitioners who worked on different ASD teams to validate the proposed research model.

5.3.2. Focus group: Design and Conduct

The main steps in conducting focus group research is summarised below (Kontio et al., 2004). Each step is briefly described followed by a discussion of its evaluation/application in the current study:

- *Defining the research problem:* the FG is best suited when the research issue is exploratory and focused on obtaining initial feedback on new concepts, generating ideas, obtaining feedback on models and frameworks, and discovering underlying motivations. It is not suitable for studying complex issues that are difficult to grasp in

a session, testing hypotheses, making final decisions, or obtaining quantitative assessments or opinions.

Since the research questions of the current study (see Chapter 1) have an exploratory component, FG was deemed as a viable research method to fulfill the purpose of deriving a strong, empirically validated, and reliable theoretical model.

- *Planning the focus group event:* the FG has a predefined schedule and structure and usually lasts for two to three hours. Sufficient time should be allocated for the participants to comprehend the issue in order to have a meaningful discussion and group interaction.

The FG consisted of a group of twenty-nine software industry agile practitioners. This is a relatively large FG as they usually consist of six to twelve participants (Johnson & Christensen, 2004). But larger FGs are recommended for topics where researchers want to collect multiple brief comments and suggestions, whereas smaller FGs are recommended when researchers want to collect more detailed commentary or discuss complex or controversial topics (Morgan, 1997). As the objective of the research was to validate the proposed conceptual framework, a larger group was preferred to obtain multiple brief descriptions of the factors. The larger group was also divided into smaller groups of five - six participants to provide detailed discussion on the complexities of the factors of the AUM. .

The researcher planned the FG event in collaboration with Dr. Meghann Drury of New York University. Dr. Drury has extensive experience in conducting focus group sessions and worked internationally on projects involving decision-making, change, governance, agile team dynamics, and organisational change. A proposal to conduct the FG (*Let's Stay Agile: Applying the Framework for Agile Sustainability in our Teams*) was submitted to an international conference on agile software development ¹² in February 2012. On receiving the notification of acceptance in April 2012 from the conference organisers, the researchers started planning the event. The time allocated was 90 minutes. A FG protocol was developed (Appendix G) was developed to ensure consistency between the two researchers in scheduling the conduct of the FG, and in allocating discussion time for various sub-topics.

¹² AGILE2012, www.agilealliance.org, 13th – 17th Aug, 2012, Dallas, Texas, USA.

Information on the background, eligibility requirements for participation (e.g. two years working experience in agile projects) process/mechanics (goal, process), session outline (duration and time), and learning outcome was developed – this was made available on the conference website.

- *Selecting the participants*: the selection of representative, insightful, and motivated participants is critical to the success of the FG study. Depending on the research purpose, participants may be less or highly experienced in the topic of focus.

As described in the previous section, participants' were attendees at a professional software development conference with 1700+ attendees. Participants self-selected to attend this FG with a choice of nineteen other sessions offered at the same time. While this is a limitation of the FG, it does provide a FG with participants focused on learning how to sustain the use of agile methods in their teams and organisations and thereby a viable group to discuss the proposed CF. As can be seen from Table 2, the participants had a range of experience as some were beginners with agile methods while others had been working with agile for up to 25 years. They came from diverse backgrounds with varying industry sector experience with agile development. The FG was hosted in the USA, and although it was an international conference, all participants came from the USA. The FG participants included agile practitioners, and customer representatives, e.g. Product owners and BAs. But the researchers did not ask the participants to differentiate themselves based on role, or organise by role. Participants listed agile methodologies they use as Scrum, XP, Kanban, Lean or a combination of these four methods.

Table 5.2: Profile of Focus Group Participants

Criteria	Response
Number of Participants	29
Mean Experience with Agile Development	4.5 years
Least Experience with Agile Development	.25 years
Most Experience with Agile Development	25 years
Mean Size of Organisation	19,950 employees
Smallest Size of Organisation	1 employee
Largest Size of Organisation	100,000 employees
Mean Number of IT/Systems/Development Practitioners in Organisation	1,542 employees
Smallest Number of T/Systems/Development Practitioners People in Organisation	1 employees
Largest Number of IT/Systems/Development Practitioners People in Organisation	16,000 employees
Industry Segments	Consulting Defence Financial Services (e.g. Banking, Insurance) Government Health Care IT Manufacturing Transportation Travel

- *Conducting the focus group session:* the session should be carefully managed to cover all the required elements within the allocated time. The goals and rules of the session should be clearly explained at the beginning of the session. The moderator should be able to facilitate discussion by steering participants as needed, without influencing the discussion by allowing her or his own opinion. It is important to ensure that the contribution was correctly understood – this could be done by paraphrasing participant points to reconfirm.

In this study, the structure of the FG was an exercise and open discussion on sustained agile usage. The term “sustainability” was used to label the four broad categories that influence sustained agile usage as “Sustainability Factors”: Innovation, Sociological, Technological and Organisational factors. The stages of how innovations diffuse in an organisation were described first, followed by an overview of the framework for SAU. Specifically, the following topics were covered:

- Five stages of diffusion of innovation (adoption, adaptation, acceptance, routinisation and infusion)
- Sustained Agile Usage Model

After a brief presentation of the above-mentioned topics, the participants divided into five teams to conduct the activity to apply the AUM. The goal was for each team to discuss examples from their own agile teams that illustrate the sustainability factor assigned to their group. They discussed examples that either enhanced or hindered the sustainability of agile methods. The researchers had previously prepared worksheets for each group to write down their strongest example that enhanced and the strongest example that hindered the sustainability of agile methods. After the participants had completed this activity, the researchers facilitated the FG discussion on the responses written on each group's worksheet about their strongest example that enhanced and the one that hindered the sustainability of agile practices. If their examples did not fit their SAU factor or they had discussed a new, more appropriate factor, they presented this finding as well.

The session outline is shown in table 5.3.

All five groups participated in this discussion. Although it was a large group, this resulted in a lively and engaging discussion. The researchers conducted the FG in a responsive (Rubin & Rubin, 2005; Wengraf, 2001) and reflexive (Trauth & O'Connor, 1991) manner in order to follow up on insights uncovered mid-session, and adjust the content and schedule of the FG accordingly. To improve the reliability and repeatability of the research, a traceable 'audit trail' of the research process, from data collection through to the drawing of conclusions, was sought. The entire session was audio recorded.

Table 5.3: Focus group session outline

<ol style="list-style-type: none"> 1. Introduce the topic of agile assimilation and why agile sustainability is important (10 mins) 2. Present Framework for Agile Sustainability (10 minutes) 3. Facilitate activity where participants apply the Framework for Agile Sustainability by listing the key factors that facilitate sustained use and assimilation of agile practices on their agile teams (20 minutes) <ol style="list-style-type: none"> a. Divide participants into groups of 6-8 people ensuring that each group has a diverse range of roles, e.g., business analyst, Scrum Master, developers, testers b. Provide each group with large sticky notes, markers and flip charts. c. Have each group apply the Framework for Agile Sustainability. 4. Discuss best practices to sustain and assimilate agile usage (10 minutes) 5. Facilitate activity where participants list the key factors that constrain sustained use and assimilation of agile practices (15 minutes) 6. Present best techniques and mechanisms that have helped other teams in overcoming constraints to achieve significant improvements in agile systems development outcomes (20 minutes) 7. Provide conclusions and contact details for participants who would like more detail on how to develop mechanisms to sustain and achieve assimilation in their organisations (5 minutes)

- *Data analysis and reporting:* qualitative data analysis methods can be used to analyse and reported focus group data.

The FG protocol based on the SAU model provided a list of “intellectual bins” or “seed categories” (Miles and Huberman 1999) to structure the data collection and the open coding stage of data analysis. The participants were divided into five teams to represent the four main categories of the SAU model: innovation (2 teams), sociological (1 team), technological (1 team), and organisational (1 team). There were two teams assigned to the innovation category because there were enough participants for an additional team. The innovation category was the most challenging and so the second team was assigned to this category. The goal was for each team to discuss examples from their own agile teams/organisations that illustrate each factors relating to the category assigned to their group. If their examples did not fit their SAU factor or they had discussed a new, more appropriate factor, they were asked to present this finding as well.

While one researcher facilitated the session, another listened, observed and took notes. The researchers then switched roles to account for any variance between their note-taking and questioning. In any cases of ambiguity, clarification was sought from the attendee during the FG.

In order to aid analysis, the written worksheets were transcribed and the FG was both recorded and transcribed, generating a total of thirty-six pages of data that were then proof-read, annotated and coded by the researchers using NVivo¹³ software. The data (i.e. sustainability factors and examples of those that enhanced and hindered agile sustainability) were also emailed to all participants for feedback and validation. No participants sent edits or changes to the data, except to comment on the usefulness of having the data for their work at their own organisations. Finally, the researchers vetted the data, whereby results and interpretations were discussed with professional colleagues to avoid the problem of what Kaplan and Duchon (1988) call multiple realities. In terms of the analysis, the FG questions and subsequent analysis were based on the SAU to understand the factors that impact sustained usage of AMs.

5.4. Evaluation criteria for qualitative research

In terms of the evaluation of more general qualitative research, validity and reliability are most often used to evaluate the quality of qualitative inquiry (Yin, 1994). These evaluation criteria are discussed in Chapters 3 and 4. Particular philosophical underpinnings or theoretical orientations and resulting methodological commitments for qualitative inquiry will require different criteria for evaluating validity and reliability (Patton, 2002). With increasing popularity of interpretive research in IS, a debate has developed on how its quality can be evaluated (O'hEocha et al., 2010). O'hEocha et al. (2010) provide a summarised review of the major contributions to this debate. This review (briefly summarised below) is used to provide rationale for the selection of evaluation criteria that was deemed most suitable to assess the focus group method used in the current study:

Early interpretive research borrowed quality criteria from well-established positivist tradition that broadly assesses validity and reliability at various levels of granularity and specificity. Eminent scholars in qualitative and case study research offered operationalised versions of these criteria (Miles & Huberman, 1994; Yin, 1994) which have been adopted by qualitative

¹³ Qualitative Data Analysis Software Package (<http://www.qsrinternational.com/>)

researchers (Johnson, Buehring, Cassell, & Symon, 2006). These well-established criteria though pervasive are not optimal, and therefore have failed to guide research design and execution appropriately (O'hEocha et al., 2010). This weakness is defended in the literature by using three distinct responses (O'hEocha et al., 2010):

- (a) Application of these criteria is seen as restricting the freedom and creativity of the researcher and limiting possibilities of the research, and resisting the change which characterizes the progressive nature of research itself.
- (b) Extending existing criteria for validity and reliability by sub-categorisation. For example, validity has been extended from the popular forms of construct, internal, and external validity to more specific forms such as 'successor', 'catalyst', and 'ironic' (Altheide & Johnson, 1994).
- (c) Using alternate criteria which are not explicitly based on validity and reliability. Walsham (2006) refers to two such alternate schemes (i) use of authenticity, plausibility and criticality (Golden-Biddle & Locke, 1993), and (ii) seven principles for conducting and evaluating interpretive field studies (Klein & Myers, 1999).

However, there is considerable ambiguity in how the various proposed criteria should be applied and therefore there is a lack of universally accepted criteria for evaluating qualitative inquiry (O'hEocha et al., 2010). Some well-established and comprehensive evaluation frameworks such as Klein and Meyers (1999) provide a more holistic view of evaluating the quality of the research as a whole. In the current study, the quality of each method is evaluated using a set of criteria specific to that method. For example, in Chapter 4, overall conduct of the case study approach was evaluated using the case research design quality criteria proposed by Dubé and Paré (2003). Therefore, a framework that addresses the specific method, i.e. FG technique was favoured rather than the complete method, and the wider aspects of the relationships between data collection, design, and other factors were considered at the end of each research cycle. Secondly, as discussed in Chapter 2, the main epistemological nature of this research is based on positivism. Therefore, evaluation frameworks which relate directly to the design and conduct of focus groups were sought from the literature. O'hEocha et al. (2010) identify two FG evaluation frameworks (Merton et al., 1990; Sim, 1998) which are briefly described below. Later the FG method used in this study is evaluated using the criteria proposed by (Merton et al., 1990), because of its prominence in the literature and its provision of more extensive operationalisation details.

5.4.1. Focus group evaluation criteria – Sim (1998)

Sim (1998) identify three criteria that are of particular importance to FG method: Issues of consensus and dissent, strength of opinion, and generalisation.

Issues of consensus and dissent

Group discussion and interactions, and emergence of dissonant views contribute significantly to the richness of FG data. However, not all viewpoints may be expressed; for example, apparent consensus may reflect only the views of dominant personalities, whereas participants who are less articulate or less confident may not share their viewpoints. Similarly, dissent and polarisation effects may merely reflect the group dynamics rather than the various views held by participants. Using techniques such as homogeneous group (in terms of knowledge, experience), skilful questioning by the moderator (Asbury, 1995), and asking participants to write down their views (techniques used in this study) may help in reducing such effects (Albrecht, Johnson, & Walther, 1993).

Strength of opinion

As discussed in the previous criteria above that various viewpoints may be a reflection of the group dynamics, it would be misleading to enumerate the occurrences of a particular viewpoint and attributing it to the strength of a viewpoint.

Generalisation

FG data is contextualised within a specific context of interaction and may not be applicable to another situation or context. In addition, a FG is likely to elicit ‘public’ accounts from participants, in contrast to the more ‘private’ accounts such as that which might emerge from an ethnographic interview. However, theoretical generalisation is possible where findings can be transferred from one context to another similar context.

5.4.2. Focus group evaluation criteria – Merton et al. (1990)

The four criteria proposed by Merton et al are Range, Specificity, Depth and Personal context. Each criterion is described first followed by an evaluation of the FG method used in the current study.

Range

Broad range of topics that are of interest to the participant should be discussed rather than that of researcher's interest. Directed research questions reflect the researcher's focus of interest and may imply certain interpretations and suggestions.

The FG in the current study involved participants from various organisations with an average agile experience of 4.5 years. Though the FG protocol (based on the SAU model) was used to guide the conduct of FG, it was used carefully. The framework was expressed as a set of factors where each factor was addressed in turn with strong demarcation as the discussion moved from one to the next. Due to the written input method used, each group (note that the participants were divided into five groups - see section 5.2.2) was encouraged to write down factors that were not currently included in the framework. This allowed sufficient flexibility for the sub-groups to identify factors they saw was relevant. Both moderators were familiar with the domain of inquiry and were attentive to both the explicit and implied content of the discussion. One of the moderators was an expert in conducting focus groups who moderated the session through "nondirective moderation" (Merton & Kendall, 1946).

Another common criticism of FG research is that the discussion between participants are usually ignored both in reportage and analysis (Wilkinson, 1998). In the current study, though the entire session was recorded and transcribed, the written input from each of the five groups was the main data used for analysis. More attention to better management of timing and monitoring individual group discussion would have significantly improved the range and depth of data collected.

Specificity

Participants' experiences and perspectives must be captured rather than just opinions (Merton & Kendall, 1946). It is also argued that participants should be allowed to interpret experiences which may help in reducing researcher bias (Hines, 2000). In the current study, moderators presented best techniques and mechanisms that have helped other teams in overcoming constraints to sustain agile usage and therefore achieve significant improvements in systems development outcomes. In a similar way, participants were also encouraged to discuss specific examples to illustrate their opinions and perspectives. However, due to insufficient time, sticky notes and flip charts could not be used as planned due to time constraints. This may have

restricted the contribution of specific input and even biased written responses to be more abstract and subjective (O'hEocha et al., 2010).

Depth

Participants should feel emotionally and politically safe, i.e. a context is established that enables revelatory and reflective elicitation of input from participants than just describing experiences or events. Depth of data refers to the extent of self-revelatory input rather than descriptive input from participants. This was easier in the current study as the participants were experienced practitioners who were very passionate and interested in the topic area, i.e. sustained agile usage. The participants were encouraged to provide critical and reflective input and feedback on the issues related to the topic. Safety was also achieved to some extent as written feedback in worksheets was the primary method of accepting input from participants. Moreover, though flip charts, post-its, etc., were provided to each group, due to time constraints, participants did not write anything in their own handwriting on the wall charts etc. which might have added to them feeling safer. Emphasis on specific factors and sub-topics and illustrations from other cases also helped in achieving depth.

Personal context

Personal context relates to characteristics such as roles (e.g. developer, BA) of individual members, their skill, experience etc. Most FG literature advocates the use of homogeneous groups randomly selected from the population (Merton et al., 1990; Sim, 1998) which helps in easier identification of the differences and convergences which can lead to deeper insights. The personal context plays an important role in effective interpretation of the input data.

In the current study, the participants represented a sample of experienced agile practitioners mainly from the USA who self-selected to participate in the FG. They differed in roles, experience among other factors (see table 5.2). However, the groups were homogeneous based on the fact that almost all participants had high levels of technical knowledge and experience in using AMs and were homogeneous in that respect. The study was evaluating a framework on sustained agile usage that focused on the whole AM rather than a specific method such as XP or Scrum. The participants' were not asked to differentiate or organise themselves into groups based on role.

In order to consider the effect of personal context on the data during the data analysis phase, it is important to attribute quotations and other input to individual group members (Sim, 1998).

The current study did not have any mechanism that allowed attribution of both written and verbal input. Such mechanisms must also be integrated with an approach that provides broader context to the input, i.e. which places each written contribution in terms of specific questions or categories or discussion topic which triggered it (O'hEocha et al., 2010). However, this was not considered in the current study, and therefore the findings cannot be considered entirely reliable.

5.5. Semi-Structured Interviews

5.5.1. Background and introduction

Interviews are one of the most important data gathering techniques for qualitative researchers and are used in all kinds of qualitative research (positivist, interpretive, or critical) (Myers & Newman, 2007). Though they are most commonly used in case study research, they are also popular in other methods such as action research, grounded theory studies and ethnographies (Myers & Newman, 2007; Yin, 2003). According to Rubin and Rubin (2012), interviews are like night goggles which permit us to “*see that which is not ordinarily on view and examine that which is looked at but seldom seen*”. However, in IS research, interviews have remained an unexamined craft, and very little guidance is available to those seeking to employ it as a research method (Myers & Newman, 2007). Case study method is a well-established context in which interviews are most commonly employed. In the current study, case study method is one of the major research methods employed (Chapter 4 – where semi-structured interviews were used as the main data collection technique), and therefore well-established methodological guidelines for the conduct of interviews were already established. These guidelines were utilised while conducting the interviews in this phase.

Interviews can be broadly classified into three basic types: *structured*, *unstructured*, and *semi-structured* interviews (Myers, 2009; Runeson & Höst, 2009):

in a *structured* interview the questions are pre-formulated and all questions are asked in the same order as in the plan and is very similar to a questionnaire-based survey.

in an *unstructured* interview, the questions are not pre-formulated. They are based on the interests and concerns of the researcher and the conversation develops based on the mutual interests of both the researcher and the participant.

Semi-structured interviews involve the use of some pre-formulated questions, but there is no strict adherence to them. They allow for improvisation and exploration of the studied objects.

The *semi-structured* provides the benefits of both (i.e. *structured* and *unstructured*) approaches – it provides some structure, and also provides the interviewee the opportunity to add important insights as they arise during the conversation (Myers, 2009). This approach allows both the interviewer and the interviewee the flexibility to change and adapt depending on the depth of probing and discussion as necessitated during the interview process. Semi-structured interviews method is therefore the most commonly used method in business and management studies (Myers, 2009). The different types of interviews are summarised in table 5.4

Table 5.4: Types of Interviews: adapted from (Myers, 2009; Runeson & Höst, 2009)

	Design and conduct	Objective
Structured interviews	The use of pre-formulated questions, strictly regulated with regard to the order of the questions, and sometimes regulated with regard to the time available.	Descriptive and explanatory
Semi-structured interviews	The use of pre-formulated questions, but no strict adherence to them. New questions might emerge during the conversation.	Exploratory and explanatory
Unstructured interviews	Few if any pre-formulated questions. In effect interviewees have free rein to say what they want. Often no set time limit.	Exploratory

In the IS discipline, case studies and semi-structured interviews are considered appropriate where research and theory are in their early formative stages (Benbasat et al., 1987). They allow investigation of an IS phenomenon such as sustained agile usage as perceived by its practitioners and users, gain understanding of actual processes in practice, and enable carrying out research in which few previous studies exist.

In the current study, the above situation is applicable for the following reasons:

- (i) Sustained agile usage is a field of research with an observable paucity of empirical studies (Abrahamsson et al., 2009)
- (ii) Agile usage is flexible, highly adaptable, and the field is constantly changing. Eliciting useful and relevant information, and learning from the insights and experiences of actual practitioners' provides a strong foundation for establishing a body of knowledge

- (iii) Due to lack of conceptual and theoretical foundations (Conboy, 2009; Wang et al., 2012) there is a great need to build good theories for explaining actual agile usage. Semi-structured interviews are an acknowledged way of uncovering theoretical concepts relevant to practitioners

Semi-structured interviews are valuable in providing the depth of information and the method is an effective qualitative research strategy when carried out methodically and rigorously. In-depth, personal face-to-face interviews are a technique well suited particularly for exploratory research such as this because it allows expansive discussions which illuminate factors of importance (Yin, 2003; Oppenheim, 1992). Its main characteristics, i.e. individual responses as source of data, the researcher's main role in data collection, and focus on stakeholder perspectives and perceptions matched the requirements of the current study (Dubé & Paré, 2003). It served as a complementary technique to the FG method - though the two methods were used in sequence, i.e. FG followed by interviews, the purpose of using the two methods was complementary. For example, analysis of findings from the interviews was not used to add to the interpretation of the previously conducted FG, but rather to seek different insights and information on sustained agile usage from different sources. The objective was to compare across different types of evidence and the literature, and to be able to generate less biased, valid and reliable theory (Eisenhardt, 1989). To provide further illustration of the SAU factors that were validated in the FG, the factors were explored in more detail by conducting twenty face-to-face semi-structured interviews.

5.5.2. Semi-structured Interview: Design

The design of semi-structured interviews can be broadly classified into three main categories: *descriptive*, *exploratory* or *explanatory* (Gable, 1994b). Descriptive interviews are used to provide a rich description of a phenomenon as perceived by individuals (Yin, 2003). The objective is to gather multiple individual perspectives in order to generate a comprehensive conceptualisation of the phenomenon under investigation (Cavaye, 1996). Exploratory interviews are typically employed to propose new theory constructs and/or build or refine theories (Wang et al., 2012). They are usually used to generate propositions or hypotheses based on the interpretive understanding of the observed concepts and relationships (Benbasat, Goldstein, & Mead, 1988). Explanatory interviews are used to determine or confirm postulated relationships and causal links between concepts or constructs in causal studies (Yin, 2003).

In the current study, semi-structured interview method is used in both an exploratory and an explanatory manner. In an *exploratory* manner, the method is used both to validate and enrich the constructs developed in the conceptual framework (SAU) with information from practitioners about the sustained use of AMs in contemporary agile settings, i.e. to uncover notions and concepts relevant to real-life practice. In an *explanatory* manner, the method is to gain preliminary insights to evaluate the proposed propositions on the relationships between the various factors and SAU, and also between SAU and agile usage effectiveness.

Based on the underlying epistemological assumptions, semi-structured interviews can be classified into the two broad traditions: i.e. positivism and interpretivism. Interpretivism and positivism rely on relatively contrary set of beliefs and assumptions on the nature and construction of knowledge (Cavaye, 1996). However, due to the versatile nature of the interviews method, they can be employed in both research traditions (Lee, 1989). From an interpretive perspective, semi-structured interviews can be used to gain insights on the complex phenomenon under investigation and any ostensibly irrational processes related to the phenomenon. From a positivist perspective, semi-structured interviews are typically used to gather information on individuals' perceptions and attitudes towards the proposed factors, constructs, and relationships. As previously discussed in Chapter 2, though the current study is predominantly based on the positivist paradigm (Benbasat et al., 1987; Lee, 1989; Yin, 1994), interpretive principles and guidelines are followed where appropriate.

Another important factor that needs to be taken into consideration in the design of semi-structured interviews is the different types of roles to be interviewed. It is good to interview a variety of people representing diverse views in order to obtain a certain breadth of opinion (Myers, 2009). Finding different types of participants is called 'triangulation of subjects' (Rubin & Rubin, 2005, p. 67). "Triangulation of subjects is a broader version of Miles and Huberman's injunction to avoid bias" (Myers, 2009, p. 133). In agile projects, a number of different stakeholders are involved (e.g. developer, Scrum Master, project manager, AC, Product Owner, BA), each of which will have their own perspective on the use of AMs. Therefore, in order to obtain multiple perspectives on the various factors and issues related to sustained agile usage, a variety of different roles were interviewed.

While interviews have specific benefits of being targeted and insightful, they are also associated with weaknesses and challenges such as reflexivity (the interviewee responds with what the interviewer would like to hear), inaccuracy, and response bias due to poorly

constructed questions (Myers & Newman, 2007; Rubin & Rubin, 2005; Yin, 2003). A summary of the main problems and difficulties associated with interviews is summarised below (Myers & Newman, 2007):

- Artificiality of the interview – interrogating someone who is a complete stranger; asking participants to give opinions under time pressure
- Lack of trust and time – lack of trust implies concern on the part of the interviewee with regard to how much the interviewer can be trusted. The interviewee may choose not to divulge information that he or she considers “sensitive”. Lack of time may mean incomplete data collection
- Level of entry – the researcher’s level of entry may have an impact on conducting interviews at other levels. For example, if a researcher enters at a lower level, it may be difficult to interview someone at a higher level, e.g. senior managers
- Elite bias – concerns overweighting data from articulate, high-level informants, and, conversely, under-representing data from less articulate, lower-level informants. This might have a negative impact on obtaining a broader view of the phenomenon under investigation
- Hawthorne effects – qualitative interviews are intrusive, i.e. the researcher’s intrusion on the social situation and setting may interfere with people’s behaviour
- Ambiguity of language – the meaning of our language is often ambiguous, and it may not be always be clear that the participants correctly understand the questions

However, semi-structured interviews, if conducted meticulously, will automatically address some of the above limitations. For example, semi-structured interviews are less intrusive to those interviewed as they provide opportunity for interviewees to ask questions of the interviewer. When the interviewer interviews in a congenial and conversational manner, the participants may feel more comfortable to discuss sensitive issues. In summation, the relevance and benefits of using semi-structured interviews method in the current study far outweighed its limitations and therefore was deemed a valuable method for collecting data. Prior empirical studies on agile methods in the literature have also used interviews as the main data collection method, mainly with agile practitioners (Mangalaraj et al., 2009a; Wang et al., 2012). In the current study, a combination of a FG and semi-structured interviews method contributes to the qualitative part of data collection in the overall research plan, i.e. to use qualitative data in preparation of the quantitative study (survey).

5.5.3. Semi-structured Interviews: Conduct

Myers and Newman (2007) suggest seven guidelines to be followed for conducting good qualitative interviews. The seven guidelines are briefly described below. The interview method used in the current study is evaluated by each guideline.

Situating the researcher as actor:

The interviewer should “situate” themselves as well as the interviewee before the interview takes place. Interviewing that establishes a relationship with the interviewee consists of three main types of questions: main questions (to begin and guide the interview), probes (to clarify an answer or ask for further examples), and follow-up questions (to pursue implications of answers to main questions) (Rubin & Rubin, 2005).

In the current study, a similar format was used to conduct interviews: the researcher (interviewer) first introduced herself (job, background, purpose of research) at the beginning of an interview session. Then the purpose for the interview was explained, confirming if the interview details were clear and checking if the interviewee had any questions before commencement. This information was included in the ‘Commencing Interviews’ section of the interview protocol (Appendix B), which included the following:

<thanks and appreciation for agreeing to participate>

<introduce interviewer, background, purpose of research>

<give participant information sheet>

<check understanding - ask if they had any questions or clarifications>

<obtain written consent – includes permission to record>

<begin>

In summary, an attempt was made to create a receptive atmosphere in order to make the communication as open as possible (Holstein & Gubrium, 1995).

Minimise social dissonance

Minimising social dissonance refers to reducing the social distance between the interviewer and the interviewee to improve the quality of disclosure.

A large amount of time was spent in planning and preparing for the interviews. After receiving confirmation of participation, background information on the research study was sent to every participant. Background information (role in the organisation, agile experience) of every participant enabled the researcher to be better prepared for conducting interviews with different types of people. During the interview, care was taken to ensure that the participant was comfortable at regular intervals of time: for example, the researcher checked the time regularly to ensure that it could be stopped any time they wished. In some sensitive cases, for example, when the interviewees became emotional, attempt was made to encourage them in a positive manner. For example, one BA who had been feeling very inferior in her current position in an agile team started crying during the interview. The researcher encouraged her by saying, “I totally understand how you feel.... its ok we can stop now”, after which the interviewee felt better and started disclosing more details about the situation in her team.

Represent various “voices”

It is important to interview a variety of people, where the idea is not to force one voice to emerge. In the present study, participants belonged to a range of different roles and positions in their organisations. A table of interviewees with their organisational positions is shown in table 5.5.

Everyone is an interpreter

This guideline recognises that the participants are creative interpreters of their worlds as interviewers are of theirs.

Though attempt was made to understand and interpret the perspectives of both the researcher and the participants when appropriate, the scope and focus of investigation of the current study did not require interpretive understanding of complex meanings, relationships, or human sense-making processes from an interpretivist perspective.

Field notes were taken by the researcher during the interviews in addition to recording the interviews. Any clarifications were checked with the interviewee immediately after the interview or via email within the subsequent few days. The objective was to clarify and extend meanings of interviewees’ statements without changing their original intended meaning. However, the researcher was the single person managing this process which was found to be challenging at times. The field notes were later compared with the transcripts during the data

analysis phase in order to establish reliability and validity of the interpretations and conclusions drawn.

Mirroring in questions and answers

Mirroring is using the words and phrases the participants in subsequent questions or comments. The idea is to focus on using the language of the interviewees rather than imposing their own. The role of the interviewer involves listening, prompting, encouraging, and directing the conversation. It is a good practice to use open rather than closed questions, and move from general to the specific.

In the present study, the above concepts were taken into account by following three guidelines suggested by (Kvale, 1996): (a) allow participants to complete, tolerate pauses and give sufficient time for them to think and reflect (*be gentle*) (b) be empathic and listen actively (*be sensitive*) and (c) relate what is said to previous statements and use it in subsequent questions (*remember and integrate – mirroring*)

Flexibility

The interviewer should be prepared to explore interesting line of research which requires flexibility, improvisation, and openness in the interviewing technique. This requirement was taken into account in the current study by means of the interview structure that allowed for follow-up questions and explorative probing to what the interviewee said, i.e. recognise and respond to what is important to the interviewee (Kvale, 1996).

The questions during the interviews were largely open-ended, allowing respondents freedom to convey their experiences and views (Oppenheim, 1992a; Yin, 2003), and expression of the socially complex contexts that typically underpin software development. Where participants suggested new factors that influence SAU beyond the factors in the model, they were asked to provide supporting evidence or examples to supplement their point, thus allowing the researcher in the analysis of the data to distinguish between opinions and actual practice. In any cases of ambiguity, clarification was sought from the interviewee, either via telephone or email.

Confidentiality of disclosures

Researchers should keep all transcripts, audio recordings, and any tools and technologies related to the interviews confidential and secure.

To address the ethical issues relating to conduct of interviews such as i) confidentiality of the interviewees and of the data, and ii) informed consent of the interviewees, ethical clearance was obtained prior to conduct of the interviews (Patton, 1990). Permission was sought from each participant in the form of written consent on their willingness to participate, audio-recording, and how and where their responses would be used. Participants were assured that their names would not be attributed in any subsequent reports or publications. Appendix F presents the complete information and consent package, which addresses the confidentiality and security issues.

5.5.4. Semi-structured interviews – Quality Measures

Semi-structured interviews method is an excellent means of gathering data (Myers & Newman, 2007). However, it is not straightforward as it appears, and good interviews are difficult to conduct (Myers & Newman, 2007). Semi-structured interviews are predominantly used in the context of conducting case studies. While methodological guidelines for conducting case studies have proliferated over the years (Benbasat et al., 1987; Lee, 1989; Myers & Newman, 2007) (case study design is discussed in Chapter 3, section 3.3), there are very few well-established guidelines for conducting actual interviews.

In order to generate valid and reliable knowledge from the collected data, it is important for empirical research designs to ensure that the data is valid and reliable. There are mainly two measures of good research design (Leedy & Ormrod, 2001): *validity* is concerned with whether the data collected really measures the proposed theoretical constructs whereas *reliability* relates to the consistency with the application of the research model or framework. Four tests are usually performed to ensure validity and reliability of a good research design (Yin, 2003):

1. *Construct validity*: identifying correct operational measures for the phenomenon being studied. Three basic tactics from case study research can be used to ensure construct validity: (i) use multiple sources of evidence (ii) establish chain of evidence, and (iii) have key informants review the draft findings.

In the present study, construct validity is ensured by using two specific measures: 1) deriving the factors and constructs in the SAU conceptual framework from well-established theoretical frameworks, and 2) using multiple sources of evidence in that a wide range of agile practitioners' with different backgrounds, roles and positions were

targeted for the interviews. During the analysis phase, well-established guidelines were followed to ensure validity of the findings.

2. *Internal validity*: establishing a causal relationship, whereby certain conditions are believed to lead to other conditions, as distinguished from spurious relationships.

Internal validity is applicable only to the explanatory purpose of semi-structured interviews, and is not relevant to exploratory or descriptive purposes. The suggested tactics to pass this test are: pattern-matching, explanation building, addressing rival explanations and using logical models, all of which relate to the data analysis phase of research. However, in preparation for data collection and analysis, these tactics were built into the research design, for example, to anticipate and consider rival explanations, to check for cohesive evidence, etc.,

3. *External validity*: defining the domain to which a study's findings can be generalised. The suggested tactics to pass the test for external validity are using theory and replication logic during research design. In the current study, the theoretical framework derived from well-established theories is being used as a foundation to derive the interview protocol. In addition, as studies using semi-structured interviews rely on analytical generalisation rather than statistical generalisation, interview participants were drawn from multiple organisations.
4. *Reliability*: demonstrating that the operations of a study – such as the data collection procedures – can be repeated with the same results.

To ensure reliability of the data collected, a semi-structured interview protocol is developed. The protocol provides consistency to the format, structure, and conduct of data collection across all participants and participating organisations thereby increasing the reliability of the data. Though in the current study only one researcher was involved, the protocol assists in maintaining consistency if other researchers were to be involved or if it is to be used in other studies. All interview data is recorded, transcribed, and stored in an interview database.¹⁴

As discussed above, all interviews were conducted using the structure specified in the interview protocol.

¹⁴ The interview database is available upon request

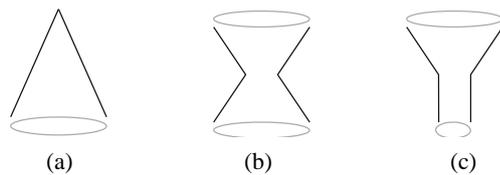


Figure 5.3: General principles for interview sessions (Runeson & Höst, 2009)

Interview sessions can generally be structured using three principles (Figure 5.3) (Seaman, 1999): (a) the pyramid model begins with specific closed questions and then uses open questions, whereas (b) the hour-glass model starts with open questions, is structured in the middle, and then uses open questions during the end of the interview (c) the funnel model starts with open questions and moves to specific ones. In the current study, the sessions were mostly structured in an hour-glass model, i.e., it was open-ended in the beginning of the session, i.e. introduction, capturing participant demographics and background information, and any other details that the participant wanted to share or clarify. After this, the semi-structured questionnaire approach was followed to explore and discuss various issues and factors relating to post-adoptive usage of AM. Last, an open discussion followed, using a set of open-ended questions, on sustained agile usage, and any other factors that might influence its effective usage. This approach enabled the researcher not only to gain insights on the factors and relationships proposed in the model but also to obtain new views/opinions or factors that impact sustained agile usage.

The interview design consisted of five organisations and overall twenty interviews. The participants were purposefully drawn from a pool of agile teams from a range of organisations with which the researcher had established contacts at the time. Participants from a wide range of roles such as developers, BAs, project managers, SMs, and IT service delivery managers were targeted, including stakeholders from the business unit and management. The average experience of participants working with agile methods was 4 years. The selected organisations ranged from banking and retail (Org B), insurance (Org D), governmental bodies (Org C) to consulting and professional service providers (Org A).

All twenty interviews were conducted in person by the researcher. They were conducted separately from the case studies, i.e. after the completion of the case studies. Interviews ranged from 60 to 90 minutes. In order to aid analysis of the data after the interviews, all were recorded, and subsequently transcribed, proof-read and annotated by one of the researchers. Table 5.5 shows the profile of the interviewees.

Table 5.5: Profile of Interview Participants

Industry Sector	Roles Interviewed
Independent Agile Practitioners (Org A)	Agile Coach (1) Scrum Master and Lead Architect (1)
Banking and Retail (Org B)	Business Analyst (1)
Government organisation (Org C)	Developers (4) QA (1) Business Analyst (2) Scrum Master (2)
Insurance (Org D)	Developers (2) Business Analyst (2)
Government organisation (Org E)	IT Delivery Manager (1) CIO (1) Product owner (1) Project Manager (1)

5.6. Data collection and analysis

A semi-structured interview protocol based (Appendix B) was used to guide data collection. The questions were largely open-ended, and the participants were given the opportunity to openly discuss and identify any other constructs or measures relevant to SAU. For this reason, participants were asked about any key projects, key milestones, resources, as well as any critical challenges that they perceived to have significant impact on sustained agile usage. As interview results accumulated, analytical induction methods (Miles & Huberman, 1999) were used to identify and classify the themes into nodes, which is the term to indicate a node in NVivo. Isolating the nodes required constant iteration between the data and the emerging set of factors – a process known as dialogical reasoning (Klein & Myers, 1999) was used to identify similarities and differences across the study data and the final set of factors. Factors that were consistent in clearly explaining their impact on effective and sustained usage were selected as critical factors.

Next, the constant comparison method (Gallivan, 2001; Patton, 2002; Strauss & Corbin, 2007) was used to identify similarities and differences across FG and interview data sets and any consistent themes or patterns found relevant to impact SAU were identified. The initial set of nodes was refined as the analysis evolved, and new nodes were created for any potential new factors that were identified during the process. The coded constructs were re-analysed to ensure that they belonged to the correct node. In summary, the coding of the FG and interview data

was conducted in two main stages: Stage 1: coded any direct or implied existence of the SAU factors within the data, simultaneously identifying any new factors. Stage 2: analysed the information already coded within stage 1 (extracting the information coded under each of the factors) to confirm the appropriateness with the categorization.

5.6.1. Findings

The integrated findings from both the FG and interviews method is described in the following sub-sections under each of the four main factors of the AUM.

5.6.1.1. Innovation

Scrum was the main AM used by most of both the FG and interview participants. While some mentioned using a structured method such as waterfall, most participants had been effectively involved with small scale development, and so were used to highly iterative approaches prior to adopting Scrum.

FG participants encountered some problems in interpreting the meaning of the term ‘innovation’ used for this category. As discussed in Chapter 2 ‘*agile*’ can be classified as an ‘innovation’ based on innovation diffusion theories such as DOI. As the focus of the current study is on the sustained use of AMs, the term ‘innovation’ was used to represent the actual practice ASD, i.e. continued practice based on acceptance of AM by practitioners. However, FG participants assigned to this category (refer to section 5.3.2) interpreted innovation as “*innovating the innovation*” or “*continuing to innovate*” by highlighting that the term “innovation” in an agile context refers to the use of newer agile practices and newer ways of doing things. For example, some FG participants explained how the use of contemporary technologies such as modern rooms, and sophisticated audio and visual equipment including cameras supported the effective use of agile practices in their organisation. Others referred to the newer innovative agile practices such as DevOps, Adaptive leadership, and Kanban, and advantages of new design techniques using agile architectural practices and technical practices.

Some FG participants also encountered problems understanding the meaning of the construct, i.e. *relative advantage* assigned to this category, i.e. whether it refers to the relative benefits in comparison with predecessor structured methods such as waterfall or to any previous methodology including agile. This had to be clarified during the discussion that it referred to any predecessor method (including other agile method) that led to improvements in development outcomes as a result of sustained usage.

There was a general consensus among both FG participants and interviewees about the significance of *relative advantage* and *compatibility* on sustained usage of AM. FG participants discussed how compatibility issues relating to disparity in tools used by different vendor partners, different internal teams, and the presence of both agile and non-agile teams within an organisation, hinders effective usage of agile practices. Some participants identified the agile process as a “more natural way of working” in comparison to traditional methods. For example, AC (Org A) commented on how most of his teams felt agile was a

“far nicer, friendlier, less pressurised way of working....we know the process that we are using and we tend to deliver to the business on time and they seem to be happier with us”.

The positive benefits of maintaining the agile process and effectively moving it into its post-implementation existence was highlighted,

“..because essentially in agile environment you start with nothing and maintain the system into its existence, that does have one advantage though – it has a very big advantage that the process is sustainable across the ‘go live’ boundary, because essentially you start with nothing and maintain the system into existence-software is the thing and you are building it, (I overstated it, but you know what I mean) it means as you cross the “go-live” boundary nothing changes, but you have been maintaining this thing into its existence and when you cross the go live boundary, and you just continue to use the same techniques and mechanisms to maintain it, that is a positive...” Scrum master (Org C).

5.6.1.2. Sociological

FG participants discussed the influence of team composition and whole team involvement on effective agile usage. The impact of team involvement was also repeatedly brought up by many interview participants which is well reflected in the following statement,

“ .. it needs to be a team that kind of works together, so you can have professional disagreements and robust professional discussions but there's nothing personal involved in the team; So that's the composition of the team, is really critical in there; co-location, so not keeping the IT team intentionally separate from the rest of it, actually bringing that team together as a whole; that is very, very important, I think. So its agile practices right across how that team is actually set up, it's not just the tool

that is used to measuring and monitoring and planning the actual development work, or project work; So, yeah, a real team culture, so co-location and being able to get the right mix of people together; that's really important...”(Project Manager, Org E).

The essential characteristics of such a team were described using concepts such as “agile mindset”, “agile mentality”, “inclusiveness, unselfishness and emotional intelligent awareness”, “team sport”, “team spirit”. An experienced AC (Org A) explained,

“for example, in one situation, they've been coaching the Subject Matter Expert and everyone's saying, “ ___, you're doing such a good job”, and the BA who was actively involved said, “ “But it's me! It's me that's doing it!” And she's going, “he's getting all the praise,” and I said, “You become the glue. If he is successful you're successful,” so it's moving from an individual culture to a team culture”.

The above statement highlights the significance of ‘team focus’ and ‘team commitment’ rather than ‘individual focus’ or ‘individual mindset’, (i.e. people who can truly think and work as ‘teams’ rather than as ‘individuals’) on sustained agile usage. Without such mentality, resistance builds up resulting in dysfunction within teams and people start reverting back to their old traits, especially under pressurised conditions. The findings also suggest that in order to build such agile teams, it is critical that people feel valued in their environments,

“So I think the whole thing at a sociological level is: Will people still feel good about working in this new way? And it moves from being an individual and optimising the outputs of the individual, to optimising the outputs of the team, the program or the business unit and then the organisation.”(AC, Org A).

Findings also revealed that ‘experience’ generally relates to a person’s overall experience in a job role or organisation which might not necessarily include working experience with agile, and in some cases might have a negative impact on SAU

“the more experienced people are, it's interesting on the one hand in my experience, people have more confidence because they have been a bit around and seen and so sometimes they can be open to try something new, on the other hand, it might be that if they have experience, then they don't want to change, and in that way experience might work against agile use” (Developer, Org D).

Most participants felt that it is more important to have a team culture that reflects agile values and principles, and an agile mind set (discussed above) rather than ‘n’ number of years of experience in systems development. It was believed that such an agile culture and mindset can only be developed/cultivated by using AMs consistently over a long period of time, i.e. gaining ‘*agile experience*’. Participants said that most of their teams lacked members with strong ‘*agile experience*’ and this was perceived to have an impact on agile usage,

“I’d say the bulk of the people who have worked on the projects would be at an average level, with maybe only a couple of people I would consider to have advanced practical knowledge of really strong understanding of using Scrum..” (lead developer, Org C)

who also explained how losing experienced agile staff for newer members with no agile experience had a negative impact on sustaining agile behaviours in a number of different teams and projects in their organisation :

“We have new Project Managers coming on that don’t know agile. You’ve got testers coming in, BA’s that have never done agile. I might have a couple of Developers that work... we had a really good experience when we started up here; we did it really, really well. I had another woman Developer who took it, some people just gravitate to it when they get it. And now all those people are gone say and now we’re just left with a couple that are on the fringes or those that are less dynamic. So now we’re having a real... and to make it sustainable you sort of need these people who are living and breathing it”.

Another concept that emerged from both the FG and the interviews was the benefits of using an AC. For example, the lead developer at Org C commented on the significance of having a formal coaching role to facilitate the effective use of AMs and improve the process, The absence of dedicated roles such as AC was perceived to have a significant negative impact on many teams in Org C which either started degrading to their previous traits or leading to ineffective use of agile practices. This perception was also echoed in the FG, *“the best way that we know of right now to create and maintain high performance teams is to have a coach”*. Comparing software intensive systems development to a high performance sport, an AC explained

“if I were to say, “What’s the number one factor in sustaining continuous improvement?” I would say, “Are you treating your organisation as a high performance organisation, are

you coaching your organisation. If you figured out how your organisation is different than high performance sports teams, let me know. I wanna know, but if it isn't, then coach that organisation to sustain that high performance." That happens to be the best way that we know of right now. If there's a better way I'd love to know, but I don't know one yet". "how come we would never dream of sending the Black Caps¹⁵ or the All Blacks¹⁶ or any high performance team out on the field without a coach? How come? Why is software engineering different? Why don't we have coaches? I mean we want high performance teams, but we're not coaching them and we're expecting high performance results out of them without a coach."

However, some others disagreed with the comparison of agile coaching with sports coaching,

"Nah, it's not the same. I definitely think it's not a sports team coach because the difference in a sporting team is the coach kinda lays out the strategy then the team have to go and deliver itin a sporting sense tends to tell the team what they've got to do. I think a coach in a business sense tends to ask questions to let people find their way and he lets them, or she, let's them make mistakes but protects them from making really big mistakes. Agile coaching is more reflecting back to them options as to how they might approach things, not telling them at all. It's never telling them this is the way you've got to do it."

Though the above statements imply different understandings and interpretations of what constitutes an 'agile coach', findings revealed a general consensus on the significance and positive impact of an agile coach on sustained agile usage.

5.6.1.3. Technological

The impact of practices such as automated testing along with appropriate tool support on developing teams' engineering excellence was highlighted by interview participants,

"from a technical perspective, refactoring and ease of automation of testing are probably the two key things..." developer (Org D),

"we are at war with complexity. So being at war with complexity for any non-trivial amount of code, as long as I've written anything substantially more difficult than, 'hello world,' I simply cannot afford to have one line of code without some supporting test frame...because

¹⁵ New Zealand Cricket team

¹⁶ New Zealand Rugby team

guess what, I'm not gonna be able to reduce any cycle climb if it takes me three weeks in testing the application. It's simply can't be done. So if you're asking me deliver me a change in 10 minutes, it can't be done. Its three weeks plus 10 minutes. If on the other hand I have an automated testing suite, then it can be 10 minutes, or whatever the lag time of deployment all the way into production is. So tools are vital..." (AC, Org A).

The above findings are consistent with the FG findings where participants highlighted that practices such as automated testing and continuous integration were critical in sustaining AMs. The significance of appropriate tools to support the effective use of these practices, such as JUnit for automated testing for Java and TeamCity for continuous integration, was also discussed. In terms of factors hindering effective agile usage, the group highlighted the lack of good collaboration tools as the main factor. The group discussed how agile promotes collaboration and better communication, and so good tool support for collaboration was deemed critical. However, though most agile practitioners expressed strong awareness on the positive impact of tool support and engineering practices on continued and effective use of AM, but in practice, they were not widely used in many participant organisations. For example, a developer from Org C stated that in spite of using agile for more than 5 years, they were

"still quite reliant on manual regression tests which are quite labor intensive and have a breaking effect on success, so that has quite an important factor to play".

5.6.1.4. Organisational

FG participants discussed that traditional management and leadership style was still very common in organisations that have been using AM for quite a long time (e.g. greater than five years). While some managers were unwilling to let go of the "*command and control*" leadership style, others saw agile roles such as Scrum Master as a leadership role and longed to be one,

"so people want to the Scrum Master because it is their moment in the sun or something and I keep saying, "it's not about that....its more about helping the team with any obstacles and really you are in the background, just facilitating everything"" (lead developer, OrgC).

The characteristics of an agile manager was explained by an AC,

"such a leader will actually engage the teams intelligence and say, "Guys show me what it is that you do; why is it that we're doing it this way; how can I help you do

better; how can I remove obstacles for you; how can I improve the flow; what are the things that are unsatisfactory; what investments will you need me to make in order to make your work simpler, smoother, with less heartache and difficulty.”

Adopting a lean leadership mind set, developing a culture of problem solving, and creating a friendly and non-threatening environment by encouraging people to speak up and removing fear from the organisation were identified as important characteristics of an agile supportive organisation. Interview participants shared that TMS should not be just limited to general support such as funding and staff training, but active involvement, participation and commitment to support complete and effective implementation of the agile process were more critical for sustained usage. Top management should be committed to implementing strategies that support effective agile implementation such as establishing dedicated roles (e.g. AC), transitioning to flatter organisational structure, funding and resourcing models, etc.

“Well you have to build the system to make it happen.....i.e. to create mentoring programmes for instance, to create new agile champions and new mentors and new coaches within the organisation. Right, I don’t have the luxury of going in outside and hiring coaches for our organisation. We need to develop our own coaches ourselves. We need to be able to coach others, right. So we need to have a good system for creating good agile champions; helping them to grow others right and develop a system that creates this self-perpetuating improvement.”

The significance of top management recognition and involvement on sustained usage was also highlighted by the FG participants,

“what really enhanced agile sustainability was that management recognising that in order to get the traction we were looking for in agile and also maintain that sustainability, was the need to bring in some external resources to help with the organisation as a whole and to focus on teams to help teams move forward”.

The need for an *Organisation Structure* that supports the agile way of working was cited by many interviewees. Independent expert practitioners shared examples of how organisations using agile methods for more than 5 years still had strong hierarchical structure and were struggling to evolve as successful agile organisations. Interviewees from Org E expressed that their funding structure (which allocates funds for achievement of specific final goals) was incompatible with the agile model (where final goal may be uncertain due to its adaptive and

flexible processes). One project manager explained how Prince 2 would have better supported the use of AM in their organisation than the current formal reporting system (Org E),

“so the whole concept of Prince2, event based reporting or event based meetings would have worked a lot better with an agile set up than formal standard, monthly steering committee meetings, because agile does fit reasonably well with the whole Prince2 thinking”.

5.6.2. Discussion

Findings from both the FG and interview data provide some valuable insights on the various factors and constructs in the SAU. Closer analysis and interpretation, through use of the constant comparison method across both data sets (Strauss & Corbin, 2007) was critical to identifying the key factors in the refined SAU. This was done by the process of renaming and regrouping some existing constructs in the SAU, and adding some new constructs which helped hone in on the factors that were found to positively influence sustained usage of agile methods. The sections below evaluate the constructs in each of the four AUM factors, and explain how the final set of constructs in the final refined AUM was derived.

5.6.2.1. Innovation

Agile methods are information systems development process innovations, and innovation characteristics (*Relative Advantage* and *Compatibility*) are commonly used in the literature (see Chapter 2) to understand and explain continued use and acceptance of software process innovations. However, as described in 5.6.1.1, FG participants had difficulties in understanding the relevance of the term, i.e. ‘innovation’, used to represent this category. This is understandable because while the phases of diffusion (e.g., adoption, acceptance, usage, etc..) may be applied to understand and evaluate an organisation’s current phase of an innovation’s use, it is difficult to distinctly differentiate between an innovation’s initial adoption and continued use at a team or individual level. This was explained by a developer (Org C),

“it is interesting, because within a development team, if you have used it and it was successful you would continue to use it, ...people are meeting around you next time you do it, for them it is adoption, and assuming that was successful, there may be the third time that you have done it, second time for them, first time for the next team, new people are always coming in, adoption never stops, probably it is quite blurry...”.

Moreover, though the term “acceptance” is commonly used in the literature to refer to the continual acceptance of an innovation rather than “adoption”, the terms “acceptance” and “adoption” are also used interchangeably to represent both initial adoption and continued and long-term use (Agarwal, 2000; Mangalaraj et al., 2009a; Overhage & Schlauderer, 2012). While innovation is an idea or practice that is perceived as new by an adopting unit (Rogers, 2003), it is also recognised as the capability of being learned and being practiced (Drucker, 1985). Therefore, no changes were made to this category in terms of renaming it. More detailed discussion and the rationale for including this category in the model is discussed in Chapter 2.

Interview data strongly suggested that both *relative advantage* and *compatibility* influence sustained agile usage. FG teams discussed the use of newer agile practices, contemporary technologies, and newer ways of doing things. The incompatibility of tools to provide support in divergent platforms was perceived to have a negative impact on sustained usage. Therefore, similar to the findings from the case studies (BBCW and Stats NZ), both interview and FG data supported the impact of the innovation factors (*relative advantage*, *compatibility*) on sustained agile usage. However, there was no evidence of any specific metrics or measurements used to track improvements in development outcomes. In a recent study of developers’ perception on the factors that impact long-term use of Scrum method, Overhage and Schlauderer (2012) identified three factors, relative advantage, compatibility, and complexity. While the impact of relative advantage and compatibility on long-term Scrum usage was strongly supported, the impact of *complexity* supported. This is consistent with the findings from the current study (case study, FG and interview findings) where agile practitioners mainly reported incompatibility issues with their resourcing models, resistance from BAs, and an inability to leverage enough support from the organisation rather than on the *complexity* related to the use of AM. This could be supported by the explanation that since agile enables and supports a high performing team to perform at a higher level, the aspect of *complexity* in learning and using AM might not have been perceived to have a significant impact on sustained usage. Another recent study, found that a clear understanding of the relative benefits of using AM was critical to the successful deployment and long-term use of AM in two organisations (an online bank and a global law firm) (Russo, Shams, & Guy, 2013). The evidence from both the findings of the current study findings and the extant literature provided strong support for the constructs relative advantage and compatibility included in this category. Thus, the following general proposition is offered:

Proposition 1: A significant relationship exists between innovation characteristics of the agile method and agile practitioners' perceptions.

This is examined with the following hypotheses:

H1: As agile practitioners' perceptions of *relative advantage* in using an agile method increase, their level of agile usage will increase.

H2: As agile practitioners' perceptions of *compatibility* in using an agile method increase, their level of agile usage will increase.

5.6.2.2. Sociological

The research model (see Figure 4.6, CF3) consists of three constructs in this category: (i) experience, (ii) attitude, and (iii) technical competence and expertise. *Experience* generally relates to a person's overall experience in a job role or organisation. In the model, the construct 'experience' referred to total experience of an agile practitioner in systems and software development including agile methods. However, the findings from both FG and interview participants highlighted the need for a clearer differentiation between '*agile experience*' and '*experience*'. As described in the findings, strong background and experience in systems development without specific experience in AM was perceived to have a negative impact on sustained agile usage. This is also consistent with the findings from the case studies – though most Stats NZ employees had been in the organisation for their entire careers, as a result of which they had strong background, knowledge, and experience in systems development, and gained very good knowledge of the business domain, they lacked the depth of agile experience – this had a negative influence on sustaining the effective use of agile practices. On the contrary, specific experience in using AM by most practitioners in BBC Worldwide was found to have a positive impact on the effective usage of agile practices. Findings from the literature also support this view. Salo and Abrahamsson (2008) found that people who had experience with XP and/or Scrum had more favourable opinions about their usefulness, and Laanti, Salo, and Abrahamsson (2010) discovered a positive association between length of agile experience and attitudes towards its usefulness. Russo et al. (2013) found that a major initiative by UK's first online bank to align IT with their existing business agility endeavours through the use of AM for all new projects was hindered due to their shortage of skills on agile methods. The bank's IT staff had strong experience with their ecommerce infrastructure, but very limited experience with the agile approach. Therefore, it was deemed important to rename the construct *experience* to *agile experience* to better reflect the findings from both the literature and the current study.

While there is evidence in the agile literature for the significance of *technical expertise* on the effective usage of agile methods (Chow & Cao, 2008; Franca, Silva, & Mariz, 2010; Misra, Kumar, & Kumar, 2009a), analysis of both the FG and interview data highlighted that ‘people’ characteristics such as attitude, motivation, trust, and respect, were more important than technical knowledge and expertise of team members. A number of sociological characteristics such as innovativeness, resilience, team beliefs (norms and consensus across different definitions), and team spirit (team members display a strong sense of identification and commitment with the team), whole team involvement and ownership by adherence to values such as trust, openness and mutual respect, willingness and ability to learn and adapt to changes in processes associated with continuous improvement were identified by both FG and interview participants. A number of these sociological characteristics relate to what is referred to as the “*agile mindset*” in the agile practitioner community. Drawing from the work of the psychologist Carol Dweck, Sidky (2012) defines a mindset as an “*established set of attitudes held by someone*”. Dweck differentiates between fixed mindset (people believe their basic qualities such as intelligence are fixed traits) and growth mindset (people believe their basic qualities can be developed through dedication, commitment, and hard work). The fundamental characteristics of a fixed mindset are to be ‘static’, to demonstrate ability, and the desire to look smart, whereas the fundamental characteristics of a growth mindset are the ability to grow and develop, and the desire to learn. Rising defines “*agile mindset*” as

“an attitude that equates failure and problems with opportunities for learning, a belief that we can all improve over time, that our abilities are not fixed but evolve with effort” (Rising, 2011).

Rising highlights the significance of agile mindset on team growth and effectiveness and its impact in turn on the effective usage of AM. She argues that it is this mindset that encourages and sustains ongoing use of innovations rather than the technical expertise and skills. It is based on the belief that everyone

“can grow, improve, you might never be a Beethoven or an Einstein, but you can be better tomorrow than you are today. An IQ test or a test of any other ability is very good at measuring where you are now but it cannot say what you will be like tomorrow, there's no way of combining the effort, the determination, the enthusiasm, the passion that you have for whatever it is that you want to do and that combined with your talent or ability that you were born with, that's what's important”(Rising, 2011).

In the context of AM, agile is identified as a mindset that is defined by agile values, guided by agile principles, and manifested through many different practices such as Scrum, XP, etc. (Sidky, 2012). It enables teams to continually learn and perform at higher levels based on effective team formation, as one project manager (Org E) stated, “*so it’s probably less about the tool and more about making of the team; the team that’s put together, the team needs to have a clear sort of focus or vision*” and in the words of a lead developer, “*...no, I think it’s people, it’s just people...it’s knowing how to do and be agile. And it’s all about agile mentality*”. The findings do not imply that constructs such as technical expertise and attitude have less impact on SAU, rather they highlight the significance of building teams which consists of all the requisite skills needed for the job which is based and related to the “agile mindset” discussed above i.e. “whole team”, “commitment to learn”, etc., This is because

“agile promotes iterative, collaborative, and experimental strategies. This promotes learning within the team, it doesn’t reduce it. Agile strategies expect the team to learn as you go. They’ll learn more about the domain, about the technologies they’re working with, about how to work effectively, and about each other. When people work together collaboratively, not alone at their own desks, they start to pick up skills from one another naturally...” (Ambler, 2014)

Therefore, the sociological constructs *attitude* and *technical expertise* in the original model were combined into one construct called “*agile mindset*”. Though the ‘sociological’ or ‘people’ focus is singled out as an essential and critical factor for the successful and effective use of AM throughout the agile extant literature, it is surprising that their relation to the concept of ‘agile mindset’ has not yet been recognised in the literature.

In AM, coaching is identified as the key factor for agile success (Linden, 2010). Kent Beck, the founder of XP, defines an AC as one whom

“watches the process as a whole and calls the team’s attention to impending problems or opportunities for improvement”(Beck & Andres, 2004).

As the influence of AC was identified and discussed in both the case study findings (i.e. BBCW – had an AC and Stats NZ – did not have a specific AC, but was played by the MC for the first 5 years of agile use), further evidence about its influence on sustained agile usage was sought during the current phase of the study. Both FG and interview participants perceived that the presence of an effective AC was critical for the sustained usage of AM. An AC was believed to

be an impartial expert (most often external) with both professional and agile experience. Interviewees from organisation C shared experiences of how many of their teams degraded due to ineffective use of agile practices due to lack of proper guidance and encouragement. This perception was also echoed in the FG, *“the best way that we know of right now to create and maintain high performance teams is to have a coach”*.

While there was general consensus on the positive influence of an AC on the sustained usage of AM, there were contradictory views on the understanding of the role itself (e.g. what is coaching? What constitutes an AC role? What is the job description of an AC role?) . This could be attributed to a number of reasons:

- i) the term coaching is used more widely in other contexts such as sports, life coaching etc. while some interviewees (who were coaches) associated the role with a sports coach, some others disagreed. Still others suggest an integrated approach, i.e. to draw relevant and beneficial skills from different non-software coaching contexts such as sports, business, and life coaching, (Davies, 2011): *“business and life coaches usually work with individuals on a one-to-one basis. They help their “coachees” uncover personal goals and work out how to achieve them. As an agile coach, your primary focus is team performance towards company goals rather than the personal growth of individual team members...so you can draw on techniques from life coaching to help people gain perspective on their work and open their eyes to new possibilities. Sports coaches share the same focus of building a team that performs effectively. They require a deep knowledge of their sport and are often former players. They work on skills, tactics, and motivation. An agile coach wants to help teams with the same things —so we see an agile coach can draw from both these coaching fields.”*
- ii) to the best of knowledge of the researcher until the date this writing was undertaken, no empirical studies on the influence of AC on agile use exists. On the contrary, a plethora of articles and blogs (mainly online) are available on ‘agile coaching’ among the practitioner community mainly driven by contemporary coaching and consulting companies - some of this information are aimed at advertising and publicizing their own coaching businesses.

The term “coach” itself can be traced backed to its origin which comes from an old Anglo-Saxon word for a carriage, which is something that takes you from where you are now to where

you want to be. A “coach” is usually associated with the role of a team leader. However, there are some distinct differences between a coach and a team leader. Team leaders foster team effectiveness by engaging in many different kinds of behaviours: structuring the team and establishing its purposes, arranging for the necessary resources and removing organisational roadblocks that impede the work, helping individual members strengthen their personal contribution to the team, and working with the team as a whole to help members use their collective resources well in pursuing team purposes (Hackman, 2005). Out of the four activities, only the last two (helping individual members strengthen personal contributions, and working with the team) align well with coaching behaviours (Hackman, 2005). Team coaching in general is an act of leadership and is defined as

“direct interaction with a team intended to help members make coordinated and task-appropriate use of their collective resources in accomplishing the team’s work”.
(Hackman, 2005, p. 269)

In ASD, while traditional leadership roles such as project manager and team leader are compatible with the role of an AC, there are some key differences (Davies, 2011):

- (1) roles such as project manager and team lead have a wider set of project and organisation specific responsibilities, such as reporting progress, performance appraisals, and pressure to deliver, which may take the focus away from process improvement,
- (2) AC is a transitory role which is not tied to a project duration whose main focus is on the team to become self-coaching and adept in applying agile practices.

The role of traditional roles such as project manager, and methodology champion has been studied both in the SDM (Iivari & Huisman, 2007) and agile (Laanti, Salo, & Abrahamsson, 2011; Nerur & Mahapatra, 2005) literature, but the role of AC on the effective use and deployment of AM is yet to be empirically validated – though there is a lot of information on ‘agile coaching’, as discussed above produced mainly by agile coaches, consultants, and proponents in the agile community. Though it might be a long way before a consensus can be reached on what exactly constitutes the role of an ‘agile coach’, a stronger consensus seems to exist on the significance of agile coach on sustained and effective use of AM as evident from findings from all phases of this study (i.e. case studies, FG, and interviews). For the purposes of the study, an agile coach is defined as someone who has advanced levels of technical,

business, and domain expertise, agile experience, and helps teams to implement and manage changes effectively by working more collaboratively. In comparison with roles such as team leader, project manager, etc. since an AC focuses more on deepening the use of AM and managing its effective use, it was deemed a key factor to be included as a sociological construct in the refined model.

Proposition 2: A significant relationship exists between sociological characteristics of the agile method and agile practitioners' perceptions.

This is examined with the following hypotheses:

H3: As agile practitioners' perceptions of *an agile mindset* in using an agile method increase, their level of agile usage will increase.

H4: As agile practitioners' perceptions of degree of AC support in using an agile method increase, their level of agile usage will increase.

5.6.2.3. Technological

Use of appropriate technical engineering practices and tools are characteristics of good professional systems development practice irrespective of whether it involves agile methods or not. While engineering practices refers to practices such as test driven development, automated testing, refactoring, etc., tool support refers to use of appropriate tools to support the effective use of these practices during various systems development tasks, such as requirements gathering, analysis, and design. Though agile methods do not prescribe specific engineering practices, use of appropriate practices and tools are often associated with success of agile projects. For example, use of test-driven development is often advocated for agile projects though it is not an prescribed practice in any agile method such as Scrum (Paulk, 2011).

In the current study, findings from both the FG and interviews revealed that though there was strong awareness of the significance of incorporating appropriate engineering practices and tools (e.g. source control, bug tracking, testing, release, and deployment) and were perceived as critical enablers of sustained agile usage, but in practice they were not used widely in most participants' organisations. The findings are very similar to the Stats NZ case findings, where there was strong awareness of their significance but were not either not used at all or were not used effectively. Lack of a good collaboration tool was seen as a major hindrance to effective agile usage and was raised by both FG and interview participants. The significance of collaboration tools in AM is well illustrated in this example by an interviewee,

“collaboration tool – highly critical, unfortunately, so far I have not seen any tool which has brought effective results in our many cross-located agile teams. For example, we have teams working in Sydney, Chennai, Bangalore, etc., all working on the same project. So, recently we bought a \$10,000 Samsung HD TV with great features, for example, HD camera which can automatically detect audio signals and change focus to that direction, it can zoom-in, zoom-out on ‘post-it’ on the wall so that the whole team can read, for example user stories in progress, and one specific user story can be zoomed into from about 10 feet, ...but the off-shore team has a different technology, they have Cisco videoconferencing facility (which is about \$100,000 investment) which cannot integrate with our Samsung TV, but they cannot talk to each other. So, what is the use? So, finally we ended with all of us going to our laptop webcams...”

This is consistent with the findings from the case studies (as discussed in Chapter 4) where lack of good collaboration tools was perceived as a critical factor that hindered the effective functioning of cross-located teams in Stats NZ. Russo et al. (2013) found that the effective usage and success of AM was heavily dependent on the use of automated technologies and tools such as automated web application testing tools, NUnit to create and write test fixtures and unit tests, NDoc to create API documentation, CruiseControl.NET for Continuous integration, FxCop for automating the process of analysing code for coding standards.

In summary, evidence from both the extant literature and findings from the current study provided strong support for the significance of technological constructs (engineering practices, tool support) on SAU. During data collection and analysis, some overlap was experienced between the construct ‘engineering practices’ and ‘vertical usage’, i.e., it was found that some of the issues discussed under the construct ‘engineering practices’ also came up under ‘vertical usage’ and vice versa (SAU construct (see Figure 4.6) which refers to the extent of adherence to agile practices of an agile method) though they are two different concepts as described in Chapter 2. And, tool support was discussed as part of either engineering practices or vertical usage, and sometimes both. Therefore, it was decided to combine the two constructs (i.e. engineering practices and tool support) into one construct (i.e. tool support) in the refined model. This would also simplify the model for the survey.

Proposition 3: A significant relationship exists between technological characteristics of the agile method and agile practitioners’ perceptions.

This is examined with the following hypotheses:

H5: As agile practitioners' perceptions of *tool support* in using an agile method increase, their level of agile usage will increase.

5.6.2.4. Organisational

The impact of TMS on both initial and continued use of systems development methodologies/process innovations has been widely studied in the literature. Consistent with the findings from the literature and also from the case study findings of the current study, TMS emerged as a key factor that influences SAU both in FG and interview findings. The findings also identified some key differences between the influence of top management role on the diffusion of prescriptive IT/IS methodologies and on the sustained usage of adaptive methodologies such as agile. For example, in an agile context, TMS does not merely imply providing financial support and sponsorship etc., but also on developing effective strategies (for example, transitioning to flatter structure, funding and resourcing models that match agile way of working) aimed at developing a whole system that facilitates agile values and principles, i.e. organisation wide changes. Top management should have a unified focus on anticipating and dealing with any challenges and disruptions in the organisation wide implementation of such an innovation. Russo et al. (2013) found that the lack of influence and sponsorship of top management was reflected in the absence of such a unified approach and overall vision for software development and provisioning – this in turn had serious negative repercussions on the sustained usage of AMs in a large organisation.

While TMS may provide a favourable environment for agile usage, the impetus for its effective and sustained use comes from individual initiatives (Beath, 1991). In the context of AMs, *MC* play a significant role in encouraging and facilitating the on-going usage of agile practices which include responsibilities such as convincing management, eliminating barriers to successful diffusion and implementation, and mentoring (Conboy et al., 2007). Though the construct *MC* was identified in the original *a priori* model, the identification of *agile coach* as a key additional sociological construct helped delineate some key differences between the constructs *MC* and *AC*. While an *AC* is usually involved in the facilitation of effective application of agile practices by a deeper understanding of the social aspects of teams, managing change, and facilitating their self-managing behaviour, the *MC* role is crucial for the effective agile dissemination throughout the organisation. A *MC* operates at a higher and broader level by acting as an intermediary and liaising between the *AC*, Scrum Master and the top management. A *MC* is usually a senior member within the organisation whereas an *AC* is

usually someone external to the organisation. This differentiation is also recently highlighted in the agile literature. In a study of post-adoption use of AM, Russo et al. (2013) found that while all teams received agile coaching and training (an AC was available to teams for six months), the role of MCs played by a large organisation's CIO and the technology director facilitated SAU throughout the organisation. Therefore, MC was retained as a construct in the organisational category.

Findings from the interview data highlighted the need for an *Organisation Structure* that is compatible with agile systems development. Participants explained how some of their current models such as funding models, project management structure, and formal reporting systems based on hierarchical structure were against agile way of working. A senior experienced agile practitioner and consultant explained how an organisation structure that supports agile values and principles was critical for sustained agile usage,

"...because a lot of organisations are reasonably hierarchical and I think agile tends to support more of a flat structure. So I think, I talked about business value, there's something here at an organisation, you've got to be more interested in business outcomes than the system widgets that you're trying to produce. And that's the trouble when we go over to metrics, we're often thinking about the functionality we get delivered rather than the business outcome which was the start of the initiative. This is what I like about the Prince2, it's all about, it comes back to a business case and the business value and making sure that the cost of the project and the value that it's bringing to the organisation are continually being monitored. And that's what we're continually doing in agile when we're trying to skin stories down so that we deliver the minimum amount of functionality that will give the business value. 'Cause, I mean, the minimum functionality is the minimum cost and so we're continually getting people to think in that space. Now if an organisation is too hierarchical then you've got to pass the communication up and down the lines. And every layer is a level of disengagement from the project which means I'm gonna want some metrics and some reports, another summary metric and report".

Lack of an organisation structure that reflect the values and principles of agile development has been recognised as one of the main reasons why many organisations do not yet feel 'agile' enough (Lucas, 2012). Strategic management also has a direct effect on organisation structure. Organisation structure has been affected by the various strategies of strategic management

since the early days of capitalism resulting in the following seven phases (table 5.6): (Lucas, 2012):

Table 5.6: Seven Strategies of strategic management Source: (Lucas, 2012)

The 1960s	The Sales Oriented Strategy
The 1970s	The Marketing Oriented Strategy
The 1980s	The Active and Interactive Oriented Strategy
The 1990s	The Value Chain and Optimisation of Resources Strategy
The 2000s	The Living Company Strategy
The 2010s	The Learning and Agile Strategy

As we are currently in the Learning and Agile Strategy phase, it is imperative that organisations must change their structure fluidly in response to changing customer needs and market pressures (Lucas, 2012). Organisations should take the initiative to implement structures such as flat lattice structure in which innovations such as agile can be sustained and flourished. In his groundbreaking design of the Lattice Organisation Structure (LOS), Gore (Gore, n.d.) defines a LOS as follows:

A lattice organisation is one that involves direct transactions, self-commitment, natural leadership, and lacks assigned or assumed authority. . . Every successful organisation has a lattice organisation that underlies the façade of authoritarian hierarchy. It is through these lattice organisations that things get done, and most of us delight in going around the formal procedures and doing things the straightforward and easy way – Bill Gore

Though the underlying philosophies of a LOS and AM are very similar (see table 5.7), it is surprising that more organisations claiming to use AM have not made this adaption (Lucas, 2012). The findings from the current study support this fact, i.e. though there is awareness about the critical need for an agile supportive organisation structure, hierarchical structure is still predominant in most organisations.

Table 5.7: Similarities between agile and lattice organisation structure

Agile Manifesto:	Lattice Organisation Structure:
<i>we are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:</i>	
<ul style="list-style-type: none"> • Individuals and interactions over processes and tools 	<ul style="list-style-type: none"> • no fixed or assigned authority, sponsors not bosses, natural leadership defined by followership

<ul style="list-style-type: none"> • Working software over comprehensive documentation • Customer collaboration over contract negotiation • Responding to change over following a plan 	<ul style="list-style-type: none"> • tasks and functions organised through commitments • person-to-person communication • objectives set by those who must make things happen
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Similar situation was evident in both the case studies (as discussed in detail in Chapter 4), where Stats NZ had a matrix structure, and BBCW’s divisional form with divisions/units having significant autonomy was based on a functional structure. While lattice structure denotes a radical departure from traditional organisation structures which have many levels of management and lines of authority, it would be feasible for organisations such as Stats NZ and BBCW to combine the benefits of various organisation structures into a hybrid structure:(Lucas, 2012)

“it uses a functionally designed hierarchical structure where work is assigned by product or initiative. The functional organisation aspect provides economy of scale advantage and proficiency of expertise while the hierarchical organisation promotes clear lines of authority and performance rewarding. Assigning work by product or initiative gives the advantage of promoting team thinking and team work with focus on the success of the product or initiative and therefore the organisation rather than the individual.”

Therefore, an *Organisation Structure* that supports agile development was deemed critical for sustaining the usage of AMs and was added as a factor in the organisational category.

Proposition 4: A significant relationship exists between organisational characteristics of agile method use and agile practitioners’ perceptions.

This is examined with the following hypotheses:

- H6:** As agile practitioners’ perceptions of degree of *methodology champion* support for agile method use increase, their level of agile usage will increase.
- H7:** As agile practitioners’ perceptions of *management support* for agile method use increase, their level of agile usage will increase.
- H8:** As agile practitioners’ perceptions of agile compatible *organisation structure* increase, their level of agile usage will increase.

5.7. Sustained Agile Usage

The influence of various factors on sustained agile usage (as measured by horizontal and vertical usage) was further investigated in the semi-structured interviews phase. However, in the FG session, the discussion focused mainly on identifying the various factors that either hindered or facilitated sustained agile usage – i.e. the model’s emphasis on sustained usage was explained to the FG participants which enabled them to validate/identify the factors, but the specific concepts of *sustained agile usage* and *agile usage effectiveness* could not be discussed in greater detail due to time constraints. Interview findings was consistent with findings from the case study phase, where is *sustained agile usage* as measured by depth of use of core agile practices and spread of their use in other projects/regions was perceived to have a significant influence on usage effectiveness, i.e. improvements in development outcomes. Though adaptation of practices was common (most participants had been using agile for at least 3 years), many participants stated that adhering to core agile practices (e.g. core Scrum practices) makes a significant impact on the effective use of AM. The need/role of other factors such as AC in the effective implementation of practices was also highlighted. The difference between ‘*doing agile*’ versus ‘*being agile*’ was discussed: ‘*doing agile*’ refers to strictly adopting and using practices and techniques of a specific agile method such as Scrum, and ‘*being agile*’ relates to the ‘*agile mindset*’ (as discussed under sociological construct) and associated behaviours used to leverage agile practices and techniques. The findings imply that while ‘*being agile*’ refers to ‘*agile mindset*’ applied to all levels (i.e. individual, team, organisation) guided by agile values and principles, ‘*doing agile*’ implies manifestations of agile behaviours in the use of specific agile practices and techniques. Both were seen as critical to sustain effective usage behaviours:

*“.. I think it’s both. Because if you only are agile you can very easily have a great culture; an agile culture and just do chaos, but it works up to a certain number of people. I also think the other extreme are those companies who do Scrum by the numbers, and **aren’t** like the ones who are obsessed with certifications, etc. So I think it’s both that is actually important. Like doing Agile without being Agile is this Cargo Cult Agile. And being agile without doing Agile is we tried baseball and it didn’t work. It reminds me of a story I heard, ...it’s the story of baseball teams, oh yeah well baseball is supposed to be this really, really cool thing and people who watch it say it’s a great spectators sport and it’s great to play. So those people go out and they say, “Let’s try baseball.” And the first thing is well, they’re saying you need nine people, but actually*

we're only four, so let's just do it with four people. And now that we're only four, so why do you need all those bases. So actually it's way better to just have one base. And they go on and on and on a ball made of newspaper and they don't have bats, nothing to do with baseball. But in the end they conclude well baseball doesn't work, which means there might be being Agile, but without actually doing it. I think they're actually important” (Agile Practitioner, Org A).

Russo et al. (2013) found that use of both vertical and horizontal usage had a positive influence, whereas lack of vertical usage (i.e. not using core agile practices of an AM such as Scrum) had a negative impact on agile usage effectiveness.

5.8. Agile Usage Effectiveness

As discussed in Chapter 2 (section 2.6), three effectiveness measures were identified as the core criteria for assessing agile usage effectiveness in the initial model: 1) improved productivity in the development process, 2) improved quality of the development process, and 3) customer satisfaction. It was recognised at the time that the list was not exhaustive and further validation was sought throughout the research process for any additions or modifications.

Though both FG and interview participants (see tables 4.1 and 5.2) came from wide range of organisational contexts which were in various post-adoptive stages of agile use, there was general consensus among the participants about the three effectiveness measures - only specific findings that were deemed distinct and different from the concepts previously discussed are presented below.

5.8.1. Customer Satisfaction

An interesting point raised relates to the difference between customer satisfaction of the end customer and customer satisfaction relating to the quality of the end system, which is best explained in the words of the interviewee (Lead Architect, Org A):

is it quality of the end system or is it the satisfaction of the end customer? because the satisfaction of the end customer is based on on-time on-cost delivery, and since we get delivery efficiency out of agile, they are happy, progress makes them happy, which techniques demonstrate, delivery on time makes them happy, delivery on budget makes them happy. So, their happiness is a fallout of the process, it is a side-effect of the other

measures rather than a measure on its own right- at least in my experience, ... that is a side-effect of, if you measure efficiency, delivery efficiency, you will also get customer satisfaction, they sort of come out to be the same measure, correlated measures. On the other hand, customer satisfaction with the quality of the system built is a different measure, if you going to measure the quality of the software, probably you want to measure it 2 distinct ways: 1) does it meet and exceed the expectations of the end customer about what they were going to get? And 2) point of delivery measure, 2nd one is much more important, and certainly more important is what is the measured quality of the solution from a maintenance perspective? Portability from a non-functional requirement perspective? is it maintainable? is it affordable? It's the internal merits the system has as opposed to the external merits. I believe that agile methods while they provide you high degrees of satisfaction to your end customer, they can do that at the expense of the interior satisfaction of the system. So, I would tend to want to measure the merits of an agile developed system post its delivery, so, it would be a fairer measure-there would be a number of measures I would take whether agile is a good thing-one of them would be if we deliver on time to customer requirements 2nd would be –did we position that software so that we were able to sustain the delivery post the initial phase?

Customer satisfaction is generally measured to measure delivering on time, budget etc., but the above statement illustrates the importance of measuring the quality of the system or software developed post its delivery, i.e. whether the product is sustainable in the long run? The current study focused on understanding the significance of sustaining of agile practices and techniques beyond the initial phases, i.e. continuing to use the agile techniques, practices, and mechanisms that facilitate its effective usage to positively impact improvements in systems development outcomes, but whether the underlying quality of what is built/developed is better or worse is probably a different measure. So, customer satisfaction, in the context of the current study can be seen as related to the outcomes of sustained agile usage due to factors such as delivery efficiency (e.g. cost to deliver and time to deliver). And, the sustainability of the system/software might be a very important quality measure to measure but is not within the scope of the current study.

5.8.2. Predictability

‘Predictability’ was identified as an important effectiveness measure by some experienced and reputed agile practitioners in their interviews. Predictability, though was seen as closely related to productivity metrics such as measuring story points, number of units delivered etc., it was also identified as a distinct effectiveness measure relating to improvements in sustaining delivery discipline beyond a single project or team,

“for example, we’ve gotta metric around story points, that we use that’s not transferable from one project team to another. And it’s really, for the team, for determining their velocity...may be the outcome of that is predictability. Predictability at acceptable cost because which really drives back to being able to deliver delivery on the date which I guess leads to certainty, i.e. improving certainty, ...whether you hit your delivery dates on a regular basis? (AC, Org A).

In support of the above view, another highly experienced agile practitioner stated,

“.. I think the key measure of success when I have used agile methods is the delivery discipline, i.e. Predictability... we had a very complex system that was being built. They were struggling to get delivery out of an off-shore vendor, because they were trying to drive functionality sets rather than time, and I spun this on its head and said, we agreed when we are going to deliver and then we are going to figure out what functionality we are going to have in that release, and that imposed a discipline on the vendor to deliver on a date and it was almost purely the application of that discipline which turned the project on its head, but then we were able to measure in terms of functions delivered, the number of units delivered, whatever they were, say, defects repaired, to get our head around, the number of individual defects repaired per week. At the beginning it was all over the place, they couldn’t get stable delivery, but, by the time we got the thing up and running and rolling, it was a flatline, we were measuring every week what was done, and we were really getting really consistent level of delivery, and a very visible level of delivery. So, predictability, i.e. visibility of delivery, delivery discipline, are all enhanced if you sustain the use these sort of techniques... (Lead Architect, Org A):

The above example illustrates the difference between productivity and predictability. While productivity refers to improvements in speed of delivery, reduction in time, cost, etc.,

predictability refers to being able to predict consistent level of delivery, i.e. achieving delivery discipline beyond a single project or team. Evidence from the extant literature supports the influence of agile usage on productivity, i.e. positive impact on development cost, reduction in development time, and a reduced cycle of software delivery time were experienced (Russo et al., 2013). However, no empirical studies were found in the extant agile literature that directly examined the relationship between SAU and predictability, i.e. the influence of usage on predictability. In the context of PSP (Personal Software Process) software process innovations, the reverse relationship has been examined, i.e. as software developers' perceptions of predictability using PSP increase, their level of satisfaction with use of PSP increase (Green & Hevner, 1999). Based on the above findings, since predictability relates specifically to achieving delivery discipline and certainty over a long period of time as a result of sustained agile usage, it was added as an effectiveness measure in the final model.

In summary, the following proposition posits the relationship between agile usage and agile usage effectiveness.

Proposition 5: A positive, significant relationship exists between agile practitioners' perceived sustained usage of agile methods, and agile usage effectiveness.

H9: As agile practitioners' perception of agile usage increase, their perceived productivity in using agile methods will increase.

H10: As agile practitioners' perception of agile usage increase, their perceived quality in using agile methods will increase.

H11: As agile practitioners' perception of agile usage increase, their perceived predictability in using agile methods will increase.

H12: As agile practitioners' perception of agile usage increase, their perceived level of customer satisfaction in using agile methods will increase.

This chapter described how multiple research methods were used to evaluate the SAU, and how the final factors and constructs in the final refined model were derived. In the sociological category, the constructs *attitude* and *technical competence and expertise* were combined to form a new construct called *agile mindset*. A new construct called *AC* was added, and

experience was changed to *agile experience*. The construct *Agile practices* was removed from the technological category due to its overlap with the construct *vertical usage*. In the organisational category, the constructs *TMS* and *MC* were retained, and a new construct *organisation structure* was added. The final refined model is shown in Figure 5.4: Innovation factors (*Relative Advantage*, *Compatibility*), Sociological factors (*Agile Experience*, *Agile Mindset*, *Agile Coach*), Technological factors (*Tool Support*), and Organisational factors (*Top Management Support*, *Methodology Champion*, *Organisation Structure*).

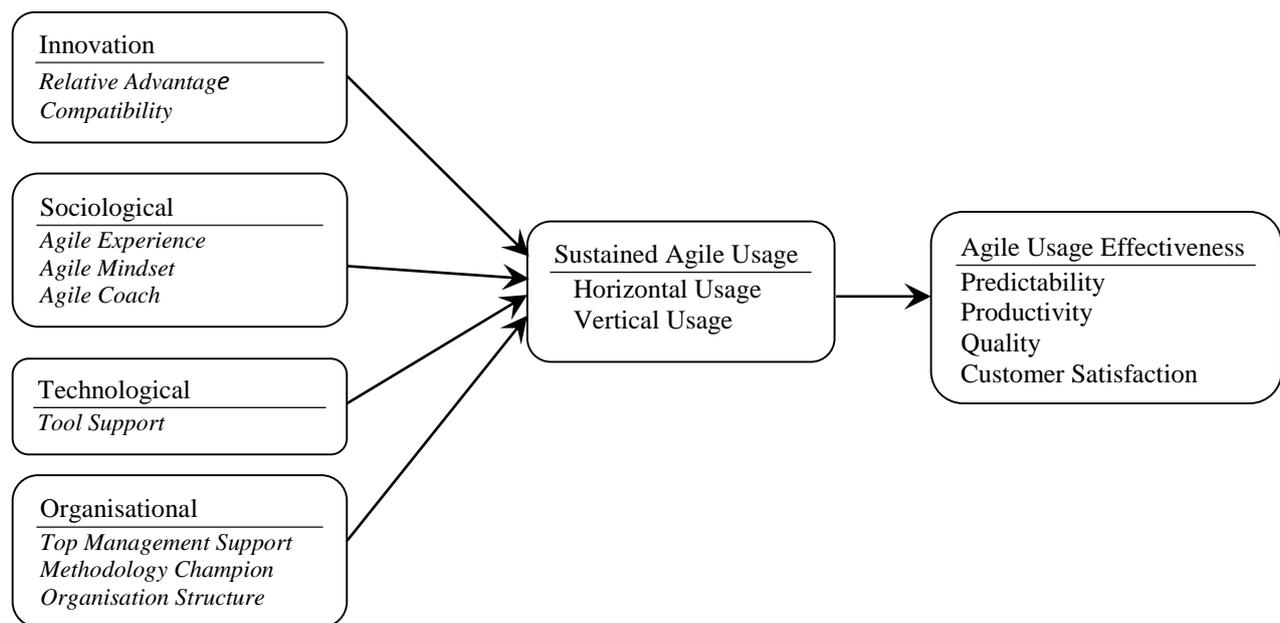


Figure 5.4: Sustained Agile Usage Model (CF4)

In summary, the initial *a priori* research model (conceptual framework, CF1), presented in Chapters 1 and 2, was developed by coalescing insights from IS implementation, traditional innovation diffusion models, and agile methodology literature. It laid out the research territory, guided, and formed the pre-understanding for the first research phase, i.e. Case Study where the model was applied sequentially to two cases, (CF1 applied to BBCW), (CF2 applied to Stats NZ). The updated model based on the analyses and reflection of the case study phase was applied to the third phase as described in this chapter (i.e. CF3 applied to focus group and semi-structured interviews). The output of the third phase is the final refined model (CF4) which integrates findings from all the previous phases which is finally applied to the last phase of this research, i.e. survey (Figure 5.5)

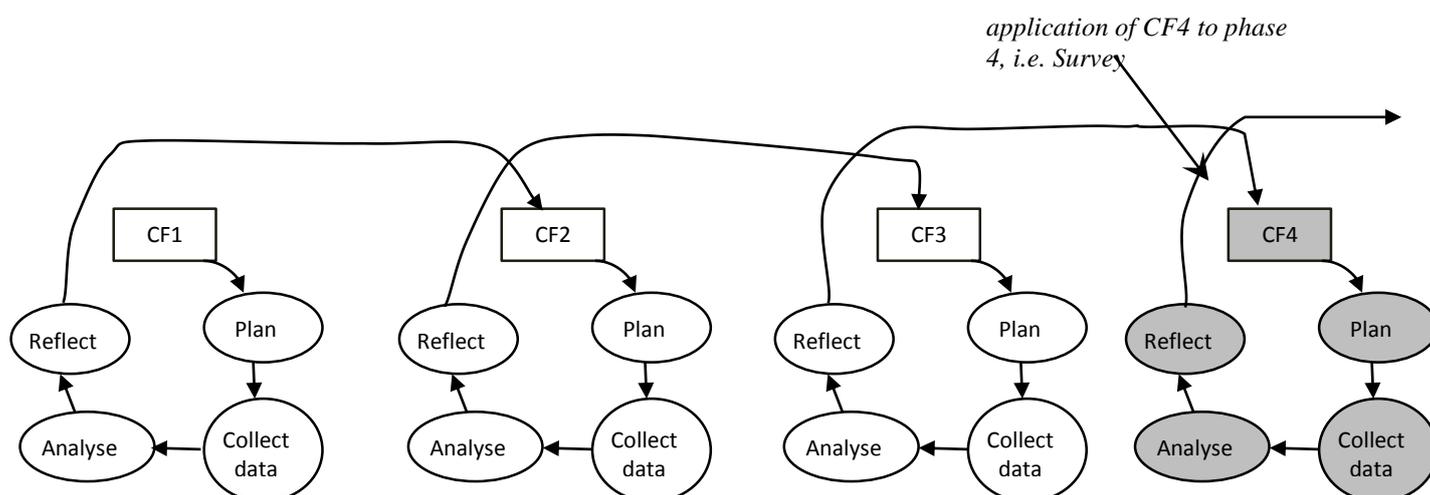


Figure 5.5: Structured-case framework

5.9. Conclusion

This chapter described the third research phase undertaken in this research, it described how the SAU model from phase 2, i.e. CF3 was applied to the third phase, (a combination of a focus group and semi-structured interviews) to further explore and gain insights on the adequacy and nature of the theoretically developed constructs of SAU, and to add to the interpretation of the results found by analysing previously collected data.

First, a brief introduction to phase 3 and the two data collection methods were presented followed by detailed information on the design and conduct of both the methods (i.e. focus groups and semi-structured interviews). Combined findings and analysis from both methods were discussed before presenting the final model along with the development of a set of hypotheses to be tested in the next phase of research, i.e. survey (Chapter 6)

Though the findings confirm that the various factors identified in the final model have a significant impact on SAU of AMs, it is acknowledged that sustained agile usage in certain organisations may be influenced by specific factors or measures not identified in the model. Therefore, further research could refine or expand the model in several ways. Studies in different organisational settings and for different types of agile practices would potentially increase the applicability of the model.

Chapter 6. Survey

Up to this point, this thesis described the development of a model (i.e. Sustained Agile Usage Model) to understand the important factors that impact SAU and the relationship between SAU and agile usage effectiveness. The remainder of this thesis is set out to describe how the final SAU model is subjected to an empirical test. This chapter describes the design of a survey to measure the constructs and their relationships comprising the SAU model described in Chapter five. The chapter starts with an introduction to the survey research followed by a description of the research design used in the current study. Later, testing and execution of the survey instrument is described.

6.1. Survey Research Method

Survey is a comprehensive research method for collecting information to describe, compare or explain knowledge, attitudes and behaviour (Fink, 1995). It is most closely associated with the use of questionnaires for data collection that emphasise quantitative analysis. The main purpose of a survey is to produce statistics, that is, quantitative or numerical descriptions of some aspects of the study population, where the quantitative subjective data (concerning individual's opinions, attitudes and preferences) constitute the data to be analysed (Fowler, 2002b). While a number of different types of surveys such as marketing and opinion surveys exist, the main objective of conducting surveys for research purposes is to advance scientific knowledge (Pinsonneault & Kraemer, 1993). The defining characteristic of survey research is the selection of a *representative sample* from a well-defined *population*, and hence to provide generalisable statements about the object of study (Easterbrook, Singer, Storey, & Damian, 2008). Survey research is also recognised for its ability to contribute to “triangulation” in multi-method research designs (Gable, 1994a).

Survey research is a widely used research method in the field of information systems (Palvia et al., 2004) for its ability to (Sedera, Gable, & Chan, 2003):

- a) document the norm accurately, and identifying extreme outcomes and delineating associations between variables in a sample
- b) analyse data both at aggregate and individual level
- c) facilitate rigorous hypothesis testing by using sample sizes bigger than, for example, case studies, and

- d) add to the inventory of prior survey instruments, which allows research to be expedited without re-inventing instruments.

Survey research method was selected as one of the methods in the current study by evaluating its appropriateness using the four aspects of research designs for which survey research method is suggested to be most appropriate (Pinsonneault & Kraemer, 1993):

1. the main research questions relate to ‘what’, ‘how’, and ‘why’ aspects of the phenomenon of interest. In the case of this research, the main research questions relate to the main factors (‘what’) that impact sustained agile usage.
2. it is not desirable to control the independent and dependent variables. As the main aim of this research was to understand individual agile practitioners’ perceptions on the various factors that impact agile usage, controlling all the potential dependent effects related to agile usage phenomenon was not desired.
3. The phenomenon of interest needs to be studied in its natural setting. In this research, agile usage is investigated by studying the use of an agile method by an individual in his or her organisational setting.
4. The phenomenon of interest occurs in current time or the recent past. Though it has been almost a decade since AMs were introduced, the concepts of its sustained or post-adoption use and usage effectiveness is characterized as being current.

6.1.1. Survey Objectives

Survey research can be classified for three main purposes: exploration, description, or explanation (Pinsonneault & Kraemer, 1993):

- the purpose of exploratory surveys is to become more familiar with a topic of interest. They are mainly used as a basis for identifying important constructs, developing concepts and methods for more detailed, systematic, descriptive or explanatory surveys.
- the purpose of descriptive surveys is to examine situations, events, attitudes or opinions occurring in a population. They are used to ascertain facts, and to test a theory.
- the purpose of explanatory surveys is to test theory and existence of hypothesised causal relations between the proposed exogenous and endogenous constructs and also the directionality of effects.

The objectives of the survey should be clearly defined where each objective could simply be a statement of the survey's expected outcomes or a question that the survey is intended to answer - in the context of software engineering, there are three common types of objectives (Kitchenham & Pfleeger, 2008):

- To evaluate the rate or frequency of some characteristic that occurs in a population (for example, the frequency of failing projects).
- To assess the severity of some characteristic or condition that occurs in a population (for example, the average overrun of software projects).
- To identify factors that influence a characteristic or phenomenon (for example, investigate factors that predispose a process improvement activity towards failure or towards success)

While the first two types of survey objectives are descriptive (i.e. they describe some condition or factor found in a population in terms of its frequency and impact), the third type of survey can be classified as explanatory as it looks at the relationship existing among factors and conditions within a population.

Survey design can also be categorised as *cross sectional*, where the participants are asked for information at one fixed point of time, or *longitudinal*, where the participants are asked for information about changes over time (i.e. either survey the same people at each time period or survey different people) (Kitchenham & Pfleeger, 2008)

In this research, survey method is cross-sectional and used in an explanatory manner (i.e. to test the relationships between the factors and SAU, and between SAU and agile usage effectiveness) to test the theoretical model. The survey instrumentation draws from a number of well-established theoretical frameworks and validated instruments.

6.2. Survey design guidelines

6.2.1. Characteristics of surveys

The following table (table 6.1) summarises important characteristics/strengths of surveys:

Table 6.1: Survey Characteristics

Characteristic	Description
Systematic	The survey follows a specific set of rules; a formal and orderly; easy to administer, score, and code
Impartial	Selects units of the population without prejudice or preference
Representative	Includes units that together are representative of the problem under study and the population affected by it
Theory-based	The survey's operations are guided by relevant principles of human behaviour and mathematical laws of probability and statistics. Specific theoretical propositions can be tested in an objective fashion
Quantitative	It assigns numerical values to non-numerical characteristics of human behaviour in ways that permit uniform interpretation of these characteristics. They can help confirm and quantify the findings of qualitative research
Replicable	They can be replicated easily, and provide an objective way of comparing responses over different groups, times, and places

Source: adopted from (Kasunic, 2005; Newsted, Huff, & Munro, 1998).

In positivist research, surveys are particularly useful in determining the actual values of variables under study, and the strengths of relationships among them (Newsted et al., 1998). While survey research offers significant advantages and is well recognised in a wide range of disciplines including IS, there are certain limitations that should be understood. Most problems are related to inappropriate and careless design and conduct of survey research rather than to fundamental misunderstanding of the survey methodology itself (Pinsonneault & Kraemer, 1993). Survey research can have the following limitations (Kasunic, 2005; Newsted et al., 1998):

- Surveys are just a snapshot of behaviour at one place and time.
- Survey data is usually superficial. It is typically not possible to go into details of looking for fundamental explanations of people's unique understandings or behaviours.
- To generalise for a population, strict procedures must be followed in defining which participants are studied and how they are selected. Validity of results and findings cannot be assumed in different contexts and settings.
- Surveys are often susceptible to low response rates, which can diminish the generalisability of the findings. Sivo, Saunders, Chang, and Jiang (2006) discuss the issue of low response rates in IS research.
- Rigorous implementation of survey can be expensive with respect to cost and time.

In order to address the challenges associated with survey research, Grover, Lee, Durand, and Durand (1993) identify a set of Survey Methodological Attributes (SMA) that reflect the main desirable characteristics of survey research.

- *Report the approach used to randomize or select samples:* all relevant details of the sampling procedure should be reported (i.e., whether the survey used simple random sampling, clustering, or stratification). Describing the randomization or selection procedure permits readers to decide for themselves the validity and representativeness of the sample frame.
- *Report a profile of the sample frame:* a well-defined sample frame should represent characteristics of all members of the population. Reporting the boundary of the sample frame shows the extent to which the sample frame corresponds to the target population.
- *Report characteristics of respondents:* describing the characteristics of the respondents permits readers to evaluate whether particular characteristics are representative of the sample.
- *Adopt a validated instrument or perform a validity or reliability analysis:* instrument validation should precede both internal and statistical conclusion validity.
- *Perform an instrument pre-test:* pre-testing helps in producing a more usable and reliable survey instrument, and in refining the instrument.
- *Report on response rate:* response rate should be considered seriously without which obtaining a large sample would be meaningless. Response rate and non-response error have been considered as major issues in IS survey research (Sivo et al., 2006).

6.3. Survey Design

The discussion in the preceding sections highlight that survey is a process which must be implemented by following strict methodological guidelines and procedures (Kasunic, 2005). The need for a process perspective is highlighted in the following statement by W. Edwards Deming which implies that it is the survey process that determines whether the results will be

The information that a statistical survey or experiment provides is not right because someone agrees with it, nor wrong because he does not; the information is useful or not useful depending on the information and the questions that were built in initially in the statement of the problem, and on the skill that went into the preparation, execution, and summary of the survey or experiment. The burden rests with the expert in the

subject-matter, and with management, in the preparation of the questionnaire or of the method of test, to get information that they can apply to the problem when the results of the survey or experiment come in. (Deming, 1960)

useful. Therefore, when evaluating survey quality, the complete survey process should be considered - for example, clear objectives, quality of the sample, of the measurement questions, of data collection, and of the mode of data collection all constitute a tightly interrelated set of issues and decisions (Fowler, 2002a; Grover et al., 1993). Though it is acknowledged that it may not always be practically feasible to address all elements fully (Grover et al., 1993), researchers should make conscientious effort to ensure that the survey process execution is of adequate quality. Accordingly, three key elements of high quality survey research that should be built into the design of the survey process have been recognised in the literature (Dillman, 2000; Fowler, 2002a; Pinsonneault & Kraemer, 1993):

- Survey design: The design of the survey involves the strategy used to address the survey's expected outcomes or the questions that the survey is intended to answer. Survey designs can be generally characterized using three dimensions: *time*, *unit of analysis*, and *data analysis* techniques used. As discussed previously, using the time dimension, survey design can be classified as either cross-sectional or longitudinal. In the current study, since the proposed SAU model does not contain any process elements such as change events, a cross-sectional design is deemed appropriate. Most surveys in IS and software engineering are cross-sectional (Kitchenham & Pfleeger, 2008). The unit of analysis refers to the level of aggregation of the data collected during the subsequent data analysis stage and can be an individual, dyads, group, or organisation, and may also be a method, tool, or technique (Sekaran, 2003). As the current study is interested in the perceptions of individual practitioners on factors influencing SAU, the unit of analysis is the individual agile practitioner who has been working with agile methods for at least three years. In terms of data analysis, while descriptive and inferential statistics may be sufficient to analyse descriptive and exploratory surveys, explanatory surveys (such as the one used in this study) and the use of cross-sectional data to test causal hypothesis requires careful consideration and design of valid and reliable measurements for the various constructs in the model. Instrument validation is one of the most crucial phases in the survey process which determines the data analysis strategy to be employed. It can absorb a large amount of time and effort and a good validation exercise typically includes a pre-test, technical validation, and pilot project

(Straub, 1989). Survey design involves four major steps: construct operationalisation, instrument development, instrument testing, and survey conduct. Each of these steps is described in section 6.3.1

- **Sampling:** the process of selecting the right individuals, objects, or events, so that a study of the sample and an understanding of its characteristics relating to the phenomenon of interest enables generalisation to the population is called sampling (Sekaran, 2003). The target sample should arise and be based on the survey objectives, and not from a sense of who is available to participate in the survey (Kitchenham & Pfleeger, 2008). One of the more fundamental mistakes that can be made in survey research relates to sampling error (Sivo et al., 2006). A number of different sampling methods exist, each of which has different consequences on the risk of sampling error. These methods are broadly classified into two main categories (Kitchenham & Pfleeger, 2008): probabilistic (e.g. stratified sampling, systematic sampling, cluster-based sampling) and non-probabilistic (e.g. convenience sampling, snowball sampling, quota sampling)
- **Data collection:** in survey research, though a number of different data collection methods such as email surveys, telephone or face-to-face interviews, and electronic surveys (e.g. web-based) exist, electronic surveys have become increasingly popular in the past fifteen years. Electronic surveys provide distinct advantages over other methods in terms of speedy distribution and response cycles (Andrews, Nonnecke, & Preece, 2003). It is also suggested that using a combination of multiple data collection approaches such as individual interviews, focus groups, email, and web-based surveys improve the results quality and sample representativeness (Andrews et al., 2003). There is sufficient literature on the benefits and limitations of different data collection methods in survey research, which enabled the researcher to make a conscientious decision in selecting the appropriate method for this study.

6.3.1. Construct operationalisation

Operationalisation is translating the behavioural dimensions, facets, or properties of a concept or phenomenon of interest into observable and measurable elements so as to develop an index of measurement of the concept (Sekaran, 2003), i.e. it is the process of identifying appropriate measures for each latent construct. There are two main approaches for deriving latent constructs and measures: (Hinkin, 1995)

(a) inductive approach - the researcher collects qualitative data, such as case study data, and interview data and categorises the data in order to generate appropriate constructs and measures of a latent construct, and

(b) deductive approach the researcher focuses on the derivation of measures following the guidelines of an existing theory, model, framework or taxonomy, i.e. it is a theory-driven approach.

In both circumstances, constructs and measures should represent the measurement phenomenon adequately with no extraneous variables (Sedera et al., 2003). Construct operationalisation is concerned with devising or developing measurement items that are reliable and valid. In this study, though the constructs and relations in the initial *a priori* model were drawn from related literature, all the latent constructs in the final refined model (please see Chapter 5) were developed/validated iteratively through a number of phases, i.e. case study, focus group, and semi-structured interviews using an inductive approach. At this point of the study, the extant literature was reviewed to make sure that the resulting constructs and measures were complete. A systematic literature review was conducted to identify all studies that had investigated and operationalised factors influencing SAU. A protocol was developed which specified the research questions, search strategy, inclusion and exclusion criteria, details on the search string and the databases in which it would be applied. The search aimed at identifying English language peer-reviewed empirical studies on sustained use of AMs that focused on factors impacting their sustained usage. Both automated and manual searches were used to increase coverage. The search included qualitative and quantitative studies, and industrial experience reports, published between 2005 and October 2012. Studies that focused on single agile practices such as pair programming or test driven development were excluded. The following electronic databases were selected: ACM Digital library, ProQuest (ABI/INFORM), IEEE Digital Library, ScienceDirect/Scopus, SpringerLink. Manual search was conducted on all volumes of the two annual global conferences on agile software development: XP and Agile. Though the findings of this review did not reveal any constructs or operationalised measures that were not already identified in the final refined model, it made the researcher to comprehend/articulate the complex task of developing a survey instrument in a not well researched domain that lacked strong theoretical foundations. The complete review report

(process, results and findings) was presented at the seventeenth Internal Conference on Evaluation and Assessment in Software Engineering (EASE 2013¹⁷).

Based on the analysis of the case study data, focus group and the interview data, the final refined model which classifies the factors that impact SAU into four categories is shown in Figure 6.1. The model's final set of constructs and relationships were used in the operationalisation and development of formal propositions as discussed in Chapter 5. Figure 6.1 shows the final set of constructs showing their direction of influence on sustained agile usage, as well as the influence of SAU on agile usage effectiveness.

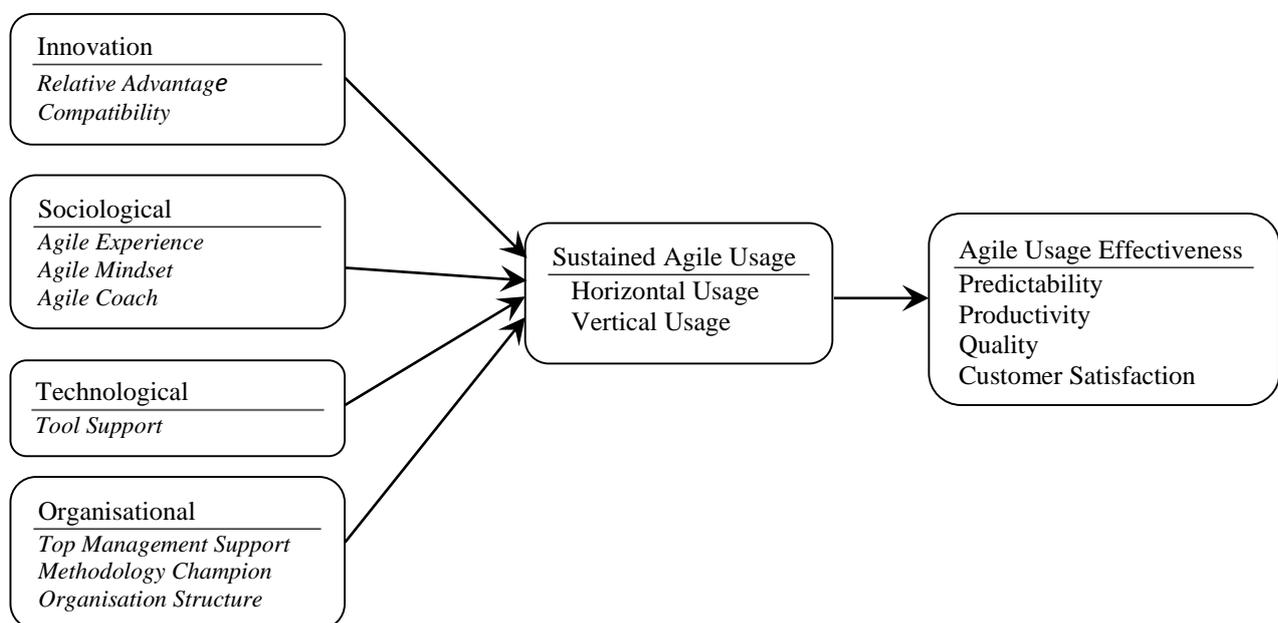


Figure 6.1: Sustained Agile Usage Model (CF4)

Though the significance of rigorous theoretical justification in construct operationalisation and development of measures has been well recognised in the literature (Hair, Hult, Ringle, & Sarstedt, 2014; Sivo et al., 2006), survey research in fields such as IS and software engineering still lack methodological rigor (Kitchenham & Pfleger, 2008). In recent years, methodological issues relating to empirical measurement has been receiving increasing attention in IS research with leading IS journals starting to report the development and validation of measurement instruments in greater detail (Burton-Jones & Straub, 2006; Froehle & Roth, 2004; Sun & Zhang, 2006). The current study makes an attempt to use a rigorous methodology for developing and validating the constructs and measures in the proposed SAU model. In particular, two major types of constructs have been operationalised:

¹⁷ EASE 2013, <http://www.cin.ufpe.br/~ease2013/> Porto de Galinhas, 14th – 16th April 2013.

- Constructs for which previously developed and validated were available (constructs such as relative advantage, compatibility from DOI and TAM)
- Constructs which had be adapted or newly developed (e.g. agile mindset, AC)

In the following sections, the rationales for adoption, adaptation or development of constructs are discussed. The final adopted items per construct as used in the final survey instrument is summarised in Table 6.2.

6.3.2. Adoption/adaptation of scales:

The number of items to measure a construct should adequately sample the domain of interest while being as parsimonious as possible (Cronbach & Meehl, 1955). With the increasing popularity of second-generation multivariate statistical methods such as Structural Equation Modelling, there have been different opinions and recommendations relating to some aspects of measurement guidelines. For example, use of single-item measures are generally not advocated as they may contribute to mis-measurement (decreased construct validity) and decreased reliability (as they do not allow adjustment of measurement error like multiple items), but more recent research highlight the practical advantages of single-items such as ease of application, brevity, and higher response rates when used under recommended guidelines (Hair et al., 2014).

In IS research, it is strongly recommended to use existing well-developed and validated measurements/instruments whenever applicable (Zmud & Boynton, 1991). In fact, almost all social science research today use measurement instruments published in prior research studies (Heir 2014). In the current study, pre-validated measurement constructs with clearly demonstrated quality measures are used wherever applicable. They were adapted to reflect the phenomenon of interest, i.e. SAU, by either rephrasing or rewording the measures. With the exception of agile mindset, AC, and organisation structure, all measures were adapted from the corresponding pre-validated measures (e.g. DOI of CASE tools (Iivari, 1996), diffusion of PSP (Green & Hevner, 1999) and information technology (IT) innovation adoption instruments (Moore & Benbasat, 1991)).

Table 6.2: Final adopted measurement items for all constructs

Construct	Adopted definition	No	Item	Adopted from
Relative advantage	<i>the degree to which an agile practitioner perceives that an agile method is better than its precursor</i>	RELAD1 RELAD2 RELAD3 RELAD4 RELAD5	Using agile enables me to accomplish tasks more quickly. Using agile improves the quality of work I do. Using agile methods/practices makes it easier to complete my tasks. Using agile enables increased flexibility in my tasks. Using agile enhances my effectiveness on the job.	MOORE and BENBASAT (1991) MOORE and BENBASAT (1991) RESEARCHER MOORE and BENBASAT (1991)
Compatibility	<i>the degree to which an agile practitioner perceives an agile method as being consistent with the existing practices, values,[and]past experiences</i>	COMP1 COMP2 COMP3	Using agile is compatible with all aspects of my work. I think that using agile fits well with the way I like to work. Using agile fits into my work style.	MOORE and BENBASAT (1991)
Agile coach	<i>the extent to which an agile practitioner perceives that the presence of an agile coach and the effectiveness of an agile coach enables sustained use of agile methods/practices</i>	ACOACH1 ACOACH2	To what extent was there an agile coach in your organisation? How effective was the agile coach in enabling effective use of agile methods?	GREEN <i>et al.</i> (1999) GREEN <i>et al.</i> (1999)
Agile mindset	<i>the extent to which an agile practitioner perceives that their team members have attributes of an agile mind set</i>	AMIND1 AMIND2 AMIND3 AMIND4 AMIND5	My team members have a strong sense of identification and commitment with the team. My team members have the willingness to learn and change. My team members have strong interpersonal and communication skills. My team members are technically competent. My team members have collaborative attitude.	WILLIAMS <i>et al.</i> (2012); RISING (2012)
Tool support	<i>the degree to which an agile practitioner perceives that the use of appropriate tools to support agile practices enables sustained and use of agile methods</i>	TOOLEFF	Using appropriate tools to support agile practices enables me to effectively use agile methods.	GREEN <i>et al.</i> (1999)
Methodology Champion	<i>the extent to which an agile practitioner perceives that the</i>	MCHAMP1	To what extent was there a methodology champion in your organisation?	GREEN <i>et al.</i> (1999)

	<i>presence/effectiveness of a methodology champion enables sustained use of agile methods/practices</i>	MCHAMP2	How effective was the methodology champion in enabling effective use of agile methods?	
Management Support	<i>the degree to which an agile practitioner perceives that he or she received support from management</i>	ORGSUPP1 ORGSUPP2 ORGSUPP3 ORGSUPP4	Management provided me with the time for training that I needed in order to use agile methods effectively. Management provided me with funding for training that I needed in order to use agile methods effectively. I had easy access to people of the necessary expertise to help me make the transition to agile methods. I had a solid “network of support” in the form of knowledgeable colleagues, internal support personnel, and/or outside consultants that helped me in the effective use of agile methods.	CHAU (1996) CHAU (1996) CHAU (1996) CHAU (1996)
Organisation Structure	<i>the degree to which an agile practitioner perceives that their organisation structure enables sustained use of agile methods</i>	ORGSTRUCT	The organisation structure in the place I work enabled me in the effective use of agile methods. (e.g., informal procedures followed in activities such as tracking requirements changes, cost/size estimating, funding, scheduling).	ZMUD (1982); TENG and NELSON (1996);
Agile Usage				
Vertical usage	<i>refers to the intensity of use or adherence to a chosen agile method i.e., depth of use of agile practices.</i>	AGVUSE1 AGVUSE2	To what extent does your department or organisation adhere to the practices of the agile methods you use? The phases/activities that I typically use agile practices/principles in are (i.e. requirements specification, Software/system analysis, Software/system design, Development, Testing, Other).	RESEARCHER IIVARI (1996); IIVARI and HUISMAN (2007); GREEN <i>et al.</i> (1999)
Horizontal usage	<i>refers to the extent of use after the methods have been adopted, learnt, and internalized.</i>	AGHUSE	The proportion of projects I use agile methods and practices (i.e. 1 – 25%, 26 – 50%, 50 – 70%, >75%).	IIVARI and HUISMAN (2007); GREEN <i>et al.</i> (1999)
Predictability	<i>the extent to which an agile practitioner perceives that agile usage impacts predictability (predict the effort required for software development, delivery of software etc.)</i>	PREDICT1 PREDICT2 PREDICT3	To what extent does the use of agile methods/practices allow you or your teams to better predict the effort required for software development? To what extent does the use of agile methods/practices allow you to better predict the quality of software that you or your teams develop? To what extent does the use of agile methods/practices allow you to better predict the delivery of software you or your teams develop?	GREEN <i>et al.</i> (1999) GREEN <i>et al.</i> (1999) GREEN <i>et al.</i> (1999)

Productivity	<i>the extent to which an agile practitioner perceives that agile usage impacts productivity (e.g., speed up development of applications, teams more productive),</i>	PROD1 PROD2 PROD3	Use of agile methods/practices has greatly speeded up my (our) development of new applications. Use of agile methods/practices has definitely made me (my team/s) more productive. Use of agile methods/practices has significantly reduced the time I (we) spend in software/systems development.	IIVARI (1996); WILLIAMS <i>et al.</i> (2004);
Quality	<i>the extent to which an agile practitioner perceives that agile usage impacts quality of the development process (e.g., decrease the number of errors, improved quality of systems/software built)</i>	QUAL1 QUAL2 QUAL1 QUAL1	Use of agile methods/practices has enhanced the functionality of applications that we build. Use of agile methods/practices has decreased the number of errors in the systems/software products we build. Use of agile methods/practices has improved the quality of the systems/software products we build. Use of agile methods/practices has made me (us) more conscious of software quality.	IIVARI (1996); WILLIAMS <i>et al.</i> (2004);
Customer Satisfaction	<i>The extent to which an agile practitioner perceives that agile usage impacts customer satisfaction</i>	CUSSAT1 CUSSAT2 CUSSAT3	Our customer(s) have been satisfied with the usability of our products since we started using agile methods/practices. Our customer(s) have been satisfied with the functionality of our products since we started using agile methods/practices. Overall, our customers are satisfied with us since we started using agile methods.	IIVARI (1996); WILLIAMS <i>et al.</i> (2004);

Sustained Agile Usage was measured using: i) horizontal usage: percentage of projects using ASD methods, ii) vertical usage: intensity or adherence to ASD method. The measures for agile usage effectiveness (i.e. predictability, productivity, quality, and customer satisfaction) were adapted from related measures in the XP Evaluation Framework and PSP literature (Green & Hevner, 1999; Williams et al., 2004a). For all scales and items used in the survey instrument (Appendix E). The following section describes the measurement for all constructs along with the rationale for adaptation and operationalisation.

6.3.2.1. Innovation factors

The items in this section ask the participants to assess the agile approach based on their continued use of agile methods and practices. Both relative advantage and compatibility measures were adapted from the innovation adoption instrument (Moore & Benbasat, 1991). The original scale for relative advantage has nine items and compatibility has 4 items with Cronbach's Alpha reliability coefficients (CA) 0.92 and 0.83 respectively where the study's target level of minimum reliability was set in the 0.70 to 0.80 range. In order to keep the length of the survey instrument relatively short, the shortened scale (relative advantage = 5 items and compatibility = 4 items) was chosen as it was deemed sufficient to capture the intent of these constructs. Moreover, the reduced scale did not pose any significant threats to both the validity and reliability (RELAD, CA = 0.90; COMP, CA = 0.86). Out of the five questions for relative advantage, the question "*using agile gives me greater control over my work*" was changed to "*using agile enables increased flexibility in my tasks*" to better reflect the agile principles of change and flexibility.

6.3.2.2. Sociological factors

This section has three constructs; agile experience, agile coach, and agile mindset. Agile experience was measured by the number of years of practical experience in using agile methods/practices, but the measure was not to use in analysing its impact on sustained agile usage. The construct AC was introduced in the final model after it consistently emerged as a key factor in all the qualitative phases (i.e. case studies, focus group, and semi-structured interviews) of this study (please see Chapter 5 for a detailed discussion on this). The key differences between traditional leadership roles (e.g. project manager) who have a wider set of project and organisation specific responsibilities and the transitory role of an AC whose main focus is on the team to become adept in applying agile practices was noted. A greater number of IS and software engineering studies acknowledge the importance of methodology champion

support (Green & Hevner, 1999; Iivari & Huisman, 2007; Rai & Howard, 1994). Beath (Beath, 1991) speaks of champions as transformational leaders who use a variety of influences (social, political, etc.) at a wider level which more closely relates to traditional leadership at the divisional or organisational level rather than that of an AC. However, the impact of the role 'AC' on an innovation's use has not been empirically validated. Since this research is concerned with the existence and the impact of an AC on sustained agile usage rather than on the ways in which the coach accomplishes his/her goals, the methodology champion's measure (Green & Hevner, 1999) was deemed sufficient and was adapted to reflect this construct. The extent to which an AC is able to sustain agile usage can be expected to influence the extent to which an agile practitioner perceives to effectively use agile methods. The definitions of the two constructs (MC and AC) and the differences between them were clearly described in the survey instrument.

The other important sociological construct that consistently emerged as a key factor influencing SAU (i.e. findings from case studies, focus group, and semi-structured interviews) was 'agile mindset'. As discussed in Chapter 5, sociological characteristics such as attitude, technical competence, and willingness to learn and change were combined to constitute this construct. A number of studies (e.g. case studies, interviews), both in the academic (Whitworth, 2008) and practitioner (see for example, (Sidky, 2012)) literature have investigated the influence and significance of these social characteristics on effective agile use of agile methods. However, no operationalisation and validation of these social characteristics as a construct was found in the extant agile literature. Therefore, items that reflected the key characteristics of agile mindset (i.e. technical competence + commitment + willingness to learn and change) were extracted from related studies (Rising, 2012; Whitworth, 2008; Williams, 2012; Williams et al., 2004b) to measure this construct.

6.3.2.3. Technological factors

Findings from previous phases (FG, interviews) also provided strong support for the significance of constructs (agile practices, tool support) on the effective and sustained agile usage. However, as discussed in Chapter 5, there was some overlap between the constructs 'agile practices' and 'vertical usage'. Therefore, in order to simplify the model, the construct 'agile practices' was removed and only 'tool support' was retained. Items from Green et al. (1999) were adapted to develop the measure for 'tool support' which asks the participants to assess the influence of tool support on the sustained usage of agile methods.

6.3.2.4. Organisational factors

Methodology champion: as discussed in the section above (please see ‘AC’) the influence of methodology champion on an innovation’s use has been well validated in the literature. Similar to the construct ‘AC’, the focus is on the existence and the impact of a methodology champion on agile usage rather than on the ways in which the champion accomplishes his/her goals, Green and Hevner (1999)’s scale was adopted to measure this construct. It measures the extent to which an agile practitioner perceives a methodology champion is able to influence agile usage.

Management (Organisation) Support: management support is a well validated measure in both IS and software engineering literature (Green & Hevner, 1999; Huisman & Iivari, 2002; Iivari, 1996; Iivari & Huisman, 2007) which is identified as a critical variable influencing the diffusion of software process engineering innovations including CASE tools. In general, MS is associated with aspects such as providing support during initial adoption and use, controlling resources needed for system development and use, and encouraging certain behaviours (Iivari, 1996). As the current study is concerned with sustained use of agile methods rather than on just initial use and development, MS does not merely imply providing support in the initial stages (e.g. financial support) and controlling resources, but also on providing sustained support in developing effective strategies (for example, transitioning to flatter structure, ongoing training to users) that specifically relate to agile use (e.g. AC). Therefore, Chau’s (Chau, 1996) MS scale which focuses on key aspects of sustained use such as providing on-going training and support for users, and reducing or eliminating barriers to use was deemed more appropriate. Chau’s scale has been validated in the diffusion and sustained use of software engineering process innovations (Green & Hevner, 1999). All four items from Chau’s scale were adapted to measure MS.

The next construct that emerged as a key factor influencing agile usage was Organisation Structure. Though organisation structure has been affected by various strategies of strategic management style since 1960s, the current (i.e. the 2010s) agile structure (i.e. learning and agile strategy) relates to one of the oldest and most intuitively appealing notions in innovation literature, i.e. organic organisations, i.e. those organisations that are informal, have flexible work rules, lacks assigned authority, and encourage lateral communication between departments can be expected to foster a higher level of individual initiative behaviour (Teng & Nelson, 1996) in using innovative methods such as agile. The following extant literature

relating to organisation structure was reviewed:

- (1) agile organisation structure ((Nerur & Mahapatra 2005))
- (2) Organisational Culture Assessment Instrument (OCAI)
- (3) SDM use and AMs use (Iivari & Huisman, 2007; Iivari & Iivari, 2011)
- (4) organisational attributes (i.e. formalisation and centralisation) often used by researchers to operationalise the organic vs. mechanistic structural dichotomy (Teng & Nelson, 1996; Zmud, 1982).

Based on this review, a single-item measure for the organisation structure construct was developed, i.e. an organisation structure that enables agile development (e.g., informal procedures followed in activities such as tracking requirements changes, funding, and flatter structure) can be expected to influence sustained use of agile methods.

As discussed in Chapter 2, the only conceptualisation of post-adoption or sustained use in an agile context is that specified by Wang et al (Wang et al., 2012), where post-adoption agile usage is defined using three main facets: 1) extensive use: most features of a prescribed agile method are used (for example, Scrum prescribes 3 roles), 2) intensive use: an agile practice is used with intensity beyond that suggested by the textbook, and 3) deeply customized use: an agile practice is adapted at a deep level to suit the need of the adopting team. However, their conceptualisation is very specific to the post-adoption use of individual practices of specific method (i.e. XP), whereas the focus of the current study is in the continued use of an agile method, i.e. at a method level rather than at practice level. Therefore, while Wang's 'extensive use' can be applied to the current study, the other two (i.e. intensive and deeply customized use) are specific to individual practices and therefore could not be applied. Wang's 'extensive use' is very similar to the concept of 'explicit use' specified by Iivari (Iivari & Huisman 2007) where system development method usage is conceptualised using two elements: explicit and implicit use: explicit use refers to the intensity of use or adherence to a chosen agile method, and implicit use refers to the extent of use after the methods have been adopted, learnt, and internalized – also known as horizontal usage. Therefore, both Wang's 'extensive' use and Iivari's 'explicit' use concepts were incorporated in the scale for vertical usage: *“To what extent is your department or organisation adhering to the following agile methods at present? You may select more than one box. Please select both the method/s below and also circle on the scale at the right the choice that best represents your belief”*. The other measure for vertical usage was adopted from the software engineering process innovation literature (Green & Hevner, 1999) i.e. *The phases/activities that I typically use agile practices/principles in are:*

requirements specification, Software /system analysis, Software/system design, Development , Testing , Other whereas horizontal usage (concept of implicit use - please see above) was adopted from Iivari (1996).

Agile usage effectiveness constructs measure the agile practitioners' perception of improvements in outcomes as a consequence of sustained agile usage. All the agile effectiveness measures were adopted from SPI and agile literature (Green & Hevner, 1999; Williams et al., 2004b).

The previous section described how scales were adapted for the various constructs in the research model (i.e. SAU model). In summary, in cases where previously developed well-validated measures were available (e.g. relative advantage, compatibility) they were either used directly or slightly adapted to reflect agile context. For specifying the theoretical constructs for which measurement scales had to be developed by the researcher (e.g. agile mindset, organisation structure), two steps were followed: (1) extant literature relating to each of the constructs was reviewed in search for any related operationalisations - this included the systematic review process described above (2) feedback was sought from two recognised academics (one in IS, and the other in software engineering) who had expertise in ASD methods. Information on the study's objectives, the survey instrument, expected feedback, etc. was made available to both academics before an individual meeting was scheduled with each of them. Each meeting lasted about an hour in which they were asked to comment and provide feedback on the following points: (i) development procedure (ii) construct definition and specification (iii) item wording (iv) assess coverage and representativeness of the constructs' measures so that they provide a comprehensive coverage of the construct's domain content. After this procedure some measures were re-worded, and changes were made to some constructs and measures.

6.3.3. Instrument development

After the development of scales for all the research model's constructs, the scales were converted to a survey instrument. A detailed description of the rationale for using an electronic web-based instrument and the implementation of the survey instrument is presented in the following sections.

Traditionally, paper-based or email surveys have been the dominant mode of data collection in survey research method. However, over the past two decades, electronic surveys have become increasingly popular, and research has confirmed that electronic surveys has strong advantages

of cost savings, speedy distribution and response cycles (Andrews et al., 2003; Yun & Trumbo, 2000). While electronic surveys have been argued to be superior to other types of surveys (Andrews et al., 2003), some of their limitations have also been recognised: that they may induce potential response bias due to internet access requirements (Porter, 2004) and issues relating to calculation of response rates (King & He, 2005). In the current study, the advantages of electronic web-based survey outweighed their limitations. The target population of this study, i.e., agile practitioners with expertise in the use, development, and implementation practice of systems/software in general and agile in particular, can be expected to be relatively well educated, technologically competent and to have easy regular access to required technology (e.g. internet).

Successful implementation of an electronic survey instrument depends on adherence to rigorous methodological guidelines. Though some of our knowledge concerning the effective design and use of paper-based surveys can be translated into electronic formats, electronic surveys have distinctive technological, demographic and response rate characteristics that affect how they should be designed, when they can be used and how they can be implemented (Andrews et al., 2003). Andrews et al. identify five methodological components critical to electronic surveys: (1) survey design, (2) subject privacy and confidentiality, (3) sampling and subject selection, (4) distribution and response management, and, (5) survey piloting. The following sections describe how these methodological components were incorporated in the current study.

6.3.3.1. Survey design

Electronic surveys present a number of design options such as wide range of textual options, format control, graphics sophistication, clicks (eliminate the need for textual data entry for all coded questions), defaults (reduce non-response to questions), menus (economical way to display many response options), and appearance (images, animation, colour etc.,) (Andrews et al., 2003). However, these options have to be carefully evaluated before incorporating them in the survey. While the range of design options listed above may enhance survey presentation (Yun & Trumbo, 2000), they are accompanied with limitations such as increasing download time and may also affect the responses participants may or may not provide (Couper, Traugott, & Lamias, 2001). For example, (Dillman, Tortora, & Bowker, 1998) found that surveys with sophisticated graphic designs that do not make clear what the respondent is to do resulted in higher attrition rates than those surveys which used more plain and straightforward designs.

Therefore, in the current study, while useful and relevant design options were incorporated in the survey instrument, conscientious effort was made to keep it clear and more straightforward.

Technically, electronic surveys should be designed to (1) support multiple platforms and browsers (Yun & Trumbo, 2000), (2) prevent multiple submissions (Yun & Trumbo, 2000), (3) have the ability to present questions in a logical or adaptive manner (Kehoe & Pitkow, 1997), (4) provide multiple opportunities for saving the work in long questionnaires (e.g., over 50 questions) (Smith, 1997), and (5) collect both quantified selection option answers and narrative type question answers (Yun & Trumbo, 2000). A number of software tools (e.g., QuestionPro, Survey Monkey) are now available which have eliminated many of the construction and administration challenges of web-based survey instruments. Survey Monkey was chosen to implement the current study's survey instrument as the researcher had access to it in her University and it satisfied most of the criteria described above. However, the following points were checked and considered before implementation and their limitations noted:

- (1) Survey Monkey supports multiple platforms and browsers (e.g. Windows, Mac, Google Chrome, Firefox, Internet Explorer).
- (2) has the ability to present questions in a logical manner, and collect both quantified and descriptive open-ended questions.
- (3) In terms of multiple submissions, the data collector was set to allow only one response per computer. This meant that the same participant could respond more than once if using two computers or devices. However, chances of this happening can be expected to be very rare, given the background of potential participants.
- (4) In terms of providing multiple opportunities for saving the work in the questionnaire, the collector was set to save responses through a cookie, i.e. the respondents could leave the survey and resume it later. However, the limitation of this is it requires the respondent to be using only one computer.
- (5) Another limitation at the time of this study's instrument development was that it was not compatible with mobile devices such as tablets (e.g. iPad), which could have had an impact on the response rate given the increasing use of mobile platforms by practitioners.

It is acknowledged that some of the above limitations (4 and 5) could have been avoided if a web survey specific to meet the current study's requirements was developed.

6.3.3.2. Design of questions:

A number of design guidelines should be taken into consideration when designing survey questions. Questions should be precise, unambiguous and understandable to participants and therefore, it is important to ensure that: (Kitchenham & Pfleeger, 2008)

- (i) the language used is clear, unambiguous, use standard grammar, punctuation and spelling
- (ii) questions are short and express one and only one concept
- (iii) questions about events that occurred a long time in the past are avoided
- (iv) sensitive questions that respondents may not be willing to answer in a self-administered questionnaire are avoided.

It is also important to make sure that respondents have sufficient knowledge to answer the questions. For example, in the initial version, the organisation structure question had five questions relating to management style, leadership style, etc. In this case, as participants are asked to answer questions on behalf of their organisation, it may have caused difficulties for participants who might not have sufficient knowledge of all factors or for participants who mainly worked at a department/team level or who had worked for the organisation only for a relatively short period of time. This concern was also highlighted during the pre-testing phase. Therefore, the construct was reduced to only one question to make it concise and applicable to participants coming from a wide range of contexts and organisations.

When a potential participant enters the survey home page, he/she is being informed about the purpose of the research, participation and procedures, confidentiality information including the ethics approval details, key words/phrases to note before beginning the survey, and guidelines for completing the survey. The next page of the survey collects the participant's background and demographic information. Information on the various categories of the research model is presented in separate sections (i.e. innovation, sociological, technological, and organisational) - data in each section is collected on a different page. Both general instructions and any additional information specific to particular sections within the survey was included (Fink, 2012). For self-administered survey instruments, it is recommended that the questions and any supporting information provided should be self-explanatory, i.e. it should enable participation without supervision. In this study, in addition to general instructions and guidelines, specific information such as definitions to key words was provided. For example, not all participants would have had specific roles such as AC, MC etc. in their organisations as the responsibilities

of such roles can also be fulfilled by other roles such as Project Manager, Scrum Master, etc. Therefore, in addition to definitions, brief and clear descriptions on specific differences between 'AC' and traditional roles such as project manager were provided (see below). This was done to ensure all participants were provided a consistent definition of the constructs that were being measured.

The goal of an agile coach is to help teams become self-coaching and adept in applying agile practices to their work more effectively. While the role of an Agile Coach is compatible with roles such as Project Manager and Scrum Master, there are some key differences. For example, the scope of a Scrum Master is to ensure that the Scrum process is followed in terms of its values and practices and is linked with a particular project; the purview of an agile coach is agility (broader) which focuses on process improvement and usually involves multiple teams, and the wider organisation. It is a transitory role and not tied into project duration.

A large rectangular space was provided in the last page where the participant had the option to leave any additional comments on the survey. Participants were asked to provide any additional information regarding the effective usage of agile methods that may help the researcher better understand their responses, or information that they feel is important to help the researcher understand their perceptions of use of agile methods. This information may be of use in interpretation of results, and/or in identifying potential enhancements to the research model (Green & Hevner, 1999).

Another important element of design consideration is the type of questions, i.e., whether they are mandatory or optional (Fink, 2012). In general, most questions were mandatory and there were some non-mandatory questions (e.g. open-ended questions to comment on any additional information that participants deemed important and relevant to the study).

Using correct wording for items (measures) is yet another important design consideration in survey research. Items that measured a construct were grouped together. Though negative worded (reversed) items may help in reducing response bias (Nunnally & Bernstein, 1994), they may induce systematic error and hence reduce the validity of the items (Hinkin, 1995), and sometimes have the tendency of loading on a single separate factor (Roberts, Lewinsohn, & Seeley, 1993). Therefore, as per the general recommendation, negative wording was avoided. All item measures were reviewed by academic colleagues and pilot test respondents in order to reduce any risk of ambiguity in specification, leading questions, misinterpretation

or misleading instructions. The goal was to ensure that the final instrument clearly conveyed the meaning of each measure to potential agile practitioners.

6.3.3.3. Designing answers to questions

In designing answers to questions, the current questionnaire consists of mainly three types of responses:

1. Numerical values (e.g. number of projects, age)
2. Response categories (e.g. current position, main agile method used)
3. Ordinal scales

For response category answers, it was taken care that they are exhaustive but not too long, mutually exclusive, allowed for multiple selections wherever required, and an "Other" category was included to capture response that might have been excluded in the list of response categories (Kitchenham & Pfleeger, 2008). For example, the question “please select the main agile method/s that you used the most” has the following response categories: Agile Unified Process, Scrum, Extreme Programming (XP), Hybrid (e.g. Scrum/XP Hybrid), Agile Modelling, Kanban, FDD, Dynamic Systems Development Methodology (DSDM), and Other. While the categories allowed multiple selections of more than one main agile method, the ‘other’ category allowed participants to specify any hybrid or customized methods.

Using an appropriate scale is another important consideration in survey instrument design. There are three types of scale (Kitchenham & Pfleeger, 2008): 1. Agreement scales (e.g. a response choice of the form: *Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree*) 2. Frequency scales (e.g. a response choice of the form: *Never, Rarely, Seldom, Sometimes, Occasionally, Most of the time.*), and 3. Evaluation scales (e.g. a response choice of the form: *Terrible, Inferior, Passable, Good, Excellent*). The constructs or the factors in the current study were designed to collect data about the impact of the perceived degree of existence of each construct (measured through indicators/measures) on agile usage. Ordinal agreement scales are generally recommended and most frequently used scale to measure perceptions, attitudes and preferences (Kitchenham & Pfleeger, 2008) in many disciplines, including software engineering and IS (Sedera et al., 2003). Accordingly, most items in the current questionnaire used 7-point agreement Likert scales ranging from either “to no extent”

to “to a great extent” or “strongly disagree” to “strongly disagree” by incorporating the following recommendations and guidelines:

- (1) Reliability of a scale is improved when the number of response choices is equal to or greater than five (Kitchenham & Pfleeger, 2008). However, while scales should be exhaustive they should not be too long, as too many points may distort the data as it tends to increase cognitive overload, and respondents may skip response categories that have little substantive meaning for them which may increase the “primacy effect” (Hodge & Gillespie, 2003). Therefore, 7-point scale was used by incorporating a neutral point mid-point response selection.
- (2) points on a scale should be labelled with words (to assist reliability and validity) rather than numbered (because numbers can be interpreted in unanticipated ways by respondents) (Krosnick, 1999). Accordingly, in the current research, all ordinal scale categories were labelled with words.

6.3.4. Survey Instrument Testing - Piloting

Survey instrument testing is crucial to achieving research goals and ensuring that participants complete the survey (Andrews et al., 2003): "*Survey piloting is the process of conceptualising and re-conceptualising the key aims of the study and making preparations for the fieldwork and analysis so that not too much will go wrong and nothing will have been left out*" (Oppenheim, 1992b). Electronic survey does not preclude poor design where various design aspects such as response alternatives (open and closed questions, reference periods, and rating scales) and question context (researcher's epistemic interest, and adjacent questions) can create bias that may destroy the quality of any survey (Andrews et al., 2003; Krosnick, 1999). A conscientious pilot of the survey instrument can help avoid frequent mistakes such as bias in question/answer wording, inaccurate or missing instructions, and insufficient space for responses (Andrews et al., 2003). It can also help in estimating average time needed to complete the survey and identifying ways to increase response rates (Fink, 2012).

Dillman (2000) suggest a multistage process for pilot testing electronic surveys. Stage 1 consists of a review by knowledgeable colleagues and analysts to ensure question completeness, efficiency, relevancy, and format appropriateness. Stage 2 is cognitive pre-testing which consists of observation and "think aloud" protocol while a participant completes the survey – this is followed up with a retrospective interview. It helps to ensure wording

understandability, interpretation consistency, logical sequencing, and overall positive impression from the look and feel of the survey. Stage 3 consists of a small pilot study that includes the administration of the survey to a small, convenient group whose characteristics are very similar to the final target sample group. In Stage 4, people who have no connection to the survey are asked to examine and catch typos and errors that may have been inadvertently introduced during the last revision process.

Following Dillman's piloting process, in Stage 1, six knowledgeable colleagues (two with expertise in ASD methods and four with background in software engineering) were asked to complete a paper-based version of the survey instrument and asked to comment on specific aspects such as item selection, item wording, question completeness, relevance, and format appropriateness. The objective of this stage was to establish face validity and to improve content validity. In Stage 2, a slightly different approach to Dillman's was taken, in that 'think aloud' protocol was not used. Instead, retrospective interviews were conducted with four out of six colleagues (with background in software engineering) who completed the paper-based survey. Notes were taken based on comments received. The combined outcomes of stages 1 and 2 resulted in: shortening the questionnaire to reduce the time needed to complete it to approximately 20 minutes (this shortening was accomplished by reducing the number of questions in the introduction section via item deletion), deletion of items that did not adequately tap the construct being measured, language simplification on some of the questions, reformatting of rating scales such that a similar 7-point Likert scale was used for most questions (Green & Hevner, 1999), and modifications in item wording for clarity. After updating the survey instrument, in Stage 3, a separate collector for review was created in Survey Monkey and an invitation to review the survey was placed on an agile practitioner group on LinkedIn. 10 people completed the survey, but this stage did not produce any outcomes that were significantly different from the previous stages. As the sample size was too small to obtain any significant results, statistical techniques were not employed and therefore the recommended validity or reliability thresholds could not be tested. However, Stage 3 enabled the researcher to perform an initial test of the overall structural model and thus gain familiarity with the structural equation modelling technique in preparation for final data analysis. In Stage 4, the survey instrument was made available on line for a post-graduate introductory Research Methods class majoring in Computing and Information Sciences who did not have any specific expertise in agile methods. The students were asked to review the instrument and comment on any typos and errors, and on the overall layout, structure and design of the instrument.

Participation was voluntary. Though most students reviewed the instrument, no specific improvements or constructive feedback was suggested - which could be attributed to the fact that the researcher was also tutoring the class.

In summary, the piloting process helped in arriving at a general consensus about the content and structure of the instrument which allowed proceeding to the next phase of the survey process, i.e. implementation.

6.3.5. Survey implementation

The next phase in the survey process is administering the survey to the target population. During this phase, considerations such as how individuals will be selected to participate in the survey, the required size of the sample, and how the questionnaire will be distributed to the target population are determined (Kasunic, 2005). While a number of challenges pertain to this phase in any survey procedure (for example, low response rates is a general problem), electronic surveys pose additional challenges. For example, incentives and techniques used in postal surveys may not be possible in electronic formats, and technical difficulties may also have an impact on response rates (Couper, 2000). A lack of survey salience (the association of importance and/or timeliness with a specific topic to potential participants) can reduce response rate (Sheehan & McMillan, 1999). Therefore, understanding the reasons for low response rates and ways in they can be addressed has been a topic of great interest among survey researchers (Dillman, 2000; King & He, 2005; Sivo et al., 2006). Accordingly, a number of guidelines and recommendations such as the tailored design method (TDM) (Dillman, 2000) have been proposed (Sivo et al., 2006). The following sections described how some of these guidelines were incorporated in the current study to increase response rates and to avoid non-response error.

6.3.5.1. Sample size determination

The first step in survey implementation is the identification and selection of people who are most knowledgeable about the topic of interest, i.e. the unit of analysis (Malhotra & Grover, 1998). In the current study, the unit of analysis is an agile practitioner who has knowledge of working with agile methods (e.g. Scrum, XP) for at least 2 years. Based on their knowledge and experience with agile methods, practitioners are asked about the key factors (what) associated with the sustained usage of agile methods. Therefore, the sample frame of interest

in the current study includes all agile practitioners (e.g. Developer, Tester, Coach, Scrum Master) who are practically involved in the on-going use of agile methods.

Once the target population has been identified, it is necessary to assure that the conditions for data gathering are theoretically appropriate and determining the required sample size. It is particularly relevant when second-generation statistical techniques such as structural equation modelling is used (Urbach & Ahlemann, 2010) (PLS-SEM method is adopted in the current study). Based on an often-cited 10 times rule of thumb developed by (Barclay, Higgins, & Thompson, 1995) cited in (Hair et al., 2014), the minimum sample size in a PLS-SEM analysis should be equal to the larger of the following: (1) 10 times the largest number of formative indicators used to measure one construct or (2) 10 times the largest number of structural paths directed at a particular construct in the structural model (Hair et al., 2014). Applied to the present study, this rule recommends a sample size of at least 80 ($10 * 8 = 80$), usage variable has maximum arrows, i.e., 8 pointing to it – see Figure 2). However, Hair suggests that researchers should follow more elaborate recommendations such as those provided by (Cohen, 1992). Assuming the commonly used statistical power of 80% and a specific level of complexity of the path model (i.e. the maximum number of arrows pointing at a construct in the path model) Cohen provides minimum sample size requirements necessary to detect minimum R^2 values (0.10, 0.25, 0.50, and 0.75) in any of the endogenous constructs in the structural model for significance levels of 1%, 5%, and 10%. Given the maximum number of independent variables in the proposed agile usage structural model is eight, one would need **84** observations to achieve a statistical power of 80% for detecting R^2 values of at least 0.25 (with a 5% probability error). A detailed discussion on the adoption of PLS is presented in chapter 7.

6.3.5.2. Sampling

Couper (2000) provides a topology for electronic surveys based upon sampling technique: (i) probability-based sampling methods of intercept, list-based high-coverage, mixed mode design with choice of completion method, and probability samples of full populations, and (ii) non-probability methods such as convenience sampling and self-selection. Given this topology, coverage error (the mismatch between the general population and the sampling frame) and random sampling within the sample frame are the biggest threats to inference from web-based surveys to general population (Couper, 2000). Firstly, people who participate in electronic surveys are different than the general population, and secondly, a sampling frame of all online

users cannot be identified (Couper, 2000). Though random sampling is recognised as a sound statistical sampling approach in an ideal survey procedure, it is extremely difficult to achieve in practice (Andrews et al., 2003). For example, Kehoe and Pitkow (1997) found it impossible to draw a random sample from an almost complete list of internet users. Therefore, in many cases, non-probability sampling is recognised as an acceptable method when survey findings are unique for a particular set of individuals (e.g. a set of individual agile practitioners), as long as it is made clear that inferences and generalisations cannot be made to those outside the respondent group, i.e. if the questionnaire were distributed to a different set of individuals, then a different set of results could be obtained (Kasunic, 2005). In the current study, it was deemed practically impossible to use random sampling method, as there was no information available on how many organisations or individuals are using agile methods in their systems development endeavours. Therefore, a judgemental sampling method was used in an attempt to identify as many agile practitioners as possible.

Participation is a voluntary exercise and no one can be persuaded to participate in the survey. In addition to reasons previously discussed (e.g. lack of survey salience), response rates may also be affected by some systematic judgement by a segment of the target population being studied (Kehoe & Pitkow, 1997). For example, invitations to participate posted on discussion groups may get higher response rates from some groups (e.g. highly interactive groups who consider survey participation as contribution to on-going learning and research), other groups may interpret it as a disturbance and categorise it as a promotion/advertisement, and still some others might not even permit survey requests in their groups. Therefore, strategies to increase response rate should be incorporated into the design of the survey process. While post-survey strategies to estimate and rectify non-response are popular, more proactive and a priori strategies should be used to increase response rate (Sivo et al., 2006). Based on principles such as TDM, Sivo recommend a number of steps that researchers could adopt to improve response rates:

Minimum costs of completion: questionnaires should be short, easy to understand, consistent, should not be discomforting, and required time for completion should be notified. Potential participants who are notified of completion time and those who receive more frequent reminders are more likely to accept the invitation (Andrews et al., 2003). In this study, as discussed previously, the survey instrument went through a rigorous iterative process of piloting. This resulted in a questionnaire which took shorter time to complete (estimated completion time 15 - 20 minutes) - estimated time required to complete was notified. Questions

were re-worded to improve clarity and ease of understanding. Definitions for key words, instructions and guidelines for completion were provided. Answering format, structure, and scales were kept consistent wherever possible.

Maximise benefits: benefits of participating in the survey for potential participants should be specified. This was achieved by stressing the significance of the study to the practitioner community, showing positive regard and appreciation, and expressing gratitude to all potential participants.

In addition, the following techniques were used to build trust with survey participants:

- Frick, Bächtiger, and Reips (1999) found that requesting personal (demographic) data at the beginning of web-based survey significantly lowered attrition rates - it is perceived as honesty on the part of the researcher and helps create greater trust and build quality relationship (Andrews et al., 2003). Therefore, techniques such as providing a full disclosure, direct access to researcher, placing/requesting demographic data at the beginning of the survey and use of sponsor organisations were incorporated in the survey procedure.
- A multi-step process in which a web-based survey is preceded by a separate invitation is recommended (Andrews et al., 2003). Dillman (2000) recommends using a multiple contact strategy to further improve response rates: (1) establishing initial contact and survey notification, (2) seeking support in announcing the survey, (3) invitation to participate, and (4) sending reminders. In addition, techniques to increase the potential participants' response rate to the initial invitation, such as language used in the invitation, title of the study, and the credibility of the research should be used. In the current research, conscientious effort was made to build a trusting relationship from the beginning of the survey experiential process.
- Sponsor organisations act like a bridge between the researcher and the potential participants in that they validate and add credibility to the research. In the current study, support was sought from agile practitioner bodies/organisations (only NZ organisations were targeted) to sponsor the survey. A number of agile practitioner bodies (e.g. Agile Professionals Network (<http://www.agileprofessionals.net>), Scrum Practitioners, International Institute of Business Analysts (IIBA), agile training providers (e.g. Software Education Institute) and linked in agile practitioner discussion groups (e.g. APN) were contacted and asked about their willingness to support. The initial contact

(via email) was first established with the key contact person in the organisation (e.g. Head of IS, General Manager of Software Applications, owner of linked in discussion group) kindly asking for their willingness to support/sponsor and participation. The email provided information such as context around the objective of the survey procedure, background and rationale for why the study is been conducted, usefulness of the study's findings and outcomes to the organisation to help position the survey with the potential responders. A customised invitation was posted to each target group. Of these, many agreed to support by including announcements of the survey and invitations to participate on their webpage as well as through internal announcements. After receiving confirmation about the organisation/group's willingness to support/participate, the second contact letter was sent which included an announcement to potential respondents directly requesting their participation, a link to the survey, information about the study, and estimated time for completion. Knowing that the majority of responses to electronic invitations occur very shortly after posting the invitations, reminders were posted each week following two weeks after the initial invitation (Yun & Trumbo, 2000). The survey was online from September 15, 2013 to December 7, 2013. Over this period, a total of 164 responses were obtained. After the omission of missing values (i.e. incomplete responses) a total of **114 usable responses** were retained which well exceeded the recommended minimum of 84.

6.4. Summary

This chapter described the survey procedure that was used to operationalise the SAU model specified in chapter five. The design, implementation, and conduct of the survey instrument were described. This section peruses the current study's survey research method along the seventeen ideal survey attributes developed by Malhotra and Grover (Malhotra & Grover, 1998).

Table 6.3: Evaluation of Survey Research Method (Malhotra & Grover, 1998)

Ideal Survey attributes	Current study
<i>Type of survey research</i>	
Exploratory (XPY) or Explanatory (XNY)	XNY – the survey tests the specified SAU model
Cross-sectional (CS) or Longitudinal	CS – data collected from individual agile practitioners at one point in time
<i>General</i>	
Is the unit of analysis clearly defined for the study?	Yes. The unit of analysis is the individual agile practitioner working with agile methods – see section 6.3

Does the instrumentation consistently reflect the unit of analysis?	Yes. Item wording and survey instructions clearly reflect the unit of analysis. Please refer to Appendix E for examples.
Is the respondent (s) chosen appropriate for the research question?	Yes. The SAU model involves perceptions of individual agile practitioners (e.g. developers, Scrum Master) who use agile methods in their systems development projects. Therefore, the target population of agile practitioners is adequate.
Is any form of triangulation used to cross validate results?	Yes. The final refined model used in the survey method is based on the findings from case studies (Chapters 3 and 4), semi-structured interviews and focus group (Chapter 5).
Measurement error	
Are multi-item variables used?	Yes. Most constructs in the research model are measured by using multi-item measures. For single-item constructs, guidelines for single-item measure use were considered (Diamantopoulos, Sarstedt, Fuchs, Wilczynski, & Kaiser, 2012).
Is content validity assessed?	Yes. Content validity was established during scale development and pre-testing, where feedback was sought from experts on item relevance, appropriateness, and the overall instrument.
Is field-based pre-testing of measures performed?	No. Field-based pre-testing of measures could not be performed (please see section 6.3.4). However, the model was validated (both measurement and structural) to assess whether the model fulfilled the quality (e.g. indicator reliability) criteria for empirical work (please see Chapter 7).
Is reliability assessed?	No. Field-based pre-testing of measures could not be performed (please see section 6.3.4). However, the model was validated (both measurement and structural) to assess whether the model fulfilled the quality (e.g. reliability) criteria for empirical work (please see Chapter 7)
Is construct validity assessed?	Yes. Construct validity was established during scale development and pre-testing where feedback was sought from experts, and further assessed (e.g. convergent and discriminant validity) during data analysis (please see Chapter 7)
Is pilot data used for purifying measures or are existing validated measures adapted?	Yes. Pilot data was not used for purifying measures. However, existing validated measures were adapted wherever applicable.
Are confirmatory methods used?	No. Confirmatory methods were not used during the pre-testing phase.
Sampling error	
Is the sample frame defined and justified?	Yes. The sample frame is defined. The sample frame is justified in Chapter 7 by providing a comparison of participants' demographics with those of general agile practitioners.
Is random sampling used from the sample frame?	CS – data collected from individual agile practitioners at one point in time
Is the response rate over 20%?	Unknown – the response rate could not be established as there was no information about the total population. However, every attempt was made to increase response rate from the target frame through follow-up activities.
Is non-response bias estimated?	No – standard techniques for non-response bias could not be employed.
Internal validity error	
Are attempts made to establish internal validity of the findings?	Yes. Structural equation modelling using PLS-SEM was employed to establish internal validity of the final model. Please see Chapter 7.
Statistical conclusion error	
Is there sufficient statistical power to reduce statistical conclusion error?	Yes. Conscientious effort was made to obtain a sample size needed for thorough statistical testing (required sample size – 84). A sample size of 114 was obtained which suggests sufficient statistical power (see section 6.3.5.2).

As evident from table 6.3, though not all ideal survey attributes could be achieved, conscientious effort was made to conduct good quality survey research.

Chapter 7. Data Analysis

This chapter reports on the analysis of the survey data collected for the purpose of validating the final refined model of sustained agile usage. First, an introduction to structural equation modelling, the chosen data analysis method, is described. Then, descriptive statistics about the data collected from the survey sample is presented followed by a description of the various testing procedures undertaken. Discussion of the findings is followed by limitations and conclusions.

7.1. Research Method

7.1.1. Structural Equation Modelling – Background

Structural equation modelling (SEM) techniques belong to the class of second-generation multivariate analysis techniques (Hair et al., 2014). The use of SEM has been widely popular in behavioural social science research for the causal modelling and measurement of multiple measures of proposed data constructs (Hair et al., 2014), and has over the recent years has been gaining increasing popularity in IS research (Urbach & Ahlemann, 2010). In contrast to first-generation techniques such as factor analysis, discriminant analysis, or multiple regression, SEM enables researchers to answer a set of interrelated research questions in a single, systematic, and comprehensive analysis by simultaneous testing and estimation of causal relationships among multiple independent and dependent constructs (Gefen, Straub, & Boudreau, 2000). An additional asset of SEM is that it supports latent variables (LVs) (Urbach & Ahlemann, 2010), where LVs can be considered as “hypothetical constructs invented by a scientist for the purpose of understanding a research area” (Bentler, 1980, p. 420). Since LVs cannot be directly measured, empirically measurable indicator variables (called manifest variables (MVs)) are used to estimate LVs in the model (Urbach & Ahlemann, 2010). Thus, the relationships between theoretical constructs that are difficult to measure directly such as perceptions, satisfaction, and intentions can be analysed (Urbach & Ahlemann, 2010). Thereby, SEM can not only be used to assess the structural model, i.e. the proposed causation among a set of multiple dependent and independent constructs, but also the measurement model, i.e. the loadings of the observed indicator items or measures on their respective latent constructs (Gefen et al., 2000). Overall, SEM offers a number of potential advantages in comparison to the first-generation statistical analysis methods (Garsons, 2012):

- use of confirmatory factor analysis by having multiple indicators per latent construct reduces measurement error
- allows testing of models with multiple dependent constructs
- provides better estimates as it allows a better estimation of both measurement and structural relationships (Gefen, Rigdon, & Straub, 2011)
- graphical modelling interfaces enable easier specification of the model and interpretation of the results.

Due to its increasing popularity and acceptance in other business fields such as marketing, SEM is evolving as a popular statistical modelling technique in the IS community and has become the de rigeur in validating instruments and testing linkages between constructs (Gefen et al., 2000). This is demonstrated by the fact that 18% of articles published during 1994 to 1997 in three major IS journals (MIS Quarterly, Information & Management, and Information Systems Research) (Gefen et al., 2000) and 20% of articles published during 1994 to 2008 in two major IS journals (MIS Quarterly and Information Systems Research) made use of SEM techniques such as LISREL or PLS (Urbach & Ahlemann, 2010). The findings reveal the increasing popularity of both PLS and CB-SEM in general, but also highlight that PLS has been used more frequently than the CB-SEM approaches. In a more recent review of SEM empirical studies published in MIS Quarterly during the 20-year period from 1992 to 2011, 65 studies contained 109 SEM estimations deploying the PLS-SEM techniques (Ringle, Sarstedt, & Straub, 2012). It is apparent from these reviews that the use of PLS-SEM has increased over time, and is in agreement with the finding that “PLS has been wholeheartedly accepted as an important statistical method in the MIS field”. (Goodhue, Lewis, & Thompson, 2006, p. 2)

SEM research usually follows a positivist epistemological belief (Urbach & Ahlemann, 2010). According to Dube and Pere (Dubé & Paré, 2003) a set of characteristics classifies research as positivist :

From an ontological perspective, positivist research assumes an objective, physical, and social world which can be relatively easily apprehended, characterized, and measured.

From an epistemological perspective, positivist research is concerned with the empirical testability of theories which are premised on the existence of a priori fixed relationships within the phenomenon of interest which can be tested through hypothetic-deductive logic and analysis.

As the current study is predominantly positivist (please see chapter 2), SEM which follows a positivist philosophical belief was deemed a suitable approach.

7.1.2. Selecting PLS or Covariance-based SEM Approaches

There are two general approaches to SEM: (1) covariance-based structural equation modelling (CB-SEM) and (2) the component-based approach PLS. They differ in their underlying philosophy, distributional assumptions, estimation objectives, and the nature of the fit statistics they produce (Gefen et al., 2011; Gefen et al., 2000). The covariance analysis is based on the developments of (Joreskog, 1973; Wiley, 1973) which typically uses a maximum likelihood (ML) estimation procedure to minimise the difference between the sample covariance and those predicted by the theoretical model (Urbach & Ahlemann, 2010). The ordinary least squares (OLS) regression-based PLS method is based on the early works of Wold's (Wold, 1966, 1985) which uses available data to estimate the path relationships in the model with the objective of minimising the error terms (i.e., the residual variance) of the dependent constructs.

To answer the question of whether to use CB-SEM for theory testing, or PLS for theory development and predictive applications researchers should focus on the characteristics and objectives that distinguish the two methods (Henseler, Ringle, & Sinkovics, 2009), (Hair, Sarstedt, Ringle, & Mena, 2012). In situations where the primary objective is prediction and explanation of target constructs, theory is less developed and there is little *a priori* knowledge on structural model relationships or the measurement of the constructs, researchers should consider the use of PLS-SEM as an attractive alternative to CB-SEM (Hair et al., 2014). On the contrary, in situations where the primary objective is to confirm (or reject) theories (i.e. a set of systematic relationships between multiple variables that can be tested empirically) based on strong theory, CB-SEM should be considered (Hair et al., 2014).

Overall, PLS-SEM can be used when the research problem has the following characteristics (Chin, 1998; Chin & Newsted, 1999; Hair et al., 2014; Urbach & Ahlemann, 2010)

- the phenomenon to be investigated is relatively new
- the goal is predicting key target constructs or identifying key “driver” constructs
- the structural equation model is complex (many LVs and many indicators)
- formatively measured constructs are part of the structural model
- the sample size is small.

The primary objective of the current study is theory development and as there is little knowledge on the concepts relating to sustained agile usage (e.g. relationships and measurement of constructs in the proposed SAU model), PLS-SEM best suited the objectives of this study (all the above requisite characteristics of PLS-SEM were met).

7.2. A Systematic Procedure for Applying PLS-SEM

A multistage procedure of the PLS-SEM process used for conducting analyses in the current study are described in the following sections (Hair et al., 2014) (See Figure 7.1). The process starts with the specification of structural and measurement models, followed by the collection and examination of data. Next, is the application of PLS-SEM and path model estimation, followed by assessment of both reflective and formative measurement models. After the data for the measures are considered valid and reliable based on established criteria, the structural model is evaluated.

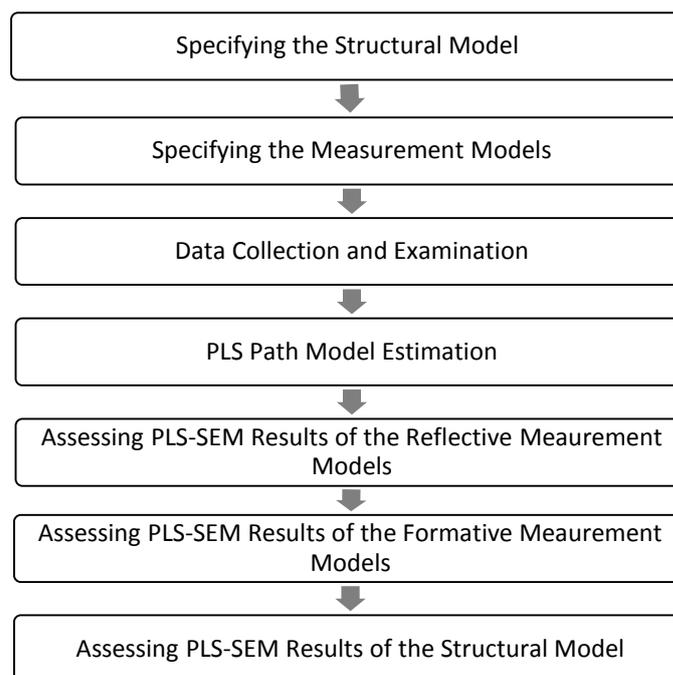


Figure 7.1: A Systematic Procedure for Applying PLS-SEM

7.2.1. Specifying the Structural Model:

The first step is the specification of a path model that illustrates the research hypotheses and proposed construct relationships which are typically derived from previous research (e.g., findings from case studies, semi-structured interviews). The path model consists of two elements: the structural model displays the relationships between the theoretical constructs (i.e.

LVs), and the measurement models of the constructs that display the relationships between the constructs (LVs) and the indicator variables (MVs) (Hair et al., 2014), i.e. a measurement model has to be defined for each of the LVs in the (Urbach & Ahlemann, 2010). There are two types of measurement model: one for the exogenous LVs (i.e. the constructs that explain other constructs in the model) and one for the endogenous LVs (i.e. the constructs that are being explained in the model) (Hair et al., 2014). The structural model and measurement models together form a complete structural equation model (Urbach & Ahlemann, 2010).

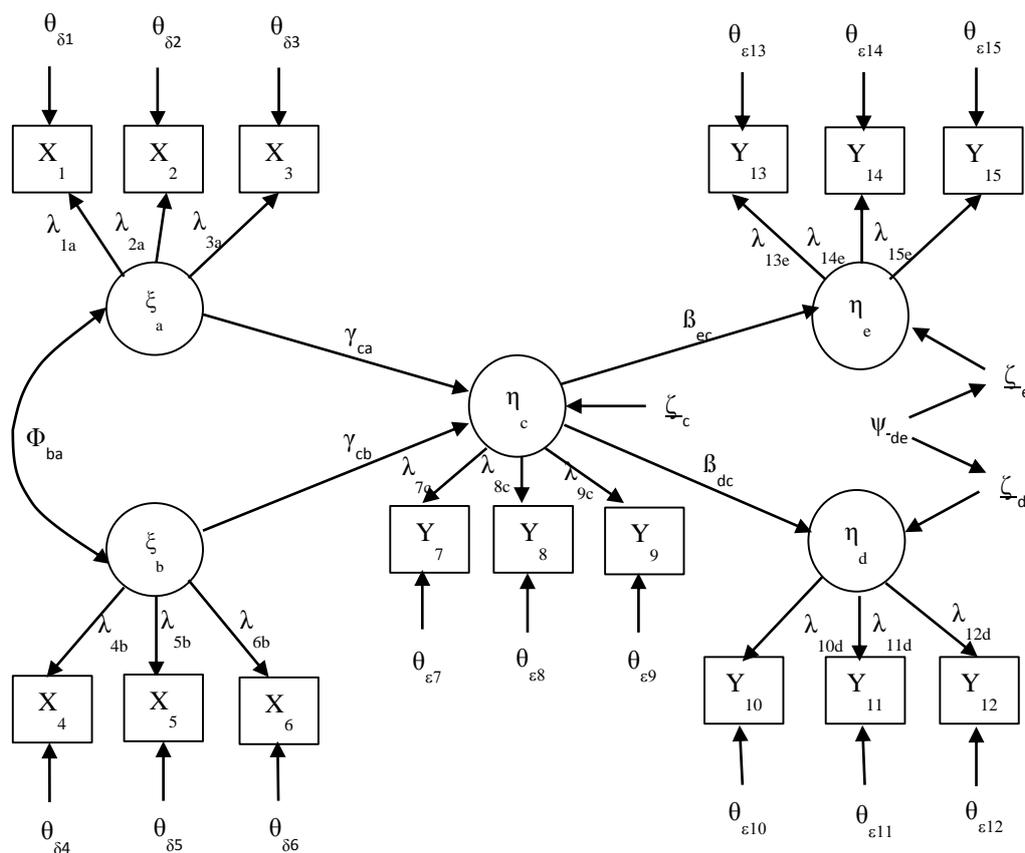


Figure 7.2: Generic SEM Model with Constructs and Measures (Gefen et al. 2000)

Consider the example of a generic SEM shown in Fig. 7.2 The model consists of two exogenous variables ξ_a and ξ_b (called Xsi) and three endogenous variables η_c , η_d , and η_e (called Eta). Dependent constructs (i.e. those that are to be explained and/or predicted) called endogenous latent variables are on the right side of the structural model. Constructs that act as independent variables are called exogenous latent variables and they appear on the extreme left side of the structural model. Constructs that operate as both dependent and independent are also considered endogenous and appear in the middle of the diagram. The paths that connect exogenous (ξ) and endogenous (η) variables are statistically represented as Gamma (γ)

coefficients. The paths connecting one endogenous (η) variable to another endogenous variable are designated Beta (β). And any shared correlations among ξ are designated Phi (Φ). All constructs in the model have error terms Zeta (ζ) associated with them (i.e., the behaviour of η that cannot be explained or predicted by ξ), and the shared correlations among the error terms of the η are called Psi (ψ). These model components together make up the structural model.

The measurement models represents the relationships between constructs and their corresponding indicator items (depicted as rectangles, see Fig. 7.2), which are observations or the actual data collected. Each X should load to one ξ , and each Y should load to one η . The Lambdas (λ) represent the path between an observed variable measure X (or Y) and its ξ (or η), i.e., the item loading on its latent construct. Theta Delta (θ_{δ}) represents the error variance associated with an observed measurement X (i.e., the variance not reflecting its latent construct), while Theta Epsilon (θ_{ϵ}) designates the error variance associated with an observed measurement Y (i.e., the variance not reflecting its latent construct).

7.2.2. Specifying the measurement model

In specifying the measurement model, the basis for determining the relationships between the latent constructs and their corresponding indicator items is a sound measurement theory (Hair 2014). Researchers must also consider two types of measurement specification: reflective and formative models. In a reflective model, the LVs cause or form the indicators, where all reflective indicators measure the same underlying phenomenon, namely the LV. Consequently, all reflective indicators should correlate positively. In a formative model the LVs of interest result from or being the consequence of their respective indicators (Chin 1998). Since there is no direct causal relationships between the LV and the indicators (and vice versa), formative indicators of the same LV do not necessarily have to correlate with each other. For example, the proposed SAU construct in the current study could be decomposed into aspects of individual agile practice usage (integrative use, emergent use, deeply customised use) or agile method usage (extent of use, intensity of use). The presence of the formative endogenous construct (SAU) in the current study's proposed model is another reason for preferring PLS-SEM. All other constructs were measured reflectively (please see Chapter 6 for more details).

The other aspect that should be taken into consideration when specifying the measurement model is the use of multiple items or single item to measure a construct (Hair 2014). While single items have practical advantages such as ease of application, and brevity, they have some

important limitations (Hair 2014); from a psychometric perspective, single-item measures are less reliable and from a validity perspective a risky decision to some extent. Nevertheless, expert feedback during the pre-testing phase of the survey instrument (please see Chapter 6 for a discussion on this) and also practical considerations (based on findings from semi-structured interviews and focus group - Chapter 5) necessitated the use of two single-item constructs (Organisation Structure and Tool Support). All other constructs in the model were measured using multiple item constructs.

In summary, the first two stages specify the structural and measurement models. The measurement model defines the latent constructs that the model will use and assigns observed indicator items to each. The structural model defines the causal relations between the latent constructs. In particular, the theoretical foundation underlying the specification of the model is particularly relevant i.e. the first two stages should identify (1) theories that may serve as a starting point for the research's model development and (2) useful construct definitions and measurement models in literature (Urbach & Ahlemann, 2010). In the current study, these objectives were achieved by means of structured literature reviews. Inductive approaches such as semi-structured interviews and case studies were also used, and existing construct definitions and measurement models were used whenever possible/available.

7.2.3. Data collection and examination

While the general assumption with first-generation statistical methods is that the data are error free, the measurement model stage in second-generation methods attempts to identify the error component of the data and remove it from the analysis (Hair 2014). Therefore, data examination is important to ensure that the methods application is valid and reliable. The primary issues that need to be examined include missing data, suspicious response patterns (straight lining or inconsistent answers), and distributional assumptions.

Based on the recommended threshold that the number of missing values per observation should not exceed 15% (Hair et al., 2014), all observations where the amount of missing data exceeded 15% were removed. Even in cases where the missing data did not exceed 15%, if there were a high proportion of responses missing for a single construct, such observations were also removed. This resulted in data set with low level of missing data. Data was also scrutinised for extreme cases of straight lining. Straight lining is when a participant marks the same response for a high proportion of the questions, i.e. for example, response pattern is mostly 4s (the middle response) on a 7-point scale., or only 1s or 7s are selected (Hair et al., 2014). Later, mean value

replacement (recommended when there are less than 5% values missing per indicator) procedure was applied.

Though distributional assumptions are of less concern because of PLS-SEM's non-parametric nature, researchers should ensure that data are not too far from normal as extremely non-normal data can be problematic in the assessment of parameters' significances (Henseler et al., 2009). The collected data was screened using SPSS version 22.0 to report on its distribution. There are different ways of testing normality. For example, statistical tests of normality (e.g. Kolmogorov-Smirnov test and Shapiro-Wilks test) test normality by comparing the data to a normal distribution with the same mean and standard deviation as in the sample (Mooi & Sarstedt, 2011). However, these tests only indicate whether the null hypothesis of normally distributed should be rejected or not and provide limited guidance when deciding whether the data are too far from being normally distributed (Hair et al., 2014) (Hair 2014). Therefore, researchers are recommended to examine two measures of distribution - skewness and kurtosis (Hair 2014). Accordingly, these two measures were applied. Though the general guideline suggests that both measures should lie in between -1 and +1 (when close to zero the pattern of responses is considered a normal distribution), it is very unlikely to encounter such values. The reported skewness and kurtosis statistics for each scale item did not exceed the thresholds as suggested by Stevens (skewness < 2 and kurtosis < 7) (Stevens, 2001). This suggests that the data was not too far from being normally distributed. As a last test, the data was also screened for any outliers, and there were no issues with outliers.

7.2.3.1. Findings – Descriptive Statistics

The main purposes of descriptive statistics are to describe sample characteristics, estimate non-response error, and assess the data set for any potential violations of assumptions underlying the chosen statistical method (Pallant, 2010). In the following sections, the descriptive statistics is first presented, followed by separate assessments of the measurement models (stage of the procedure for using PLS-SEM – section 7.2.4) and the structural model (stage – section 7.2.7).

A total of 114 responses were obtained. The survey instrument collected demographic information on survey participants as well as general information on agile method usage. The origin of survey participants was tracked as either New Zealand (NZ) or non-NZ – only the NZ responses are used in this analysis. The descriptive statistics tests were run using SPSS version 22.0. Table 7-1 summarises the descriptive data. The table shows that the majority of

participants have worked in the IS field for seventeen years and most of them have used agile for approximately five years.

Table 7.1: Descriptive Data on agile usage

Variable	Value
Systems/Software Development Experience (Years)	Mean = 16.9 Range = 1 - 35
Agile Development Experience (Years)	Mean = 4.8 Range = 2 - 15
Number of agile projects	Mean = 11.5 Range = 7 - 200
Percentage of Projects using agile:	
1 – 25%	23%
26 – 50%	14%
51 – 75%	21%
> 75%	42%
Agile Project Types:	
Initial projects only	2%
Mostly small projects	7%
Mixture of large and small projects	47%
Mostly large projects	10%
Routine (all projects)	35%
Development Phases where agile used:	
Requirements Specification	61%
Analysis	60%
Design	63%
Development	89%
Testing	67%
Other	15%

It also shows that AMs have been used by agile practitioners on an average of twelve projects. Over forty percent of agile practitioners surveyed currently use agile methods on more than seventy-five percent of their systems development projects, and over eighty percent of these projects have been either in a mixture of large and small projects, or in all projects. Though the use of agile methods is evident throughout all the phases of systems development (about sixty percent), its use is higher during development (ninety percent).

Respondents came from different roles: Agile coach – 10.5 %, Business Analyst – 9.6%, Business Stakeholder – 4.4 %, Designer – 1.8%, IT Delivery Manager – 9.6%, Programmer or Developer – 26.3 %, Project Manager – 5.3 %, Scrum Master – 11.4 %, Tester – 4.4 %, and other – 16.7 %. Roles specified in the ‘other’ category included process engineer, architect, agile champion, software engineer, development team lead, and positions involved in multiple

roles, for example, “*most of the above (not PM or ITDM)*”. Both the frequency and percent values (rounded to the nearest decimal place) are shown in the Figure 7.3

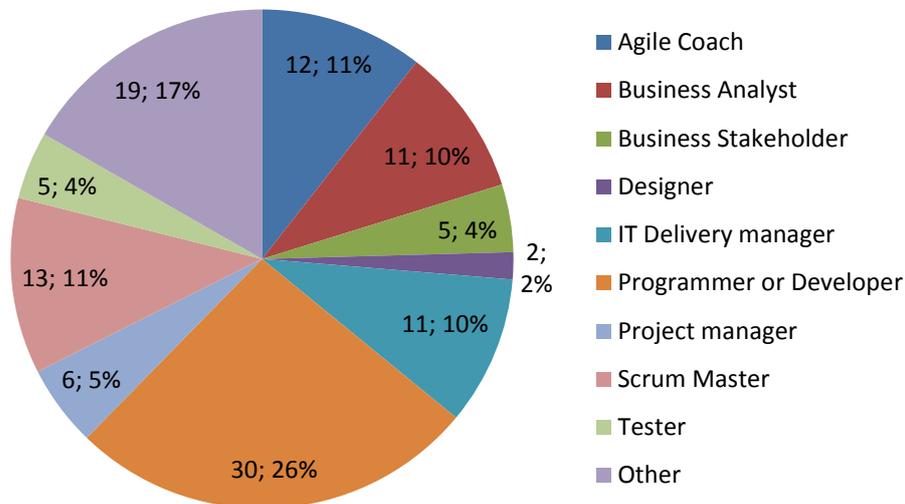


Figure 7.3: Participant Current Position

Agile was used by practitioners on an average of twelve projects (mean = 11.5). More than one-quarter (35%) of the practitioners’ surveyed currently use agile methodologies on all their software development projects. Almost half of them were used in in a mixture of small and large projects (47%).

The most widely used agile methods were Scrum (85%), Kanban (50%), Hybrid (33%) – methods mentioned in the other category (12%) included Disciplined Agile Delivery, LSD, Scrum + XP Portfolio, and Kanban + Scrum. Both the frequency and percent values (rounded to the nearest decimal place) are shown in the Figure 7.4.

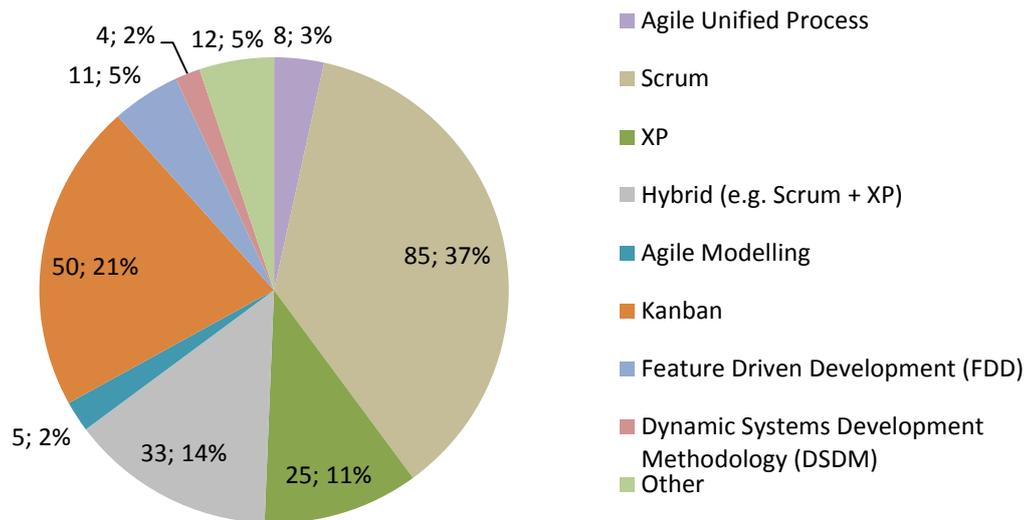


Figure 7.4: Agile Methodology used

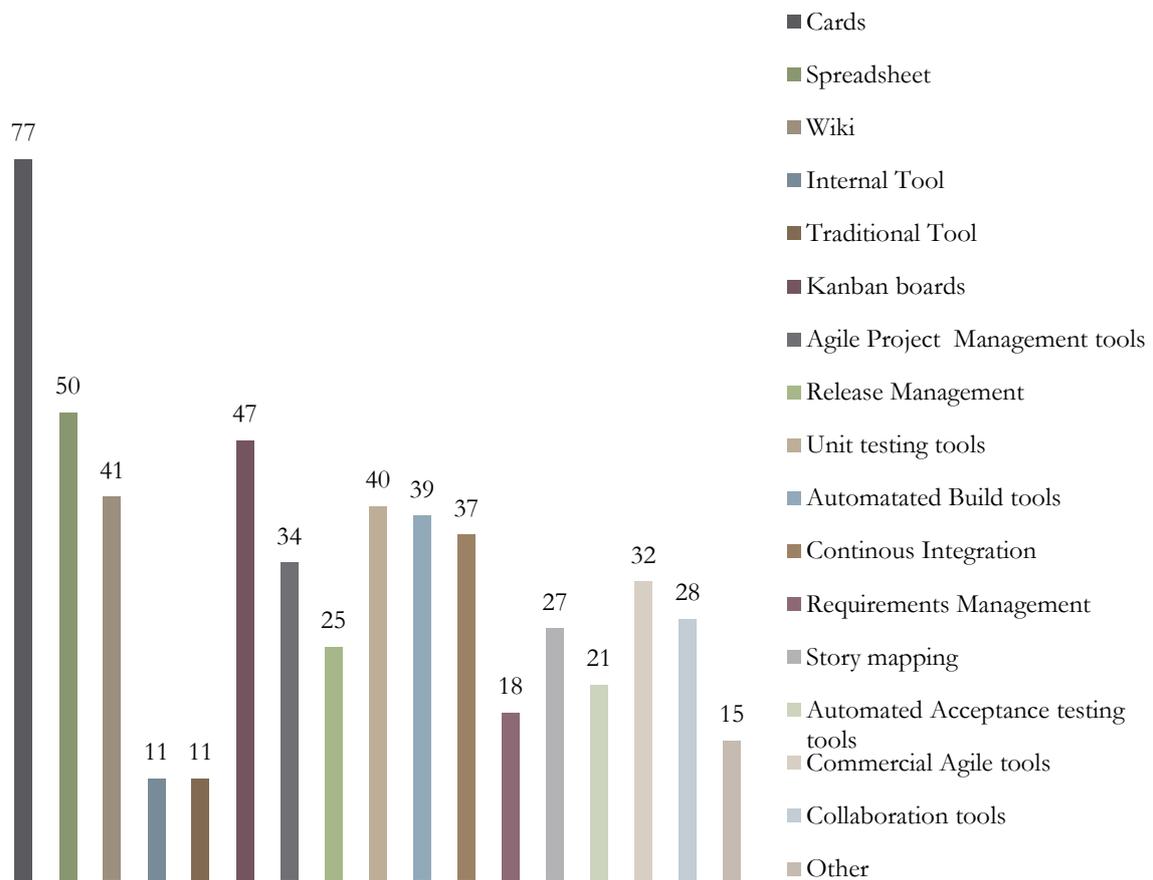


Figure 7.5: Use of tools in agile usage

On average, participants used between 5 and 6 different tools. Specific tools most commonly used are cards (77%), office productivity tools such as spreadsheet (50%), Kanban boards

(47%), Wiki (41 %), unit testing (40%), automated build tools (39%), continuous integration (37%), and commercial agile tools such as VersionOne (32%) (Figure 7.5).

7.2.4. PLS Path Model Estimation

After the data examination stage, the PLS algorithm was run in Smart PLS 2.0 (Ringle, Wende, & Will, 2005) to calculate the model parameter's estimates. The following suggested parameter settings were selected for the initial estimation of the path model (Hair et al., 2014): structural model weighting scheme (path weighting scheme was used as it maximises the R^2 values of the endogenous constructs), data metric (z-standardized data), initial values of +1 for the relationships in the measurement model, a small number, i.e. 1.10^{-5} for the stop criterion, and a sufficiently large maximum number of iterations (300). Model estimation delivers empirical measures of the relationships between the indicators and the constructs (measurement models), as well as between constructs (structural model) – this enables comparison of the theoretically established measurement and structural models with the sample data (Hair et al., 2014).

Unlike CB-SEM, PLS-SEM does not provide an established global goodness-of-fit criterion (Urbach & Ahlemann, 2010). However, it is recognised that *fit* statistics have different meanings in the contexts of CB-SEM and PLS-SEM (Hair et al., 2014): in CB-SEM, they are derived from the discrepancy between the empirical and the theoretical covariance matrix, whereas PLS-SEM focuses on the discrepancy between the observed (in the case of manifest variables) or approximated (in the case of latent variables) of the dependent variables and the values predicted by the model in question. As a consequence, in PLS-SEM, measures that indicate the model's predictive capabilities are used to judge its quality, i.e. the evaluation of the measurement and structural model results are built on a set of non-parametric evaluation criteria using procedures such as bootstrapping and blindfolding (Hair et al., 2014).

The above criteria were systematically applied by following the advocated two-step procedure of evaluating the measurement models first, and then the structural model (Hair et al., 2014).

7.2.5. Assessing Results of the Reflective Measurement Model Evaluation

Based on the validation guidelines of (Straub, Boudreau, & Gefen, 2004),(Lewis, Templeton, & Byrd, 2005), and (Hair et al., 2014), the following criteria were used to assess the results of the reflective measurement models:

- *Indicator reliability*: it describes the extent to which an indicator or set of indicators is consistent regarding what it intends to measure (Urbach & Ahlemann, 2010). Higher loadings on a construct indicate that the associated indicators have much in common, which is captured by the construct (Hair et al., 2014). As it is postulated that a latent construct should explain at least 50 percent of each indicator's variance, it is recommended that the indicator loadings should be significant at least at the .05 level and greater than .707 (Chin, 1998).

In the current study, the indicator reliability of reflective items was assessed by checking the outer loadings of each item on its respective latent construct. All outer loadings of the reflective constructs were well above the recommended threshold of 0.707. All loadings were significant (t-statistic > 1.96) and therefore retained. It is recommended that the reflective items should be removed only if their outer loadings are less than 0.4 (Henseler et al., 2009).

- *Internal consistency reliability (ICR)*: it is a form of reliability used to determine whether the items measuring a construct are similar in their scores (i.e. if the correlations between the items are large) (Hair et al., 2014). The traditional criterion for assessing ICR is Cronbach's alpha (CA), which provides an estimate of reliability based on the inter-correlations of the observed indicator variables (Hair et al., 2014; Urbach & Ahlemann, 2010). CA assumes that all indicators are equally reliable (i.e. all the indicators have equal outer loadings on the construct), but PLS-SEM prioritises the indicators according to their individual reliability (Hair et al., 2014). Moreover, as CA is sensitive to the number of items in the scale and generally tends to underestimate the ICR, it may be used as a conservative measure of ICR (Hair et al., 2014). In contrast, composite reliability (CR) which takes into account the different outer loadings of the indicator variables is recommended as a measure for ICR (Henseler et al., 2009). The CR values vary between 0 and 1, with higher values indicating higher values of reliability (Hair et al., 2014). Values above .700 for exploratory research and values

above .800 or .900 in more advanced stages of research are desirable, and values below .600 indicate a lack of reliability (Hair et al., 2014; Urbach & Ahlemann, 2010). Values above 0.95 are also not desirable as they indicate that all the indicator variables are measuring the same phenomenon and are therefore unlikely to be a valid measure of the construct (Hair et al., 2014).

In the current study, while CR values of most constructs have high values of ICR and well above the recommended threshold of 0.7 (see table 7.2), two values are closer to 0.95 (Customer Satisfaction: CR-0.966; CA-0.948) and (Methodology Champion: CR - 0.955; CA – 0.905). Methodology champion has two items that measures different aspects (i) extent of their presence and (ii) effectiveness. Customer satisfaction has three items that measure satisfaction with (i) usability (ii) functionality of products, and (iii) general overall satisfaction. The use of very general phrase ‘with us’ to measure overall satisfaction might be semantically redundant with the first two items. Both values are borderline and as this was the first attempt to test the model, no changes were made.

- *Convergent validity (CV)*: it is the extent to which a measure correlates positively with alternate measures of the same construct (Hair et al., 2014). A common criterion to measure CV at the construct level is the average variance extracted (AVE) proposed by Fornell and Larcker (1981) (Urbach & Ahlemann, 2010). It is defined as the grand mean value of the squared loadings of the indicators associated with that construct (i.e., the sum of the squared loadings divided by the number of indicators) (Hair et al., 2014). An AVE value of 0.5 or higher indicates that the construct explains more than half the variance of its indicators. All AVE values in this study’s findings are well above the required minimum of 0.5 (see table 7.2).
- *Discriminant validity*: it is the extent to which a construct is truly distinct from other constructs by empirical standards (Hair et al., 2014). While CR tests whether a particular item measures the construct it is supposed to measure, discriminant validity tests whether an item measures the construct that it is not supposed to measure (Urbach & Ahlemann, 2010). Discriminant validity is assessed using two methods (Hair et al., 2014):
 - (1) Fornell-Larcker criterion: suggests that the square root of each construct’s AVE values should be greater than its highest correlation with any other construct. It

is based on the idea that a construct shares more variance with its associated indicators than any other construct.

Table 7.2 shows the final results of the Fornell-Larcker criterion assessment with the square root of the reflective constructs' AVE on the diagonal (shown in boldface) and the correlations between the constructs in the lower left triangle. For example, the reflective construct *Orgsupp* which has a value of **0.865** for the square root of AVE when compared with all correlation values in both row and column is higher than its correlations with all other constructs. Overall, the square roots of the AVEs for all the reflective constructs are all higher than the correlations of these constructs with other latent constructs in the path model.

- (2) examining cross-loadings: this test suggests that an indicator's outer loading on the associated construct should be greater than all of its loadings on other constructs (i.e. cross-loadings).

Appendix D (table D1.1) shows the loadings and cross-loadings for every indicator. For example, the indicators AM1, AM2, AM3, AM4 have higher values for the loading with its corresponding construct AMind (0.8353, 0.8693, 0.8869, 0.7042) respectively, while all cross loadings with other constructs are considerably lower (e.g., AM1 on Cussat: 0.3518).

Overall, cross-loadings as well as the Fornell-Larcker criterion provide evidence for the constructs' discriminant validity. As shown in the summary of the results in table 7.2, all model evaluation criteria have been met, providing support for the measures' reliability and validity.

Table 7.2: CR, AVE, Cronbach's (CA), Correlations

	CR	AVE	CA	ACoach	AMind	Compat	Cussat	Mchamp	Orgsupp	Predict	Prod	Qual	Relad
Acoach	0.909	0.833	0.804	0.912									
Amind	0.921	0.700	0.891	0.230	0.837								
Compat	0.897	0.813	0.771	0.193	0.323	0.902							
Cussat	0.966	0.905	0.948	0.339	0.412	0.575	0.951						
Mchamp	0.955	0.913	0.905	0.492	0.446	0.153	0.376	0.956					
Orgsupp	0.923	0.749	0.889	0.488	0.485	0.294	0.607	0.390	0.865				
Predict	0.897	0.743	0.827	0.274	0.368	0.518	0.530	0.207	0.416	0.862			
Prod	0.922	0.797	0.874	0.201	0.394	0.588	0.636	0.311	0.407	0.675	0.893		
Qual	0.917	0.734	0.878	0.208	0.392	0.594	0.631	0.306	0.361	0.749	0.819	0.857	
Relad	0.914	0.682	0.882	0.264	0.358	0.731	0.631	0.254	0.473	0.691	0.752	0.737	0.826

Note: Numbers along the diagonal in bold font refer to the square root of AVE score. Formative construct (*sustained agile usage*) and single-item measures (organisation structure and tool support) are not included.

Legend: **Acoach** = Agile Coach, **AMind** = Agile Mindset, **Compat** = Compatibility, **Cussat** = Customer Satisfaction, **Mchamp** = Methodology Champion, **Orgsupp** = Organisation/Management Support, **Predict** = Predictability, **Prod** = Productivity, **Qual** = Quality, **Relad** = Relative Advantage.

7.2.6. Assessing Results of the Formative Measurement Model Evaluation

The statistical evaluation criteria for formative measurement models requires a different approach where indicators are likely to represent the construct's independent causes and thus do not correlate highly (Hair et al., 2014). Formative indicators are assumed to be error free which means that the concept of ICR is not meaningful (Diamantopoulos, 2006). Furthermore, assessing convergent and discriminant validity using criteria similar to those associated with reflective measurement models is not appropriate when formative indicators and weights are involved (Chin, 1998; Hair et al., 2014). Rather validity of formative constructs should be assessed on two levels: the indicator and construct levels (Henseler et al., 2009).

In this study's model (SAU), there is only one formative construct, i.e. agile usage (AUsage), which was assessed using two methods (Hair et al., 2014):

- (1) *Collinearity*: collinearity refers to high correlations between formative indicators. High levels of collinearity are a crucial issue because they have an impact on the estimation of weights and their statistical significance and affect the results of analyses in two respects (Hair et al., 2014): first, it boosts the standard errors (particularly in analyses based on smaller sample sizes where standard errors are generally larger due to sampling error) and thus reduces the ability to demonstrate that the estimated weights are significantly different from zero. Second, high collinearity can lead to weights being incorrectly estimated, as well as in their signs being reversed.

In this study, collinearity was assessed by computing tolerance and variance inflation factor (VIF) using IBM SPSS Statistics. Tolerance represents the amount of variance of one formative indicator not explained by other indicators in the same construct, whereas VIF, a related measure is the reciprocal of tolerance. In PLS-SEM, a tolerance value of 0.2 or lower and a VIF value of 5 or higher indicate a potential collinearity problem. Calculations for the formative indicators of AUsage (refer chapter 6 for construct operationalisation) i.e., *Agvuse1* (vertical usage 1), *Agvuse2* (vertical usage 2), and *Aghuse* (horizontal usage) showed that collinearity was not a problem (see Table 7.3).

Table 7.3: Collinearity test values

	Tolerance	VIF
Agvuse1	.812	1.232
Aghuse	.942	1.062
Agvuse2	.805	1.242

3) *indicator validity* – to answer the question whether formative indicators truly contribute to forming the construct, the significance and relevance of outer weights must be assessed by using the bootstrapping procedure (Hair et al., 2014). However, the number of indicators used to form a construct can also have an impact on the outer weights, as formative measurement has an inherent limit to the number of indicators that can retain a statistically significant weight (Cenfetelli & Bassellier, 2009). With the assumption that the indicators are uncorrelated, the maximum possible outer weight is $1/\sqrt{n}$, where n is the number of indicators. For example, with 2 uncorrelated indicators, the maximum possible outer weight is $1/\sqrt{2} = 0.707$.

Bootstrapping procedure (5000 samples) was used to calculate each indicator weight's significance and t values. With three uncorrelated indicators, the maximum possible outer weight is 0.57 ($1/\sqrt{3}$). All indicator values were significant at 0.05 levels which suggest that all indicators are relevant for the construction of the formative index, and thus demonstrate a sufficient level of validity as shown in table 7.4.

Table 7.4: Outer Weights Significance testing results

Formative indicator	Outer weights	t-value	Sig	p-value
Aghuse	0.3094	2.3164	**	0.022
Agvuse1	0.6231	5.1134	***	0.000
Agvuse2	0.4141	2.8238	***	0.006

* $p < .10$, ** $p < .05$, *** $p < .01$

7.2.7. Results – Evaluation of the Structural Model

After evaluating the reflective and formative measurement models and the validity and reliability of all measures is confirmed, the next step is to address the structural model results. Assessment of the structural model enables to determine how well empirical data supports the

theoretical model – the key criteria for assessing the structural model in PLS-SEM are the significance of the (i) path coefficients, (ii) coefficient of determination, i.e. the level of the R^2 values, (iii) the f^2 effect size, and (iv) the predictive relevance (Q^2) (Hair et al., 2014)

The evaluation of the path coefficients involves checking the algebraic sign, magnitude, and significance of each coefficient. A path coefficient's magnitude indicates the strength of the relationship between two constructs and should exceed .100 to account for a certain impact within the model (Urbach & Ahlemann, 2010) The path coefficients should be significant and consistent with proposed directions. As the analysis of the structural model relationships showed low values for some path coefficients, the bootstrapping procedure was run to assess the significance of the relationships with the following settings: mean replacement, no sign changes option, 114 cases, and 5,000 samples. The path coefficients, t values, p values, and their significance levels are shown in table 7.5. Though the exogenous constructs together explained 39% (R^2 of AUsage = 0.388) of the variance in *agile usage*, not all path coefficients were significant and only two hypotheses were strongly supported. Firstly, an increase in a practitioner's perceived relative advantage is positively and significantly associated with agile usage. The second construct that is positively and significantly associated with *agile usage* is agile coach. In contrast, all the remaining constructs have very little bearing on agile usage. In particular, the result of association between organisation factors (MS, MC, structure) and tool support did not provide any statistical support for their effect on agile usage.

Table 7.5: Significance testing results of the structural model

	Path Coeff	t values	sig	p values
ACoach → AUsage	0.296	2.943	***	0.004
AMind → AUsage	0.101	0.996	ns	0.322
AUsage → Cussat	0.420	5.066	***	0.000
AUsage → Predict	0.535	7.161	***	0.000
AUsage → Prod	0.513	7.147	***	0.000
AUsage → Qual	0.547	8.090	***	0.000
Compat → AUsage	0.105	0.797	ns	0.427
Mchamp → AUsage	0.010	0.096	ns	0.924
Orgstruct → AUsage	0.069	0.593	ns	0.555
Orgsupp → AUsage	-0.093	0.717	ns	0.475
Relad → AUsage	0.338	2.289	**	0.024
tooeff → AUsage	0.038	0.457	ns	0.648

Note: ns: not significant * $p < .10$, ** $p < .05$, *** $p < .01$

The coefficient R^2 is a measure of the model's predictive accuracy and is computed as the squared correlation between a specific endogenous construct's actual and predicted values. It represents the exogenous (independent) LVs' combined effects on the endogenous LV (Hair et al., 2014). R^2 values range from 0 to 1 with higher levels indicating higher levels of predictive accuracy. Though it is difficult to provide rules of thumb for acceptable R^2 values (Hair et al., 2014), values of approximately 0.670, 0.333, and 0.190 are considered substantial, average, and weak respectively (Chin, 1998). The exogenous constructs together explained 39% (R^2 of AUsage = 0.388) of the variance in SAU. As hypothesised, all effectiveness measures were associated with SAU, i.e., SAU explained 29% of the variance in predictability (Predict R^2 = 0.286), 18% of the variance in customer satisfaction (Cussat R^2 = 0.176), 26% of the variance in productivity (Prod R^2 = 0.263), and 30% of variance in quality (Qual R^2 = 0.299).

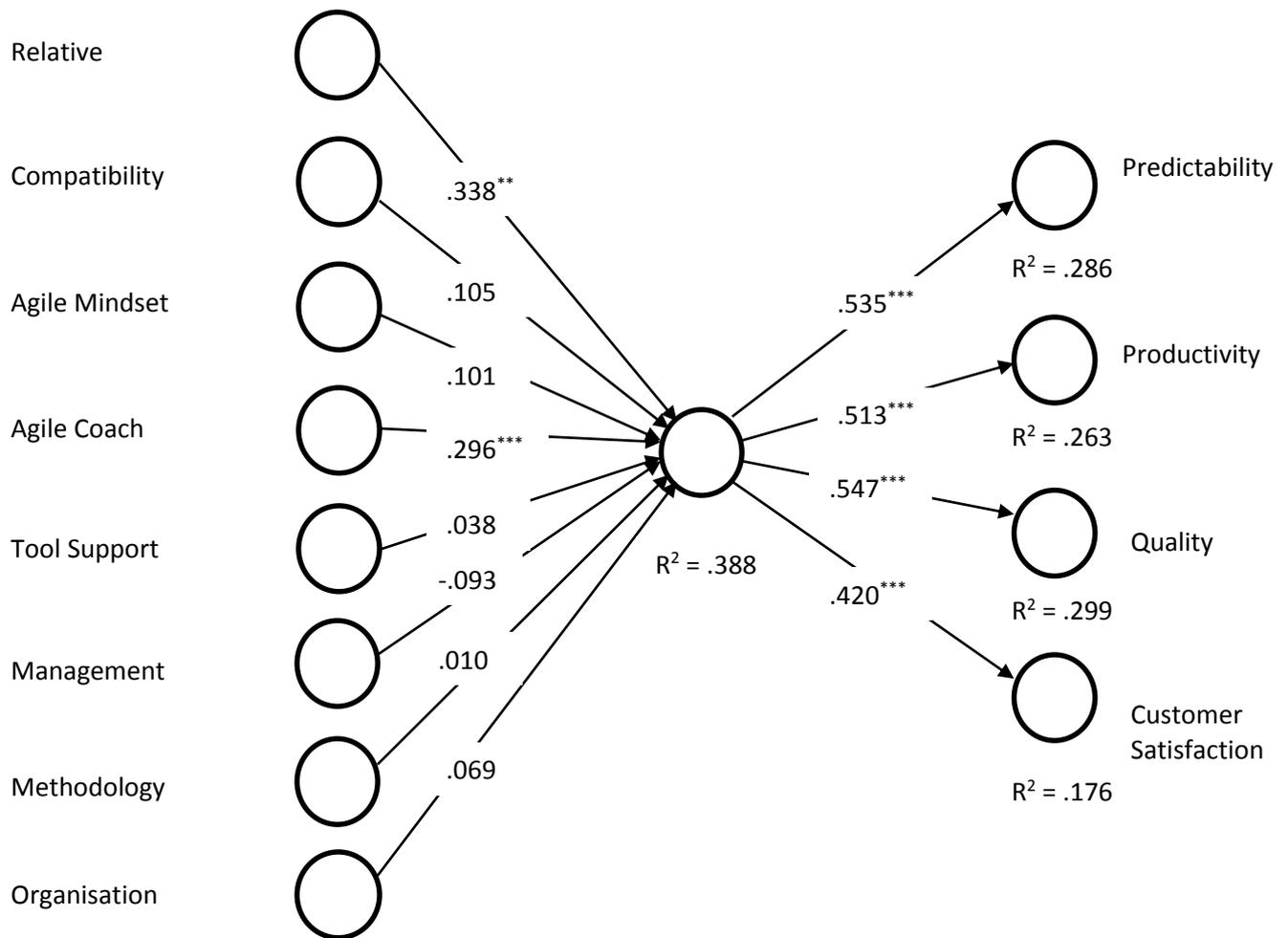


Figure 7.6: Final Model with results

The final model with the results is shown in Figure 7.6. See table 7.8 for a summary of the hypothesis test results.

Q^2 : In addition to R^2 , researchers are urged to examine Stone-Geisser's Q^2 value, a measure of the model's predictive relevance, which predicts the data points of indicators in reflective measurement models of endogenous constructs (Hair et al., 2014). Q^2 values larger than zero for a certain endogenous LV indicates the path model's predictive relevance for that particular construct (Hair et al., 2014). To assess the predictive relevance of the endogenous constructs (i.e., predictability, productivity, quality, and customer satisfaction), the blindfolding procedure was conducted. The predictive relevance of all the constructs was greater than zero (see table 7.6).

Table 7.6: Results of R² and Q² values

Endogenous LV	Q ²	R ²
Ausage		0.388
Predict	0.207	0.286
Cussat	0.158	0.176
Prod	0.205	0.263
Qual	0.212	0.299

Effect size f²: In order to evaluate whether the omission of a specified exogenous construct has a substantive impact on the endogenous constructs, a measure called f² effect size is used (Hair et al., 2014). The effect size is calculated as

$$f^2 = \frac{R_{included}^2 - R_{excluded}^2}{1 - R_{included}^2},$$

where $R_{included}^2$ and $R_{excluded}^2$ are the R^2 values of the endogenous LV when a selected exogenous LV is included or excluded from the model - f^2 values of 0.02, 0.15, and 0.35, represent small, medium, and large effects respectively of the exogenous LV (Hair et al., 2014). Applied to the current model, except Relad, AMind, and AC, all other f^2 values have small effects on the endogenous construct AUsage (see table 7.7), which is consistent with findings of the structural model.

Table 7.7: Results of effect size test

R² included (Ausage) = 0.388		
	R² excluded	f²
Relad	0.347	0.067
Comp	0.384	0.007
AMind	0.382	0.010
AC	0.334	0.088
tooleffect	0.387	0.002
Mchamp	0.388	0.000
Orgsupp	0.385	0.005
OrgStru	0.386	0.003

7.3. DISCUSSION

This study examined both the factors that influence sustained agile usage and the influence of SAU on agile usage effectiveness. The model was developed from various streams of literature (IS implementation, DOI, agile), case studies, semi-structured interviews, and a focus group. The above section presented the findings of applying PLS-SEM to the research model. Six hypotheses (out of a total of twelve) pertaining to the sustained usage model were supported. This supports the general viability of the suggested research model for explaining and predicting the influence of the determinant factors on sustained agile usage. The factors in the research model explained 38.8% of sustained agile usage variance. Though the amount of variance explained is similar to previous studies based on diffusion innovation models¹⁸ (Bhattacharjee, 2001; Venkatesh & Davis, 2000), it is not overwhelming. Firstly, the findings cannot be compared to previous diffusion innovation studies in entirety, because the SAU model has drawn only partly from traditional adoption models such as TAM which are by themselves are not suitable for understanding complex phenomenon such as post-adoption usage of agile methodologies which have high knowledge-burden (Gallivan, 2001). Secondly, only *relative advantage*, *agile coach*, and *agile mindset* (based on effect size test measures - f^2 values) were found to have medium to large effects i.e. omitting them from the model would have had substantive impact on sustained agile usage, whereas all the remaining constructs returned small effect sizes, i.e. that they did not significantly influence agile usage. However, since this is the first time that the constructs and relationships in the suggested model have been empirically tested, these results should be further validated before any changes can be made to the model.

The following sections present key observations regarding the major sections of the model.

7.4. Agile Effectiveness

Sustained agile usage had significant relationships with all effectiveness measures, i.e. Predictability, Productivity, Quality, and Customer Satisfaction. Thus, the study supports the hypothesis that significant relationships exist between SAU and usage impacts (agile usage effectiveness): i.e. agile usage explained a good portion of the variance in predictability (29%), productivity (26%), quality (30%), and customer satisfaction (18%). In other words, sustained agile usage (measured by the extent and intensity of agile method use) has a significant impact

¹⁸ Most studies based on innovation-diffusion models achieve R² values of around .40 (Venkatesh & Davis, 2000)

on agile usage effectiveness, i.e. predictability, productivity, quality of systems development as perceived by agile practitioners. Sustained agile usage is also associated with increased customer satisfaction as perceived by agile practitioners.

The above findings are consistent with the findings from the previous phases of this study, i.e. where improvements in usage effectiveness measures were reported as a result of sustained usage of agile methods. In both the case studies (BBCW and Stats NZ), evidence of improvements in development outcomes provided justification for the management to continue using AM. As a result, agile usage continued not only in other software development teams, projects, and regions, but also in areas such as SAP teams, product development teams, and business. While the findings support the literature on post-adoption use of SDM and IS innovation (Huisman & Iivari, 2002; Iivari & Huisman, 2007; Iivari & Iivari, 2011) which emphasize that high knowledge-burden methodologies such as agile must be used deeply and extensively in order to achieve improvements in system development outcomes, the findings of this study should be confirmed by future studies on sustained use in an agile context. Most studies in the agile extant literature until now have focused on ‘success’ measures with an emphasis on agile use from an initial adoption perspective (see for example, (Williams et al., 2004a; Williams et al., 2004b), (Chow & Cao, 2008) (Begel; & Nagappan, 2007) , (Misra et al., 2009b), and (Franca et al., 2010)). This study therefore furthers the knowledge of effectiveness of complex methodologies such as agile by investigating the significance of their sustained use on effectiveness, by supporting the use of multiple effectiveness dimensions. While this study has explored the role of sustained agile usage on usage effectiveness, how the various factors and effectiveness measures can be applied more effectively needs to be explored. More work is also needed to examine exactly how the measures of effectiveness interrelate. Another area for future investigation would be to explore the influence of sustained agile usage on customer satisfaction on the quality and sustainability of the delivered system (i.e. satisfaction on systems developed using agile methods).

Table 7.8: Summary of hypotheses testing results

H1	As agile practitioners' perceptions of relative advantage in using an agile method increase, their level of agile usage will increase	Supported
H2	As agile practitioners' perceptions of compatibility in using an agile method increase, their level of agile usage will increase	Not Supported
H3	As agile practitioners' perceptions of an agile mindset in using an agile method increase, their level of agile usage will increase	Not Supported
H4	As agile practitioners' perceptions of degree of agile coach support in using an agile method increase, their level of agile usage will increase	Supported
H5	As agile practitioners' perceptions of tool support in using an agile method increase, their level of agile usage will increase	Not Supported
H6	As agile practitioners' perceptions of degree of methodology champion support for agile method use increase, their level of agile usage will increase	Not Supported
H7	As agile practitioners' perceptions of management support for agile method use increase, their level of agile usage will increase.	Not Supported
H8	As agile practitioners' perceptions of agile compatible organisation structure increase, their level of agile usage will increase.	Not Supported
H9	As agile practitioners' perception of agile usage increase, their perceived productivity in using agile methods will increase.	Supported
H10	As agile practitioners' perception of agile usage increase, their perceived quality in using agile methods will increase.	Supported
H11	As agile practitioners' perception of agile usage increase, their perceived predictability in using agile methods will increase	Supported
H12	As agile practitioners' perception of agile usage increase, their perceived level of customer satisfaction in using agile methods will increase	Supported

7.5. Sustained Agile Usage

Though the factors in the research model explained 38.8% of sustained agile usage variance, as discussed in the previous section (7.4), only *relative advantage*, *agile coach*, and *agile mindset* were found to have medium to large effects i.e. omitting them from the model would have substantive impact on sustained agile usage. Findings from the PLS-SEM analysis confirm the role of perceived benefits and coaching in driving sustained usage of agile methodologies, as they explained a greater proportion of the variance (significant results). Hence, organisations should devote to strategies aimed at providing specific evidence of benefits and improvement outcomes of using AM, and towards creating a positive learning experience (e.g., by investing in coaching) that can aid sustained agile usage rather than by temporarily inflating practitioner involvement and participation during the initial phases of adoption. As evident from the findings of this study, only sustained usage can yield long lasting benefits and improvements in development outcomes. The proportion of variance in agile usage

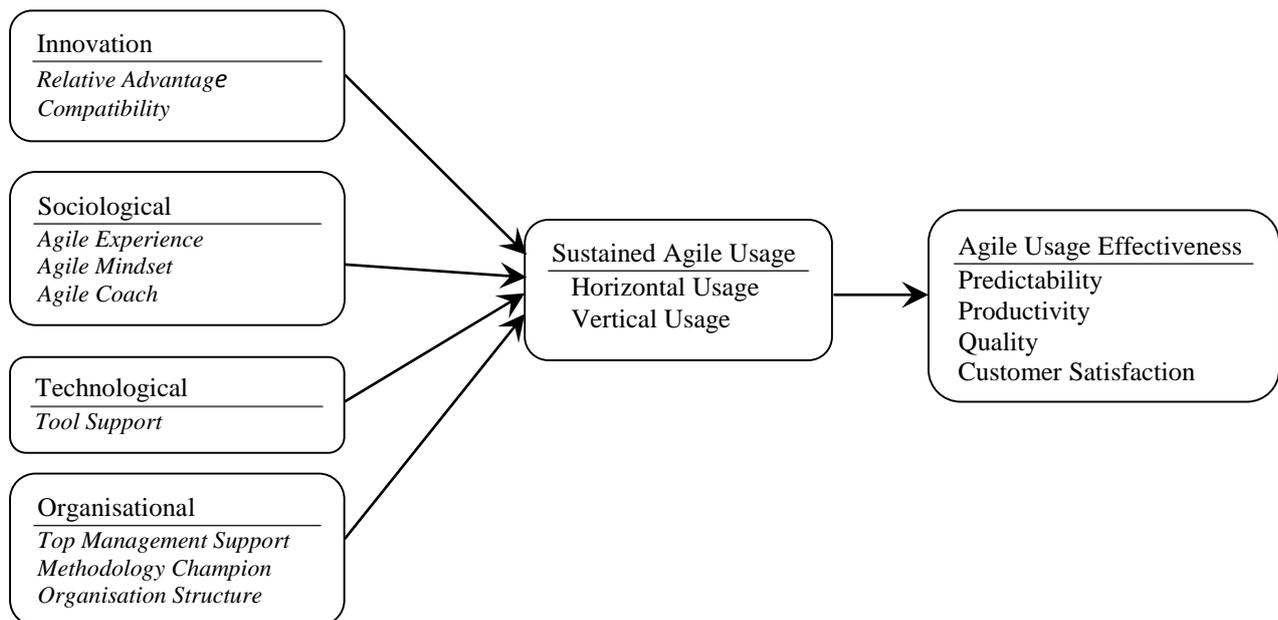
left unexplained (the remaining constructs did not significantly influence agile usage) leaves open the possibility that additional constructs not included in the model may also be relevant in explaining the dependent variable, sustained agile usage. Some of these constructs, revealed in the qualitative analysis phase, may include resource constraints (e.g. lack of time, budget), and team effectiveness. Further research is therefore needed to validate and explore other factors that might impact sustained usage.

7.5.1. Factors that influence agile usage

Relative advantage emerged as a significant factor, which shows that increased awareness of the various benefits of using agile methods in comparison with their previous methods has an impact on SAU. *Compatibility* had the next higher path coefficient (0.105) though it did not return significant results. This is consistent with the findings from the previous phases of this study, i.e. case studies, interview and FG data. The findings also support the SDM literature in general - for example, *relative advantage* has been consistently reported as a key factor influencing use and acceptance of innovative tools and methodologies (Agarwal & Prasad, 2000; Huisman & Iivari, 2002), and also in the context of agile methodologies where significant results have been reported for the effect of *relative advantage* and *compatibility* on agile use, i.e. practitioners who believe that AMs are compatible and provide increased benefits (relative advantage) are more likely to accept and sustain AMs (Bonner et al., 2010). Similar results have been reported for the impact of relative advantage and compatibility on long-term usage of agile methods such as Scrum (Overhage & Schlauderer, 2012).

The construct “*agile mindset*” (path coefficient – 0.101) was found to have a positive impact on agile usage, though it did not return significant results. The construct *agile mindset* was included in the model based on the findings from the cases studies, FG and interview data which highlighted that ‘people’ characteristics such as resilience, team spirit, whole team involvement and commitment, and willingness and ability to learn were more important than technical knowledge and expertise of team members (please see chapter 5 for a detailed discussion). Theoretical concepts and findings that relate to the above characteristics (e.g. team factors, agile mentality) from both the academic (Mangalaraj et al., 2009b) and practitioner literature (Rising, 2012) were referred to operationalise this construct. The operationalisation is based more on the sociological aspects drawn from SDM and the agile literature, rather than from the general theoretical characteristics of ‘mindfulness’ or individual mindset, where mindfulness is identified as a way of working characterized by a

Figure 7.7: Sustained Agile Usage Model



focus on the present, attention to operational detail, willingness to consider alternative perspectives, and an interest in investigating and understanding failures (Butler & Gray, 2006; Weick, Sutcliffe, & Obstfeld, 1999). This concept of mindfulness is also recognised as a useful theoretical lens for understanding agile methods (Matook & Kautz, 2008), but yet to be empirically validated. Future research is needed to further explore its relationship with measures such as success, effectiveness, and performance outcomes. For example in ASD, do the theoretical aspects of mindfulness (*openness to novelty, alertness to distinction, sensitivity to different context, awareness of multiple perspectives, orientation in the present*) (Butler & Gray, 2006) influence sustained usage of ASD? Which aspects? How can they be operationalised? These questions still need to be addressed.

Similar to '*agile mindset*', the construct '*AC*' was included in the final research model (not present in the original *a priori* model (see Chapter 2)) when all data (i.e. case study, FG, and interviews) consistently highlighted its significance on the sustained usage of AM - the absence of AC was perceived to be the main reason for many agile teams degrading to their previous traits and led to ineffective use of agile practices in many organisations. The significance of roles such as methodology champion in the effective diffusion of innovative methodologies are well recognised both in the SDM (Iivari & Huisman, 2007) and agile (Laanti, Salo, & Abrahamsson, 2011; Nerur & Mahapatra, 2005) literature. However, though the significance of the role of an '*AC*' in facilitating the effective and sustained use of AM has been strongly

advocated by its proponents (e.g. practicing agile coaches, coaching federations¹⁹) in the practitioner community, this is first time its influence on the sustained usage of AM is empirically validated. Therefore, the positive significant result of AC (path coefficient – 0.296) is noteworthy²⁰. It implies that coaching is an effective mechanism for sustaining the use of AM. This finding is consistent with the findings from the previous phases of the current study and also with the practitioner literature that substantiate the value of this factor. In medium to large scale organisations, AM grow in a phased manner (i.e. team, project, region) starting typically from the grass-roots of an IS department. Therefore, the influence of a transitory role such as AC in transitioning the use of agile methods from the initial phases of adoption to post-adoption phases of continued and effective use seems logical. There must be substantial commitment for the provision of coaching facilities in organisations, recognising that the greatest benefits of agile development usually occurs later rather than immediately. Unfortunately, some organisations experience problems in this area. The primary role of an AC is to boost the agile teams' performance and proficiency in ASD (i.e. in teams who have been already applying agile practices and techniques) though this does not limit them to introducing agile into organisations and establishing new agile teams (Davies, 2011). Currently, coaching is a big 'hype' in the agile industry, and though there is a big supply of agile coaches (some of whom are internal, i.e. project managers or Scrum Masters who either claim to be coaches or mandated to be in that the role by the company), the biggest challenge for organisations is to find expert coaches (external) who can make the agile teams self-coaching and adept in applying agile (Davies, 2011). Moreover, finding right expert coaches demands a large investment (e.g. time, financial) that can be difficult to convince management without guaranteed up-front tangible benefits (as seen in the findings of Stats NZ case of this study). As a result, many organisations have made choices to staff from within, independent of whether their staff has relevant coaching experience, which may potentially lead to adverse repercussions. But the implications from the findings of this study are clear that it is worth the time, money and effort investment given the pivotal role of coaching.

Against expectations, *tool support* (path coefficient, 0.038) had no significant effects on agile usage. This is contradictory to both the findings from the previous phases of the current study and the agile literature where post-adoption and effective usage of agile methods are found to

¹⁹ <http://www.coachfederation.com> , agilecoachinginstitute.com

²⁰ 10.5% of respondents were agile coaches which might have had an impact on the results, and therefore further studies to validate this finding are warranted

be heavily dependent on the use of tools and technologies such as automated web application testing tools, NUnit for testing, and CruiseControl.NET for Continuous integration. (Mangalaraj et al., 2009b; Russo et al., 2013). However, the above findings (including previous phases of the current study) are based on case studies and therefore should be interpreted within the context of the studies. The practitioner literature contains considerable supporting literature on the benefits and impact of appropriate tools and technologies on effective agile usage, though mostly from proponents and tool vendors (e.g. Version One, Rally). More recently, a new practice called “Technology-Driven Development” claims that tools and techniques do not just influence effective agile usage but also foster learning and collaboration (ITO, 2014). Automation and development techniques such as Continuous Integration and Test Driven Development along with supporting tools such as Jenkins, Atlassian Stash, and JUnit, were found to not only improve effective usage of agile methods but also enabled learning and collaboration (ITO, 2014). While automation tools and development techniques are powerful, they can contribute to only short-term effects and may not be sustainable (ITO, 2014): “to make effects long lasting, it is necessary to grow the team continuously. That is to say, we ought to grow an agile culture”.

Therefore, the findings from the survey could be interpreted as follows ways: firstly, respondents’ perceptions might have been influenced by the fact that tools are not actually widely used in practice. This is consistent with the findings from the qualitative phase (case studies, FG, and interviews), where though most participants had strong awareness on the positive impact of tool support on agile usage, but in practice were not widely used in many participant organisations. According to the data collected in the survey, 77% of the respondents used Cards, 50% used standard office productivity tools such as Excel Spreadsheet, 47% used Kanban boards, 41% used Wikis, etc., which shows commonly used productivity tools are more popular rather than other specific purpose tools. According to the 2013 annual survey conducted by Version One, 69% of the respondents used Excel, and 48% used Microsoft Project (VersionOne, 2013). Interestingly, this survey did not include ‘index cards’ in spite of its popularity in agile development. The above findings provide evidence that standard productivity tools such as cards and Excel continue to be some of the most commonly used tools. Further research is needed to validate these findings and also to explore the reasons why tools are not commonly used. Secondly, it could be attributed to the lower predictive validity of the construct, as it was modelled as single-item construct.

The factors *methodology champion (MC)*, *organisation/management support (MS)*, and *organisation structure (OS)* had no significant effects on SAU. The result of *MC* contradicts findings in previous research where the significance of *MC* in facilitating the continued usage of both SDM (Green & Hevner, 1999; Huisman & Iivari, 2002; Iivari, 1996) and AM has been recognised (Conboy et al., 2007; Russo et al., 2013). This could be due to the following reasons: in many organisations *MC* is a much broader role which encapsulates many responsibilities including championing innovative methods such as agile. Also, the influence of the *MC* role may be more prevalent during the earlier phases of agile adoption than the later phases of sustained use. In comparison with the role of *AC* which is more directly and closely associated with the effective functioning of agile teams, specific influence of *MC* on agile usage might not be transparent and therefore not directly experienced by agile practitioners.

The results of *MS* and *OS* also contradict findings from previous post-adoption literature on SDM research (Huisman & Iivari, 2002; Iivari & Huisman, 2007), agile (Iivari & Huisman, 2007; Nerur & Mahapatra, 2005; Russo et al., 2013), and also findings from the qualitative phase of the current study (case study, FG, and interviews). On the other hand, they are consistent with agile ‘success’ factors studies in the agile adoption literature. For example, though statistically significant relationships were not found between organisation factors (e.g. structure, culture) and ‘success’ (Chow & Cao, 2008), respondents highlighted the critical role of organisational factors such as strong management support, organisation culture, environment, etc., in their responses to the open-ended success factor questions (Misra et al., 2009b). Comparing the findings of these three studies (i.e. (Chow & Cao, 2008; Misra et al., 2009b), and the current study), it can be concluded that while practitioners have strong awareness of the significance of *MS* and *OS* on successful and sustained usage of AM, they are not widely practiced in many organisations. Though it has been increasingly recognised that more flexible and flatter organisation structures which are more compatible with agile development are critical to sustaining agile methods (Lucas, 2012), most organisations are not moving in that direction. Lack of *MS* and appropriate *OS* are identified as the biggest challenges for sustaining agile usage in organisations (VersionOne, 2013; Work, 2012).

All of these factors suggest that there is a need for total commitment from organisations for successful deployment and sustainability of AM. Management support implies that the top and executive management have clear understanding of the implications of using agile with realistic expectations, and an understanding of their role in implementing agile - effective usage is a by-product of sustained use, i.e. there will be a period of transition and growth before AM can be

optimised to deliver improvements in development outcomes. This requires that organisations are committed to implementing continuous process improvement (which includes changes to organisation structure, culture, etc.) mechanisms.

In summary, the significant results of *relative advantage* and *agile coach* imply that organisations should implement effective coaching mechanisms, and strategies to increase the awareness of the relative benefits of using AMs. Other notable interpretation of the findings is that high agile usage tends to increase the productivity, predictability, and quality of software development. This has clear practical implications. It would indicate that if agile methods are not used effectively (i.e. extensively, intensively, frequently, adhered to) by not sustaining their use would lead to a great loss in terms of productivity, predictability, and quality of software development.

As a final note in this discussion, a word of caution must be voiced: this study derived a research model of sustained agile usage based on the extant literature and findings of the qualitative phase (i.e. case studies, semi-structured interviews, and FG) of the current study., and then used a survey to test the model. The results presented above must therefore be interpreted within the context of the study. Though a conscientious effort has been made to cover all relevant factors, it is acknowledged that there may be other factors not included in the model (as discussed in section 7.5) that may explain a greater amount of variance of sustained agile usage. Also, this study provided one way of operationalising constructs, in particular new constructs such as *agile mindset* which have not been operationalised in any previous research. Other ways of conceptualising and operationalising these constructs may lead to different findings.

7.6. Conclusions

This chapter used PLS-SEM to analyse the data and test the hypotheses specified in Chapter five. Special attention was given to the quality of the measures used by developing reliable and valid measures of study constructs. The collected data was analysed and various statistical results were presented. The findings were used to either support or reject the proposed hypotheses. Overall, twelve hypotheses were proposed, out of which six received support from the data. Overall, the empirical results confirm a model of sustained agile usage that presents a first step towards developing a comprehensive understanding of the factors pertaining to continued or sustained use of AMs, and the influence of sustained use on usage effectiveness.

It sheds light in to the nature and significance of a number of factors (including new constructs such as agile mindset, AC) relating to effective and sustained use of AM. The study, therefore, yields a promising conceptualisation of sustained agile usage associated with the sustained use of AMs.

7.7. Limitations

The study was a retrospective cross-sectional analysis based on perceptual data. Even though it has been argued that subjective perceptions provide a sounder basis for theory development than more objective data (Moore & Benbasat, 1991), responses based on retrospective data have the potential for bias in that more recently encountered experiences may overshadow or skew judgements about less recent experience (Green & Hevner, 1999; Hufnagel & Conca, 1994). Because the focus of this research was on post-adoption or sustained usage of AM, it required participants to assess the relative effects of sustained agile use (more recent use) in comparison with their initial use (less recent use), this potentially biasing effect is minimised.

While the survey design used in this study is appropriate for the investigation of hypothesised relationships, it does not allow conclusions on causality. The use of a randomized or quasi-experimental design where levels of the study variables are manipulated would have addressed this limitation (Green & Hevner, 1999). However, the relatively large number of exogenous constructs that would have to be manipulated along with the constraints on time and resources would have made such a design more difficult to implement.

As the research involved a self-report survey design, it has the risk of common method bias. Though it has been doubted that the method alone causes systematic variance (Spector, 2006), Harman's one-factor test (Podsakoff, Todor, Grover, & Huber, 1984) was conducted to assess the presence of common method bias. The analysis revealed that there was no single factor which explained a substantial amount of variance, which provides evidence that common method bias did not pose a significant threat to the measurement validity of this study.

Chapter 8. Closure

The preceding seven chapters of this thesis presented the development and application of the *sustained agile usage* model. This chapter concludes the thesis and discusses the study's outcomes in light of its significance, main contributions, and limitations. First, the research process is recapitulated. This is followed by a discussion of the study's major contributions. Implications of the study for both research and practice are discussed. Next, limitations of the research are presented, followed by an outlook to future research.

8.1. Reprise

This thesis was motivated by the relevance of effective use of system development methodologies in IS practice and set out to understand the sustained usage of agile methodologies. Thus, the main research question, “*How can organisations sustain the use agile methods?*” had two investigative components:

1. What are the factors that impact *sustained agile usage*?
2. What relation, if any, exists between sustained agile usage and the results effectively achieved in terms of systems development outcomes?

In order to answer the above questions, it became imperative to build and test a model for understanding sustained agile usage. A mixed method design based predominantly on positivist assumptions was used. The design employed a sequential combination of (a) the qualitative phase (e.g. case study, semi-structured interviews): used to review and refine the constructs and relationships proposed in the initial *a priori* model, and develop hypotheses based on the final refined model and (b) a quantitative study to test the hypotheses. First, an *a priori* model was developed based on a detailed and systematic review of related streams of literature (e.g. post-adoption usage, SDM, IS implementation, and AM). The *a priori* model was used to guide the first case, BBCW, which had empirical evidence of achieving specific improvements in systems development as a result of sustained agile usage of AMs (i.e. it satisfied the theoretical relevance which ensured that the substantive area addressed, i.e. the SAU was similar).

The findings from BBCW confirmed that the proposed *a priori* model could be utilised to understand the various factors that influence sustained usage, and the impact of sustained usage, in turn, on *agile usage effectiveness*. For example, innovation factors (*relative advantage, compatibility*) highlighted that real evidence and awareness of the relative benefits

of using AMs had a significant influence on sustained usage. The emphasis on deeply adopting all the core properties/practices of Kanban was found to play a critical role. Findings revealed that restrictions on budget and schedule (time) influenced the application of engineering practices such as reducing technical debt, use of appropriate tools such as testing environments, and automated deployment. The findings also identified some key differences between a coach and other roles such as MC, team leader, and project manager. For example, while a coach is usually a transitory role (typically someone external to the organisation) not tied into project duration or to a specific organisation, MC is typically an internal organisational role with broader responsibilities. In summary, the first case assisted not only in testing the initial model, but also in obtaining formative feedback, and refining data collection plans (e.g. to use observations, daily stand-up meetings) with respect to both the content of the data (e.g. new constructs) and procedures (e.g. conduct of interviews, development of case study protocol).

The lessons learnt from the first case were applied to the design and conduct of the second case, i.e. Stats NZ. For example, additional data collection methods (e.g. observations) were used to gain better understanding of the implementation of agile. Additional factors identified in the first case were further tested – for example, time and budget constraint, coaching. Contrary to the findings from the first case, it was found that budget had a positive influence on sustained agile usage. Later, based on a cross-case analysis of the two cases (BBCW and Stats NZ), a number of additional findings were identified, e.g. the significance of a number of sociological characteristics, and the critical role of organisation structure was highlighted.

Findings from the case study phase was further applied to the third phase (i.e. focus group and semi-structured interviews) to further explore and gain insights on the adequacy and nature of the model, and to add to the interpretation of the results found by analysing previously collected data. Closer analysis and interpretation, through use of constant comparison method across data sets was done by the process of renaming and regrouping some existing constructs in the model, and adding new constructs which helped hone in the factors that were found to positively influence sustained agile usage. In summary, the sociological constructs *attitude* and *technical competence and expertise* were combined to form a new construct called *agile mindset*. A new construct called *AC* was added, and *experience* was changed to *agile experience*. The construct *Agile practices* was removed from the technological category due to its overlap with the construct *vertical usage*. In the organisational category, the constructs *TMS* and *MC* were retained, and a new construct *organisation structure* was added. A new construct *predictability* was added to agile usage effectiveness. The final refined model is shown in Figure 8.1:

Innovation factors (*Relative Advantage, Compatibility*), Sociological factors (*Agile Experience, Agile Mindset, Agile Coach*), Technological factors (*Tool Support*), and Organisational factors (*Top Management Support, Methodology Champion, Organisation Structure*).

The final research model, which provides a comprehensive conceptualisation of sustained agile

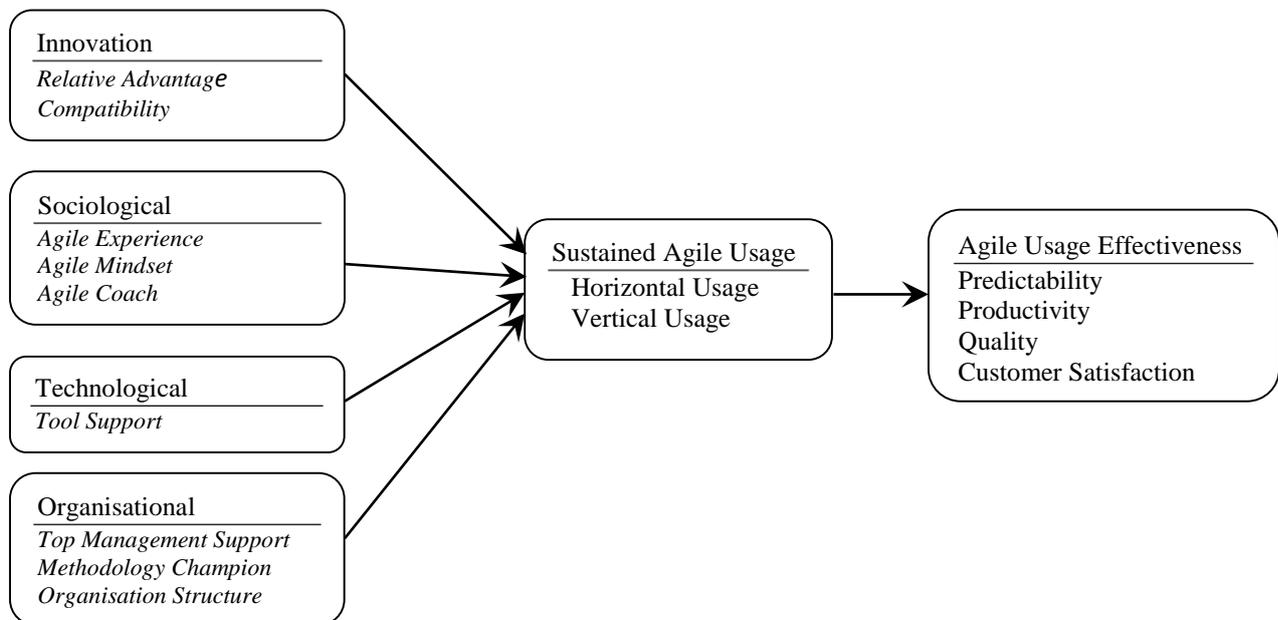


Figure 8.1: Final Sustained Agile Usage Model

usage was tested statistically using PLS-SEM on the basis of survey research carried out to measure the theorised constructs and relationships. The data analysis showed good support for the research model and confirmed six out of the twelve proposed hypotheses, which provided support for the general viability of the suggested research model for explaining and predicting the influence of the determinant factors on sustained agile usage. Though the factors in the research model explained 38.8% of sustained agile usage variance, only *relative advantage*, *agile coach*, and *agile mindset* (based on effect size test measures - f^2 values) were found to have medium to large effects i.e. omitting them from the model would have had substantive impact on sustained agile usage, whereas all the remaining constructs returned small effect sizes, i.e. that they did not significantly influence agile usage. Since this is the first time that the model has been subjected to an empirical test, it was deemed necessary to replicate the study in order to further validate the survey findings before incorporating them in the model.

One of the important aspects in the conduct of this study was to rely on, and incorporate, as much empirical evidence as possible. Evidence from two case studies, a focus group, twenty

semi-structured interviews, and an online survey (responses from one hundred and fourteen New Zealand agile practitioners) was collected. Feedback sought from experts, practitioners in the industry, academic colleagues, and students has also been incorporated.

This thesis contributes to the body of knowledge by comprehensively gathering and discussing knowledge about the effective and sustained usage of agile system development methodologies. The goal of this research is to improve the efforts to sustain effective methodologies such as agile in organisations.

8.2. Contributions

The central contribution of this thesis is the development of a comprehensive, empirically validated model which conceptualises important constructs pertaining to sustained usage of agile methodologies, and the association of sustained usage with agile usage effectiveness. The model integrates relevant theories from core research streams (DOIs, systems development methodology, IS implementation, and agile methodology) in order to identify and provide a greater understanding of factors that influence sustained and effective usage of AM. Apart from this central contribution, this study makes a number of additional contributions to IS research and practice. These are summarised in table 8.1

Table 8.1: Summary of Contributions

Research Phase	Level of Contribution	Discussion
Literature Review	Methodology	This study presented a comprehensive review of the literature which covered a number of major areas related to the phenomena of sustained agile usage: the historic evolution of SDM, relevant theoretical concepts and foundations from well-established research streams of DOI, SDM, IS implementation, post-adoptive usage, and agile methodology. By highlighting areas where the underlying assumptions of some of these traditional innovation models are either well- or poorly- suited to the actual context of agile usage, this study has provided justification for the need for new constructs to complement existing models.
	Results	One of the main outcomes of the review was the initial formulation of an <i>a priori</i> model, which provides a foundation to conduct empirical research based on an initial set of constructs and relationships that relate strongly to methodology usage, and enables further refinements to the model. For practitioners, the review serves as a repository of published information on the problems, challenges, and good working practices associated with the effective usage of AM. For

		researchers, it assists in identifying gaps in the extant literature and opens new opportunities for future research.
Case study	Methodology	This study assessed the use of the case study method to test the <i>a priori</i> model in investigating the phenomenon of sustained agile usage. The application of the model to two cases, BBCW and Stats NZ was helpful, not only for collecting data for refuting and/or supporting the proposed constructs and relationships but also for exploring situational and contextual factors of relevance. The level of methodological rigor in the research process and its adherence to the criteria of good practice for positivist case study research in IS was evaluated using the framework proposed by Dubē and Parē (2003). This research has shown that it is possible to produce rigorous qualitative research which complies with the standards of positivist research and meets the criteria of validity, reliability and replicability of the natural sciences. The protocols developed will assist future research in similar contexts/settings.
	Results	The robustness of the findings not only give valuable insights into the sustained usage of AM in systems development, but also highlights the appropriateness of the case method, which is particularly suited to the study of IS use in organisations, and permits the collection of rich qualitative data. It offers a rich description of two organisations (BBCW and Stats NZ) implementing AM and their efforts in sustaining their use. The results offer a useful complement to the very few studies that have examined the post-adoptive use of AM, yet whose results have been limited to descriptive analyses of their goals.
Refining the Model	Theory	First, this study showed how existing well-established theories on IS implementation, innovation diffusion, and post-adoptive agile usage can be coalesced into one model. This demonstrates a significant move made in gaining a more comprehensive understanding of the various factors relating to sustaining AM. Second, the model which laid out the research territory and guided the pre-understanding for the case study method, was further explored to gain insights on the adequacy of the theoretically developed constructs and relationships of sustained agile usage by using two additional methods (a focus group and semi-structured interviews), in order to add to the interpretation of the results found by analysing previously collected data. The final refined model provides a rich, customisable framework that may also be adapted to other related studies to develop a greater understanding of the various issues and challenges facing practitioners in the effective and sustained usage of development methodologies in a variety of settings. Thus, from a theoretical perspective, the main contribution is the opportunity it provides for future research to test and validate some of the implied conjectures.

	Methodology	<p>This is one of the very few studies in the domain of ISD to use the focus group method to explore the viewpoints of practitioners working on different ASD teams. Well-established methodological guidelines developed during the case study phase were utilised for conducting additional interviews with practitioners representing a wide range roles such as developers, business analysts, project managers, SMs, and IT service delivery managers.</p> <p>The constant comparison analysis method which assisted in the identification of similarities and differences across both (FG and semi-structured interviews) data sets, and any consistent themes or patterns relevant to sustained agile usage was critical in finalising the final set of constructs in the refined AUM. The protocols and guides developed can assist future research in similar settings.</p>
	Results	<p>The results not only give empirical insights into the sustained usage of ASD, but also highlight the fruitfulness of combining two methods of qualitative inquiry in the study of post-adoption phenomena associated with systems development methodologies. Given that the goal of this study was theory development rather than theory-testing, the multi-method approach employed here provided rich data with which the initial research model was continuously refined, and the final outcomes were used to identify specific propositions for further validation in the survey phase.</p>
Survey	Construct operationalisation	<p>This study presented the operationalisation of the various constructs identified in the SAU model. Pre-validated measurement constructs with clearly demonstrated quality measures were adapted to reflect the phenomenon of sustained agile usage whenever applicable, and new measures were developed for some new constructs (e.g. agile mindset, agile coach, and organisation structure). The procedure described ensures high levels of confidence in the quality of measures used, i.e. development of reliable and valid measures of study constructs. The resulting survey instrument can be used in other related studies on post-adoption or sustained usage.</p>
	Online survey design and administration	<p>This study applied a set of well-established guidelines in the design and administration of an online survey. Successful implementation of these guidelines was described and demonstrated - sample documentation of all supporting documents is presented in Appendix. This will assist other researchers to evaluate the effectiveness of the method adopted and also to replicate the survey in other settings/regions.</p>
	Results	<p>This study demonstrated the conduct of a well-designed survey research process where special attention was given to the quality of the measures used by developing reliable and valid measures of study variables.</p>
Data analysis	Methodology	<p>This study employed techniques such as pattern-matching, cross-case analysis, and dialogical reasoning</p>

	during the qualitative phase (i.e. case study, interviews), and PLS-SEM for analysing quantitative data (i.e. survey). To the best of the researcher's knowledge, this is the one of the very few studies in systems development methodology (and AM in particular) practice that has made use of advanced second-generation statistical analysis techniques such as SEM and path analysis. Given the growing popularity of SEM and PLS in IS research, the application PLS-SEM in the current study should encourage other researchers to apply these techniques in related areas of research.
Results	A major contribution of this research to the research community is the development of an integrated model that provides a greater understanding of factors that impact this sustained usage. The study demonstrated how well-established theories and ideas from related research streams can be used in a domain such as agile methodologies which lack strong theoretical base - in this way, this study adds to the growing body of agile literature. While the proposed model incorporates constructs previously suggested in traditional diffusion, SDM and agile implementation literatures, it is the synthesis of these constructs and relationships that is novel, and thus requires additional validation. The results and the iterative process of deriving the final model are documented in detail which enables both replication and adaptation in different settings and contexts. While such studies will help in further validating and refining this model, it is also hoped that researchers who study other contemporary innovations such as Kanban, DAD (Disciplined Agile Delivery) will apply this model to their own study research data and, in turn, evaluate, critique, and suggest modifications to the model, as necessary.

8.3. Conclusions

8.3.1. Implications for Research

The proposed sustained agile usage model has the potential to guide a variety of related research streams. It serves as a reference model for a wide range of studies that could be conducted to evaluate and critique the model, apply the model to different domains, test different conceptualisations of the model, and suggest modifications to the model. For example, such empirical studies could be conducted for several specific agile development methods such as Kanban, Lean development, or DAD (Disciplined Agile Delivery). Such studies would not only provide insights on the validity of the proposed model, but could also highlight potential differences in the sustained usage of different types of agile methods (e.g., Scrum versus Kanban). Given the large number of agile methods in systems development practice, alongside

with the dearth of research investigating their effective and sustained use, the proposed model serves as a foundation stone upon which a number of future empirical investigations in a variety of related context and domains can be built.

Second, this study provided empirical evidence to show that the integration of relevant existing theories in IS provides a useful conceptualisation of sustained usage. This implies that the study offers guidance not only to research relating to sustained usage of innovative development methodologies such as agile, but also to IS research in general. While some aspects of general IS theories on post-adoption use and implementation were found relevant to the agile development domain, this study also highlighted some key differences in some factors that are specific to agile, e.g. *AC*. It was also found that characteristics of *agile mindset* such as personal resilience and willingness and ability to adapt and change, were critical to sustained agile usage rather than on initial stages of adoption. Another key finding was the role of organisation structure on the sustained usage of AM, where strong support was found during the qualitative analysis phase but was not statistically supported in the survey findings. Thus, the study offers new opportunities to explore the nature of the differences in these factors in greater detail.

Thirdly, this study focused mainly on the key factors that influence sustained agile usage and the impact of sustained agile usage on usage effectiveness, but it did not explicate the set of influences and processes leading to sustained usage. Thus, the proposed factor-based usage model can be integrated with appropriate process models (e.g. assimilation process model) to forge a new model in order to gain a better understanding of sustained usage of innovative methodologies such as agile in organisations.

Fourth, the findings from this study demand deeper understanding on personal and organisational variables and their influence on sustained usage. For example, future research could study the differences between novice and expert agile practitioners, difference between technical and business-oriented usage of agile methods, and conducting studies in other regions (except for FG, which involved mainly US participants, all other participants (case study, semi-structured interviews) in this study were mainly from New Zealand).

Finally, this study made a conscientious effort to derive the final model of sustained agile usage based on the analysis of the data collected throughout various qualitative research methods – which was also empirically validated in New Zealand context using a survey. However, further evaluation of the model is necessary. The final refined model is offered as a generalisable model that seeks to explain the various factors and relationships that influence sustained agile

usage in organisations. The nature of generalisation sought by case studies is called *analytic generalisation* rather than *statistical generalisation*, which is sought by survey studies (Orlikowski, 1993; Yin, 2003). While the issues and factors occurring at one case site, e.g. Statistics NZ, are not alleged to be representative of sustained usage in other organisations, and the findings from the NZ survey are not alleged to be statistically representative of other regions, generalisation is sought in terms of the proposed theoretical constructs and relationships (Yin, 2003). The objective is to generalise the theoretical concepts that capture the key constructs and relationships underlying sustained usage, and to offer these concepts and patterns to practitioners and researchers as a useful formulation that may be extended to other scenarios (Gallivan, 2001). While the model proposed is generalisable – that is, it is capable of being generalised to other organisations, regions, and to other innovations, it has not been generalised, i.e. applied in other contexts and settings. The actual steps to employ this model and evaluate whether it adequately generalises to other contexts and settings lies in future research.

8.3.2. Implications for Practice

This study contributes to a number of different categories of practitioners including, amongst others, top management, developers, Scrum Masters, project managers, business analysts, as well as tool vendors and training providers, in many ways. These are described below.

The model developed in this study identifies the significance of the relationship between sustained usage and usage effectiveness, i.e. improvements in development outcomes. While traditional IS and agile literature focuses more on objective indicators of success and effectiveness such as quality and productivity improvements, these improvements will not be realised without the incorporation and sustained use of agile methodologies into practice. This implies that successful outcomes cannot be achieved by a few users or teams or projects independently using the innovation during the initial phases of adoption.

A second key contribution of this research to practice is the identification of factors that influence sustained agile usage. These factors can be influenced and monitored by IS management in order to better ensure sustained use of AM:

One significant finding that is consistent with the IS literature is the influence of *relative advantage*, i.e. improved benefits of using agile in comparison with predecessor methods had a significant impact (findings from the survey also returned significant results) on sustained

usage. However, while some organisations (as seen in the BBCW case) used traditional project metrics such as number of defects, lead time, etc., others were either not aware or were not ready to measure. Therefore, it is strongly recommended that organisations have strategies to track measures of improvements, though not from a purely metric driven approach, but from the perspective on its influence on effective use of innovations such as agile.

The other finding of this study is the significance of the construct *AC* on the sustained usage of AM - the absence of agile coach was perceived to be the main reason for many agile teams degrading to their previous traits leading to ineffective use of agile practices in many organisations. This implies that organisations must make substantial commitment for the provision of coaching facilities, i.e. investing in expert coaches who can make the agile teams self-coaching and adept in applying agile. The other factor was *tool support* i.e. the significance of appropriate tools (including collaboration tools) on the effective use of agile practices was identified, though it did not return significant results in the survey findings. Interestingly, though most agile practitioners had strong awareness on the positive impact of tool support on effective use of AM, but in practice, they were not widely used in many participant organisations. This has serious implications for organisations to critically assess the capabilities and benefits of using relevant tools, and accordingly invest resources in the identification and use of appropriate tools. Another factor of relevance is to carefully assess the individual characteristics of agile practitioners involved in agile projects, i.e. organisations should carefully monitor their *agile mindset* characteristics – as this was found to strongly influence sustained use.

Findings revealed that management, organisation structure and cultural challenges are very real issues facing many participants' organisations. For example, the significance of active involvement, support and commitment of management, and organisation structure that is more compatible with ASD was highlighted. This implies that top management do not merely accept the concept of 'agile' but commit to the role they have to play in order to sustain agile in their organisations. In addition to traditional support mechanisms such as financial support, staff training etc., key focus should also be on developing effective strategies for establishing dedicated roles (e.g. *AC*), creating mentoring programmes, transitioning to flatter structure, funding and resourcing models that match agile way of working, i.e. strategies which are aimed at developing a whole system that facilitates agile values and principles, i.e. organisation wide changes. Top management should have a unified focus on anticipating and dealing with any challenges and disruptions in the organisation wide implementation of such an innovation.

8.4. Limitations

Every effort has been made in this research to develop a comprehensive research model, use appropriate research design and methods, develop reliable and valid measures, and analyse the study data using appropriate and robust analytical techniques. However, limitations of this study do exist and have been discussed within the previous chapters of this thesis. Table 8.2 provides an overview by summarising some of the limitations pertaining to various aspects of this study.

Table 8.2: Summary of Study's Limitations

Research Phase	Limitation	Discussion
Case Study	Design and Conduct	<p>The methodological rigor and adherence to the criteria of good positivist case study research practice was evaluated using assessment criteria specified by Dubé and Paré (2003) – please refer to tables 4.3, 4.4., and 4.5 which show the findings of this assessment. However, it is acknowledged that the case study phase was conducted within some of the weaknesses of the approach identified in the literature such as site selection and data collection procedures. For example, the selection of the cases was convenience based on geographic proximity (New Zealand) rather than the sampling frame procedure outlined in the case protocol, but they still did fit the overall sampling requirements defined in the case protocol.</p> <p>Data collection, collation, and analysis were all done by a single researcher which could have introduced researcher bias. While this might have resulted in either over- or under-emphasis of some constructs, it is believed that further validation in the subsequent research phases has addressed this limitation to a great extent.</p>
Focus Group	Methodology	<p>In contrast to the normal convention of conducting a FG, this FG was conducted in a conference setting, where a targeted group of experienced practitioners self-selected to participate which imposed some limitations, for example, it was not possible to attribute written and verbal data to individual groups members (i.e. effect of personal context on the data could not be considered during the data analysis phase). Therefore, though the findings cannot be considered entirely reliable, as described in section 5.2.1, effort was taken to evaluate the design and conduct of the FG using prominent frameworks (Merton 1990)</p>
	Scope	<p>A group of 29 software industry agile practitioners is a relatively large FG compared to a normal group which usually consists of six to 12 participants. This was mitigated by dividing the group into smaller groups of 5-6 participants. Moreover, larger FGs are recommended</p>

		for topics where researchers want to collect multiple perspectives and suggestions rather than to collect more detailed commentary (Morgan, 1997) – this also met the objective of this research, which was to validate the conceptual model.
Semi-structured interviews	Methodology	Section 5.4.2 describes the challenges and limitations associated with semi-structured interviews and how they were addressed in the current study. Problems relating to design measures such as validity and reliability were addressed by following guidelines suggested by leading experts in the field.
	Scope	As with the case study phase, the scope of the interviews phase was also restricted. Only five New Zealand organisations were contacted. Interviews from more organisations, different geographic locations, would have strengthened the insights obtained from this phase, or could have provided some new additional insights. Trying to address this limitation (by incorporating more organisations, interviews, etc.) would have added more resource constraints on the one hand, but on the other hand, it was also deemed unnecessary given the role of this phase (i.e. further validation of the research model) in the overall multi-method approach adopted in this study.
Model building	Selected research methods and theories	The final refined model is based on a number of different theoretical foundations and also the findings and analyses of a number of different research methods used in the current study, i.e. case study, semi-structured interviews, etc.. Accordingly, the model inherits the limitations of each of the research methods and those of the underlying theories.
	Constructs	While conscientious effort has been made to derive a comprehensive set of key factors that impact sustained agile usage (based on both suggested by the extant literature and the findings from the various phases of this study), it is possible that some important factors might have not been identified. Further empirical studies should validate and explore any additional factors not included in this study.
	Development of hypotheses	Similar to the development of constructs, it is possible that some important associations might have been left out.
Survey	Methodology	Some of the limitations of survey research (see section 6.2.1) can be associated with this research too. Well-established guidelines prescribed in the literature were followed to mitigate some of the associated risks.
	Construct operationalisation	Construct operationalisation and development of measures has some limitations. First, since some measures were adapted from previous research, this implies that they might not have been specific enough in capturing the meaning of the constructs in an agile context. Second, the adapted set of scales restricts its application to other contexts. Third, operationalization of new constructs (e.g. agile mind set) did not go through a

		specific validation phase before implementation – this implies that they could have been conceptualised in other ways, which may have led to different results. However, the scale validation procedure confirmed the quality of measures used, i.e. the measures were of appropriate validity and reliability.
	Common method variance	As the research involved a self-report survey design, it has the risk of common method bias. Though it has been doubted that the method alone causes systematic variance (Spector, 2006), Harman’s one-factor test (Podsakoff, Todor, Grover, & Huber, 1984) was conducted to assess the presence of common method bias. The analysis revealed that there was no single factor which explained a substantial amount of variance, which provides evidence that common method bias did not pose a significant threat to the measurement validity of this study.
	Sample	The sample was restricted to the NZ context. Also, it was practically not possible to adopt a random sampling procedure, which poses a threat to the robustness and generalizability of the findings. However, the description of the sample frame and the survey administration permits evaluation of the representativeness of the sample.
	Retrospective data collection	The study was a retrospective cross-sectional analysis based on perceptual data. Responses based on retrospective data have the potential for bias in that more recently encountered experiences may overshadow or skew judgements about less recent experience (Green & Hevner, 1999; Hufnagel & Conca, 1994). Because the focus of this research was on post-adoption or sustained usage of AM, it required participants to assess the relative effects of sustained agile use (more recent use) in comparison with their initial use (less recent use), this potentially biasing effect is minimised
	Causality	While the survey design used in this study is appropriate for the investigation of hypothesised relationships, it does not allow conclusions on causality. The use of a randomized or quasi-experimental design where levels of the study variables are manipulated would have addressed this limitation (Green & Hevner, 1999). However, the relatively large number of exogenous constructs that would have to be manipulated along with the constraints on time and resources would have made such a design more difficult to implement.
Data analysis	Methodology	The study employed PLS-SEM for analysing quantitative data (i.e. survey). Other quantitative analysis strategies (e.g., CB-SEM) or qualitative analysis strategies (e.g., content analysis) would have provided either different or additional insights respectively.
	Missing data	While well-prescribed measures (Hair et al., 2014) were used to handle missing data, the final data still suffers from concerns about potential patterns of occurrence which cannot be necessarily assumed to be random – this

	may have led to skewed results.
Results	The factors in the research model explained 38.8% of sustained agile usage variance. The proportion of variance unexplained leaves open the possibility that additional constructs not included in the model may also be relevant in explaining the dependent variable, i.e. sustained agile usage. Further research should validate and explore other factors that might impact sustained usage.

8.5. Future research

The previous section includes suggestions and recommendations for future research on the sustained usage of innovative systems development methodologies such as ASD. Other suggestions for future research are:

- As the research model is grounded in well-established theories, the model is expected to be applicable for a wide range of system development methodology innovations. Therefore, future research should validate this model by using another SDM innovation.
- Using the data collection to investigate the influence of *agile experience* on SAU. Also, since *AC* returned statistically significant results, and given that 10.5% of respondents were agile coaches, future research could validate this finding and repeat the study by filtering these responses.
- The model hypothesised that 'sustained agile usage' as a factor that influences 'agile usage effectiveness.' Future research could explore the significance of the reciprocal relationship, i.e. agile usage effectiveness influencing sustained agile usage.
- The study could be replicated in other regions and the data collected could be used to investigate the differences on SAU. For example, how do perceptions on SAU change across different regions?
- Data analysis in the survey phase found no support for constructs such as *tool support* and *organisation structure*. Thus, another area for future research is in developing alternate measures for these constructs, and retesting the relevant hypotheses to see, if there is, in fact, any differences between the results.

8.6. Concluding remarks

This thesis set out to describe an effort made in developing a comprehensive integrated model in an attempt to gain a deeper understanding of sustaining the use of innovative methodologies such as ASD in organisations. The results of this research make many important contributions to research and practice as described in the previous sections of this chapter. However, the overall contribution of this research is improving the effectiveness of systems development by increasing the likelihood that the use of beneficial SDM innovations such as agile will be sustained. On the whole, this research is nothing more than a first attempt to establish a body of knowledge about the chosen phenomenon of study.

Appendix A – Case Study Protocol

Investigation of factors that impact Sustained Usage of Agile Methodologies

Case Study Research Protocol

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1. Case Study Protocol

1.1.1. Objectives

The main objectives of the case study phase are to:

- i. test the proposed initial *a priori* model: are all constructs and relationships correctly captured? Is there any inadvertent exclusion of any important constructs? Any redundant constructs?
- ii. aid in the iterative development of the research model (using the structured-case methodology)
- iii. aid in the design of the subsequent survey: obtain sufficient evidence from the cases for the proposed relationships before deriving the hypotheses
- iv. support meta-analysis of data: to combine analysis from case studies with findings from other phases (e.g. semi-structured interviews) and survey analysis to support triangulation and meta-analysis.

1.1.2. Research Questions (also see interview guide)

- 1.1.2.1. How can organisations sustain the use of agile methods?
- 1.1.2.2. What are the driving factors that influence sustained usage of AMs?
- 1.1.2.3. What initiatives and strategies are companies applying to manage SAU?
- 1.1.2.4. What are the benefits and limitations of these initiatives?

1.1.3. Purpose

1. Examine factors (e.g. organisational, social, technological) that influence (either facilitate or hinder) sustained usage of AMs
2. In doing (i) above, uncover any associations with improvements in systems development outcomes as a result of sustained usage of AMs

1.1.4. Unit of Analysis

This case study is an investigation into the phenomenon of sustained usage of *agile methodologies* at OrgX²¹.

²¹ OrgX to be replaced with the name of the specific organisation.

1.1.5. Research Model and Key Constructs

An overview of the initial conceptual framework that drives this case study is shown in Figure below. The model need to be revised at the end of each case/research cycle as needed to incorporate understanding about the research themes, which forms the basis of a subsequent case, i.e. the conceptual framework is a series of evolving models that are reviewed and refined over the life of the research project.

Key constructs

(1) Innovation (*relative advantage, compatibility*) (2) Sociological (*technical expertise, business/domain expertise, experience*) (3) Technological (*agile practices, tool support*) (4) Organisational (*methodology champion, top management support*) (5) SAU (*horizontal usage, vertical usage*) and (6) Agile Usage Effectiveness (*productivity, quality, and customer satisfaction*)

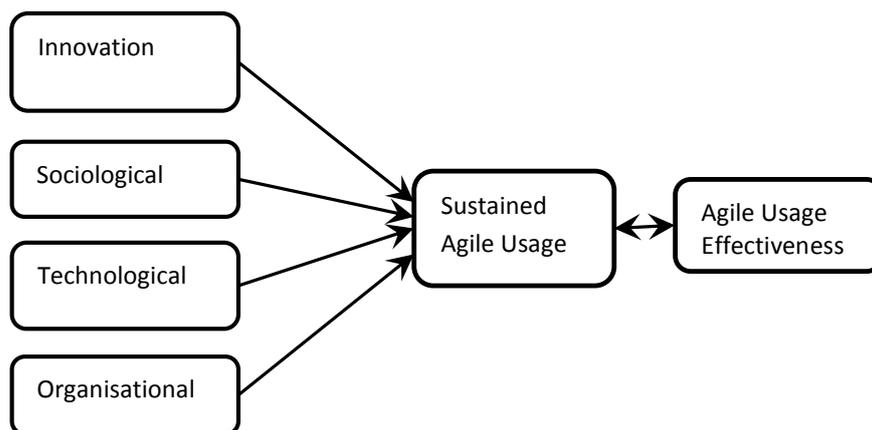


Figure 1: Agile Usage Model – Research Framework

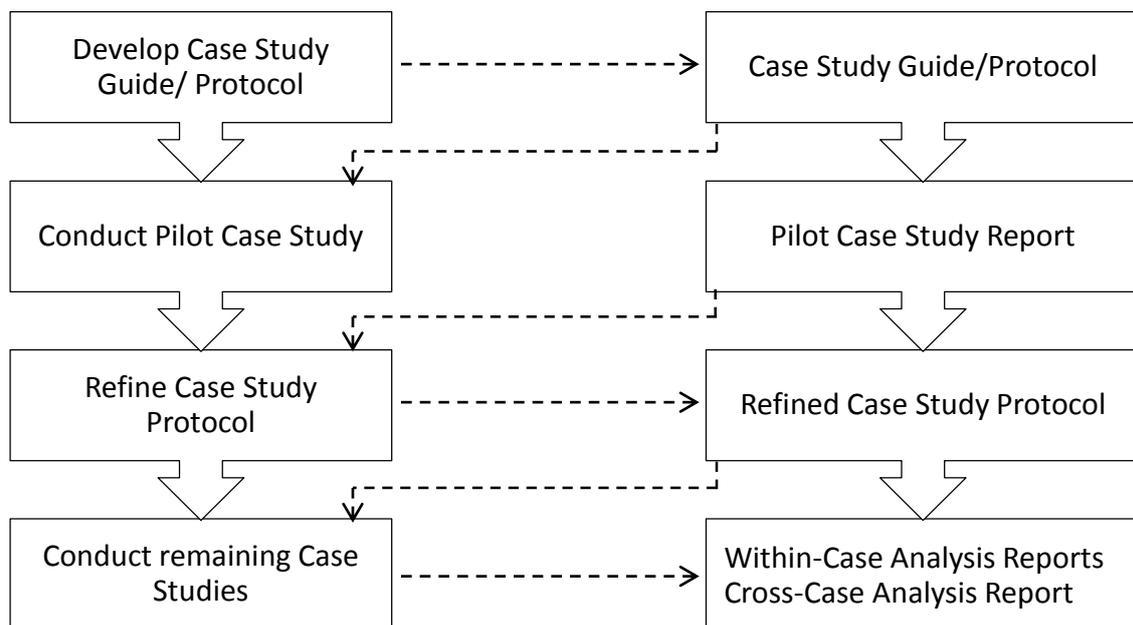
1.2. Case Study Design

Ethics approval to be obtained before the commencement of the investigation to assure participants that all information will be confidential and that there will be no prejudice if they did not participate.

1.2.1. Multiple-Case Design

- i. Conduct each case an experimental treatment
- ii. Write up each case - a single narrative to describe and analyse the case using standard case report format

- a. pattern-matching to compare an empirical based pattern with the predicted one, i.e. the *a priori* conceptual framework, analyse the findings within each case.
- b. implications for research and recommendations for practice.
- iii. Write multiple-case report
 - a. describe, compare and analyse cross-case analysis and results.
 - b. prepare overall analysis/write-up based on patterns, inferences, and implications.



1.2.2. Population

Organisations using one of the main agile methodologies (Scrum, XP) agile methodologies (use > 2 years) in their systems development operations

1.2.3. Sample Selection

- i. Initial (pilot) case chosen as representative leader in technology management with empirical evidence of achieving specific improvements in systems development outcomes as a result of SAU
- ii. Willingness to participate

- iii. Organisations represent different industry sectors in different technological and market environments, and use one of the core agile methodologies to develop systems/software

1.2.4. Data Management Issues

1.2.4.1 Multiple Sources of Evidence

- i. Semi-structured interviews with key informants – e.g. developers, Scrum Master, agile coaches, business analysts
- ii. Internal documentation (e.g. ASD life cycle development, organisation strategic policies and planning, published documentation)
- iii. Secondary data sources (published articles)
- iv. Direct observation (e.g. daily stand-up meetings, phone meetings between regions)

Data collection includes the background and contextual information relating to the use of agile methodology and data pertaining to testing the various constructs and relationships in the proposed conceptual framework – table

Data	Sources of Evidence
1. Organisation	<ul style="list-style-type: none"> ➤ Internal documentation ➤ Organisation web site ➤ Published information
1.1. Industry sector, major activities	
1.2. Organisation goals, Corporate mission and vision	
1.3. Background and Context	
1.3.1. Number of branches in agile systems development	
1.3.2. Number of employees in each branch and total IS staff	
1.3.3. Organisation structure	
1.3.4. Other supporting information	
1.4. Rationale/motivation for using AM	
1.4.1. Practitioners’ and management perspectives’	<ul style="list-style-type: none"> ➤ Interviews of key informants both from technical (practitioners) and management
1.4.2. Major projects involved in agile development	<ul style="list-style-type: none"> ➤ Interviews of practitioners’ involved in major agile projects ➤ Supporting project documentation
2. Overall AM initiative	

2.1. Introduction of AM	➤ Internal documentation
2.2. Overall purpose and role of AM	➤ Interviews
2.3. Overview of major agile projects	
3. Agile Methodology Project teams	
3.1. Agile teams	
3.1.1. Agile team facilitators/proponents (e.g. Scrum Masters)	➤ Interviews ➤ Project documentation
3.1.2. Number of agile practitioners	
3.1.3. Experience (e.g. number of years, number of projects using agile), expertise (e.g. agile training, certification)	➤ Individual interviews with practitioners
3.1.4. Nature of employment (e.g. full-time/part-time, external/internal)	➤ Interviews
3.2. Agile Methodology	
3.2.1. Core agile methodologies	➤ Interviews
3.2.2. Development domain (rationale for choosing agile)	
3.2.3. Number of projects using agile	➤ Observation
3.3. Agile Practices	
3.3.1. Adherence to core agile principles and values	➤ Interviews
3.3.2. Adherence to core agile practices	➤ Observation
3.3.3. Meetings (e.g. daily stand-up meetings)	
3.3.4. Agile teams communication (e.g. level of contribution, effectiveness of communication across distributed teams, issues/consequences)	
3.4. Tool support	
3.4.1. Tools used to support AM use (e.g. TFS)	➤ Interviews
3.4.2. Other tools used to support AM (e.g. communication, collaboration tools)	
3.4.3. Extent of effective use (e.g. functionality, tool features)	➤ Observation
4. Specific details on SAU	
4.1. Factors that influence SAU	➤ Interviews
4.2. Evaluation of AM	➤ Project documentation
4.2.1. Evidence of any existing evaluations	
4.2.2. Perceived benefits of using AM	
4.2.3. Factors that influence SAU	
4.2.4. Factors that influence agile usage effectiveness	

1.2.4.2 Case Study Data Base

The Case Study database contains all relevant and supporting data collected throughout the data collection phase. It includes documentation of all methods used to collect data, e.g. list of all documents and interviews, field notes during data collection (e.g. interviews), contact summary sheet.

1.2.4.3 Chain of evidence

References to evidence along with the actual evidence in an easily accessible manner in the Case Study database enables in establishing a chain of evidence from data collection, analysis to interpretations and conclusions.

1.2.4.3 Coding

Based on the conceptual *a priori* framework, the coding scheme was divided into three broad sections (i.e. constructs for each of the main and sub-categories): (1) four sub-categories, innovation, sociological, technological, and organisational (2) agile usage, and (3) agile effectiveness. The actual coding was conducted as below:

- (i) Code data under corresponding predefined constructs (*a priori* model) in the coding scheme
- (ii) Identify or inductively develop any potential new constructs (e.g. using in-vivo coding)
- (iii) Further analyse the coded data to validate its relevance, categorisation, etc.,

1.3 Data Analysis

The initial *a priori* coding (conceptual framework derived from the literature) were used in the analysis of individual transcripts. Individual transcript summaries were created from each participant's interview transcript which enabled the researcher to develop a clearer picture of participants' responses to key questions posed during the interviews (Miles & Huberman, 1999).

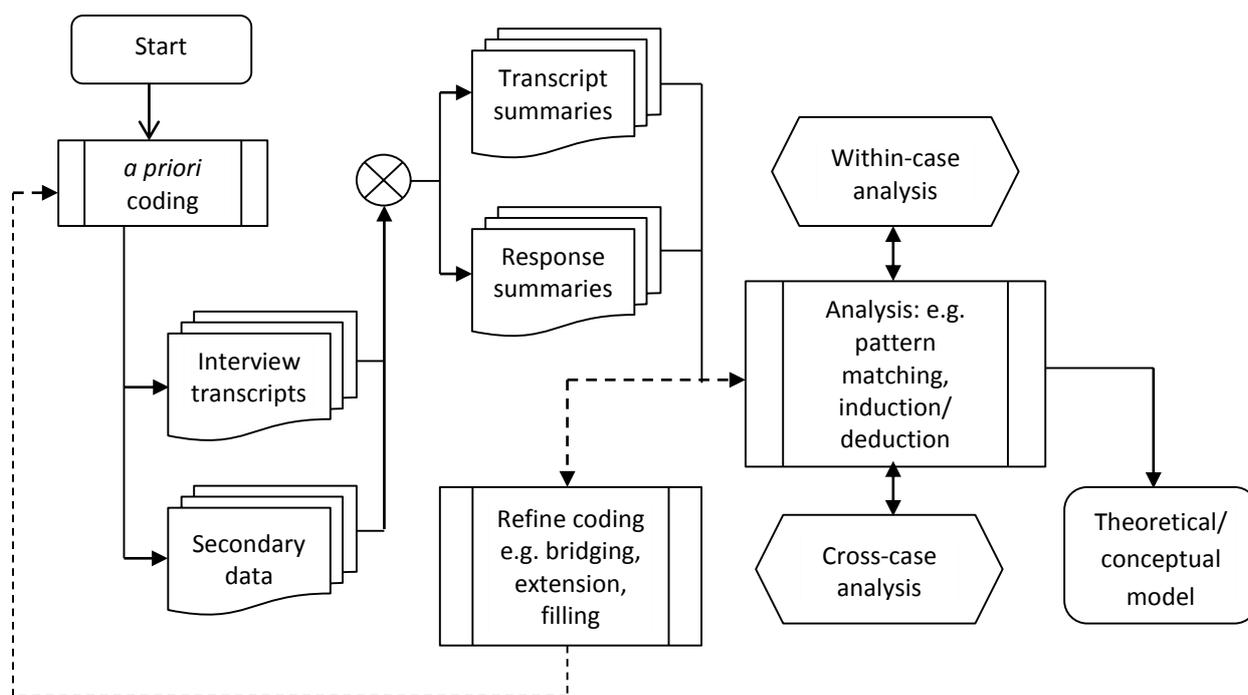


Figure 8.1: Data Analysis

(Source: adapted from (Maimbo & Pervan, 2005))

A case response summary, which is a collation of all participants' individual responses to each question, was developed to facilitate comparative analysis of participant responses (see Figure 8.1). Secondary data collected from various sources such as companies' internal documentation, minutes of meetings, and published documentation was also analysed in parallel with the interview transcripts. Combined analyses of transcript and case response summaries, and secondary data contributed to in-depth analysis of each case (i.e. within-case analysis) and used to develop a case report for each case. Well established guidelines and optimal qualities of a case report (Pare, 2001) were followed in developing the Case Study Reports, i.e. the report included introduction to study objectives, background and context, analysis of cases (e.g. within-case and cross-case), interpretation and discussion of results, and implications for research and practice. The case reports, in turn facilitated cross-case analyses of the two cases (i.e. BBCW and Stats NZ). The outcomes of analysis were evaluated by reflecting on any emergent themes and changing the conceptual framework to incorporate the knowledge accumulated.

Appendix B – Interview Guide

Interview Guide - Semi-structured Interview Protocol

Investigation of factors that impact Sustained Usage of Agile Methodologies

Semi-Structured Interview Protocol

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Interview Guide

Description: This document serves as a guideline specifying the types of questions we would like to know in continued and sustained usage of agile methodologies in your organisation.

Purpose of Interview: the study seeks to collect data and information about the following:

- A brief description of the organisation
- An overview and description of the contextual data about the agile project
- Data relating to the main driving factors that either influence or hinder sustain usage of AM
- Information justification and follow up.

Organisation: _____

Name: _____

Role/Position: _____

It is expected that each potential participant may be required to participate in at least two interviews in the form of semi-structured interviews.

Commencing Interviews

<thanks and appreciation for agreeing to participate>

<introduce interviewer, background, purpose of research>

<give participant information sheet>

<check understanding - ask if they had any questions or clarifications>

<obtain written consent – includes permission to audio record>

<begin>

Part A: Background Information

1. How long have you been working in software or systems development?
2. How many years have you been in using agile methodologies?
3. How long have you been working in the current organisation?
4. How your organisation is best described? For example, consulting, software development, government, telecommunications, Banking/Finance/Insurance, health etc.
 - a. When was agile methodologies adopted first?
 - b. What was the main motivation and main reasons for adopting agile methods?
 - c. How? Briefly explain the steps undertaken to introduce an agile method
 - d. Which project/s adopted agile methods?
 - e. How many agile projects has your organisation run?
 - f. What form of agile processes is most common in your organisation? For example, XP, Scrum, etc.,
 - g. The size of the ISD department in your organisation is ____
5. Briefly describe the current agile project/projects you are involved in.
6. What is your role in the agile project/s?

Part B: Factors that impact Sustained Agile Usage

The following sections consist of questions relating to various issues and factors associated with the effective and sustained usage of AM.

B1: Innovation

1. Which main methodologies were used prior to adopting agile in your organisation?
2. How can you compare agile with its predecessor?
 - a. What are the relative benefits?
 - b. What are the main challenges?
 - c. How would describe compatibility issues related to the use of agile projects? i.e. what were the main compatibility issues in relation to previous methodology/practices used in the organisation?
 - d. What were the main challenges involved in adopting agile practices

e. Do you track improvements in development outcomes? If so, please explain how? How do you compare with its predecessor methods?

B2: Sociological

- What is the average team size in a team?
 - Please specify the main criteria used to select members for an agile project (e.g. willingness, experience, skills etc.,)
 - Please state the status of employment of members in agile teams (Full-time/Part Time/Contract)
 - Please provide information about your team members.
 - **overall experience with systems development methodology**- Please rate your team’s experience with developing systems/software professionally. Include each full-time member including the number of interns and/or co-ops.

 < 5 years (Low) 5-10 years (Moderate) 10 - 20 years (High)
 - **Domain Expertise** - Please rate your team’s experience with the problem domain, i.e., domain associated with the project, for example, familiarity with database systems, web applications, banking, retail system, embedded systems.
Low Moderate High
 - Please describe attitude and motivation of team members with who have worked most in agile projects
 - Please describe the team management practices of the agile teams in which you have worked most
 - Please describe the main team practices that facilitated the effective use of agile methods.
1. Is there is a coach or a related leadership role that facilitates the effective use of AM? If so, is this role external or internal to the organisation
 2. Please describe the significance of this role in terms of facilitating the effective use of AM

- Traditional – a tool used in non-agile processes such as requirements management, item workflow tracking, project
- Project management/Gantt charts, etc.
- Any other (please specify)

B4: Organisational

1. Describe the significance of executive involvement and participation in adopting/using AMs

2. If not from the beginning, at what stage did management got involved in supporting AM? What form of support did you received from the top management? For example, a solid “network of support” in the form of knowledgeable colleagues, internal support personnel, and/or outside consultants, which enabled easier transition to agile methods, etc., and any other please specify:

-
-
-
-
3. Did you have a methodology champion (MC) who promoted/facilitated the ongoing use of agile methods in your organisation? Please note that a MC is different to other roles such as agile coach (MC usually works at a higher level than coaches and project managers and is defined as one who actively and vigorously promotes their personal vision for using innovations such as agile, typically have lesser resources and authority than sponsors, but use a variety of influence processes to experiment with and implement innovations. They work toward convincing higher management that an innovation is worthy of significant investment.

Was there such a role in your organisation? If so, do you see this role as critical in the effective usage of AM?

4. Improving SD approaches has been identified as a key mechanism that Information Systems Departments could use to effectively meet user needs. ISDs could respond to threats to their very existence by being customer-driven, reducing resources consumed and cycle times associated with system development and modifications, and by enhancing the productivity of their programmers/developers/analysts. Such ISDs will explore and possibly implement SDMs such as agile.

Was this the case in your organisation? Were agile methods introduced as a result of such pressure/demand from the user groups?

5. Please describe the organisation structure of your organisation. To what extent is the current structure compatible with agile development?

5.1. What are the main issues and challenges with the current structure? Why?

5.2. How can this be improved to better reflect agile development?

6. Please describe the organisation culture of your organisation. To what extent is the current culture compatible with agile development?

6.1. What are the main issues and challenges with the current culture? Why?

6.2. How can this be improved to better reflect agile development?

B5: Sustained Agile Usage

Agile Principles

The following questions relate to the agile principles practiced in your organisations. Please read each question carefully and circle on the scale at the right the choice that best represents your beliefs.

Strongly Disagree	Moderately Disagree	Disagree	Neutral	Moderately Agree	Agree	Strongly Agree
SD	MD	D	N	MA	A	SA

- 1) Our highest priority is to satisfy the customer through early and continuous delivery of software.

SD MD D N MA A SA

- 2) Our agile product teams welcome new or changing requirements, even ‘just before delivery’.

SD MD D N MA A SA

- 3) Project stakeholders work closely with our agile teams and are readily available.

SD MD D N MA A SA

- 4) We build agile teams around motivated individuals.

SD MD D N MA A SA

- 5) Our agile teams are provided with the environment and support they need to succeed.

SD MD D N MA A SA

- 6) Our agile teams are trusted to get the job done.

SD MD D N MA A SA

- 7) Our agile teams are self-organising.

SD MD D N MA A SA

- 8) Working Software is the primary measure of progress of our agile teams.

SD MD D N MA A SA

- 9) Our agile teams are allowed to work at a sustainable pace.

SD MD D N MA A SA

- 10) Our agile teams give continuous attention to technical design and excellence.

SD MD D N MA A SA

- 11) We do some initial requirements modelling at the beginning of agile projects for planning and scoping purposes.

SD MD D N MA A SA

12) The requirement details emerge over time on our agile projects.

SD MD D N MA A SA

13) We do some initial architecture modelling at the beginning to get going in the right technical direction.

SD MD D N MA A SA

14) The architecture and design details emerge over time on our agile projects.

SD MD D N MA A SA

15) At regular intervals the team reflects on how to become more effective in future iteration/sprints.

SD MD D N MA A SA

Horizontal Usage: Horizontal Usage refers to as the extent of use of AMs, e.g. proportion of projects using agile methods/practices, proportion of analysts/developers using agile methods/practices.

1. To what extent are AMs used in your organisation?

- i) in initial projects only
- ii) in mostly small projects, but not in large projects
- iii) in a mixture of small and large projects
- iv) in mostly large projects, but not in small projects
- v) completely routine (in all the projects)

Vertical Usage: Vertical Usage refers to the depth and intensity of use of the agile method, e.g. if Scrum is the AM, then whether all core practices of Scrum are adhered to?

2. Please indicate the extent to which core agile practices are adhered?

- a. Which ones and how consistently are these practices used on your agile systems/software development projects?
- b. If not, why are they not practiced? What are the issues and associated challenges?
- c. Please explain adaptation of agile practices

3. Do you think that SAU (i.e. Horizontal Usage + Vertical Usage) has an impact on improvements in development outcomes? If so, please explain.

Appendix B – Interview Guide

Agile Practices

For each of the following management practices, please indicate how commonly they are practiced on your agile systems/software development projects?

1. Burndown Chart
2. Daily Scrum Meeting
3. High-level Release Planning
4. Iteration/Sprint Planning
5. Prioritized Worklist
6. One Product Owner/Customer
7. Produce Potentially Shippable Software each Iteration/Sprint
8. Retrospectives
9. Status Reports
10. Story Board with Task Breakdowns

For each of the following development practices, please indicate how commonly they are practiced on your agile systems/software development projects?

1. Collective Code Ownership
2. Follow Coding Standards
3. Follow Database Standards
4. Follow User Interface Standards
5. Pair Programming

For each of the following quality practices, please indicate how commonly they are practiced on your agile systems/software development projects?

1. Automated Acceptance Testing
2. Automated Developer Testing
3. Code Refactoring
4. Continuous Integration
5. Database Refactoring
6. Database Regression Testing
7. Test Driven Development (TDD)

8. User Interface Refactoring
9. User Interface Testing

For each of the following modelling and documentation practices, please indicate how commonly they are practiced on your agile systems/software development projects?

1. Active Stakeholder Participation
2. Documentation treated as a Requirement
3. Executable Specifications
4. Continuous Integration
5. Initial Architecture Envisioning
6. Initial Requirements Envisioning
7. Just In Time (JIT Model Storming)

B6: Impacts of using Agile Methodologies - Agile Usage Effectiveness

Effective implementation of agile methodologies: (Improvements in system development outcomes, e.g. improvements in quality, productivity, etc.)

1. Do you think your organisation an overall successful agile initiative?

2. If yes, what is your perception of “success” or “effectiveness”? How can this be measured?

- a. Improvements in quality (e.g. enhanced functionality of applications, decrease in the number of errors in the systems/software, improved quality of the systems built)
- b. Improvements in productivity (e.g. greater speed in the development of new applications, making people more productive, significant reduction in the time spent in software/systems development)
- c. Improvements in customer satisfaction (e.g. improved customer feedback, involvement, satisfaction - How would you measure customer satisfaction?)
- d. Any other measures? Please explain

B6: Evaluating the use of implementing agile methodology use

After the completion of major agile projects in your organisations, were there formal evaluations of its use, effectiveness, etc.?

1. Do you believe that your organisation achieved the goals set forth by using AMs?
2. Does your organisation intend to continue to use agile methods in the future? Why or why not?
 - If yes, are there any changes? or any planned steps for doing it differently?
Please explain
 - What approaches for sustaining AMs have worked well and what approaches have not worked so well? What are the important lessons you have learned?
 - What is the greatest challenges your organisation is facing regarding sustaining the use of AMs effectively?
 - Thank you!

Appendix C – Focus Group

Focus Group – Applying the Framework for Agile Sustainability

Session Type: 90 Minute Focus Group Workshop

Keywords: agile sustainability, effective usage, organisational assimilation

Facilitators: Mali Senapathi, and Meghann Drury

Background

How do we sustain the use of agile methodologies both in our project teams and in our organisations? How do we know we have improved our project performance by using agile methods? How can we assimilate agile methods more deeply into our organisations? These questions are the focus of this workshop on agile sustainability.

Much of our time is spent understanding how to implement agile methodologies but less is spent on understanding how we can sustain these methodologies and the ramifications if we do not sustain them. Agile methodologies have well passed the phases of adoption in many organisations. Yet the ultimate success of an agile methodology depends on the sustained use of the method both on the project team and in the organisation.

Within an organisation, the greater the amount of project teams using agile methods and the deeper the use of agile practices are assimilated into that organisation, the greater the likelihood of specific improvements in agile systems development outcomes. However, what facilitates the early stages of agile assimilation in an organisation is different to what facilitates the later stages of the assimilation.

Therefore, this workshop and its participants will discuss the key factors that either facilitate or prevent the sustainability of agile methods in an organisation. We will discuss how to achieve significant improvements in agile systems development projects and provide an overview of mechanisms that can be used to track improvements during organisational assimilation of agile methods.

Participants attending this focus group workshop will contribute to identifying the key factors that facilitate or constrain organisational assimilation by discussing the impact of sustained agile usage and organisational assimilation on systems development outcomes. Specific mechanisms to quantify improvements in agile systems development outcomes as a result of agile assimilation will be discussed.

Participants should have at least two years working experience in agile projects and include a wide range of roles such as manager, Scrum Master, business analyst, Product Owner, testers and developers.

Process/mechanics:

Based on our experiences of working with companies who have been using agile practices for at least three years, we have developed a framework that identifies a set of facilitating factors that are deemed crucial to achieve specific improvements in agile systems development. Agile practices need to be used deeply and widely throughout the organisation in order to ascertain their impact on systems development outcomes. For example, while *horizontal usage* may refer to the spread of the use of Scrum practices from one project to multiple projects, or from one region to many regions within an organisation, *vertical usage* is concerned with the maximum intensity of their use. Teams gain an understanding of what agile practice works better for them as they start observing how things like quality and productivity change, which may lead to further adaptations as they start reflecting on and drawing conclusions from the results.

The important thing is not the agile practices that a team starts with, but the set of practices that the team ends up with, i.e., the set of agile practices that is derived based on continual learning, improvements, adaptations and change based on a particular context. One developer commented, “...*the depth of adoption maps to an exponential curve of success – I think if you just do a couple of practices you are not going to get much benefit. If you do a lot of them and they are deeply engrained you are likely to be more successful*”. Thus, it is worthwhile to discuss how breadth and depth of agile usage impacts on specific improvements in systems development outcomes.

The goal for the participants of this focus group workshop is to identify the attributes that facilitate or constrain the assimilation of agile methods in their project teams and organisations and to understand how to act for or against such forces.

Aspects of this work have been presented in a number of venues including XP2010, XP2011, and Agile 2011. The speakers have extensive public speaking experience, including

presentations at previous agile conferences. One of the workshop facilitators (M. Drury) has presented related workshops to multiple industry audiences. She has also presented related workshops at Agile Alliance conferences. At Agile 2010 she received positive feedback stating the workshop gave “*so many great techniques and lessons to be learned and so many valuable bits of information [were] gleaned (especially in your presentation)*” (IT Specialist). At Agile 2011, she also received positive feedback as participants stated that she “*tied the information together very well*” and “*engaged the participants*”.

Therefore, this focus group workshop builds on those experiences to deliver a 90-minute session on how participants can sustain the use of agile methods both within their agile project teams and their organisations as a whole.

Focus Group Session Outline:

1. Introduce the topic of agile assimilation and why agile sustainability is important (10 minutes)
2. Present Framework for Agile Sustainability (10 minutes)
3. Facilitate activity where participants apply the Framework for Agile Sustainability by listing the key factors that facilitate sustained use and assimilation of agile practices on their agile teams (20 minutes)
 - i. Divide participants into groups of 6-8 people ensuring that each group has a diverse range of roles, e.g., business analyst, Scrum Master, developers, testers.
 - ii. Provide each group with large sticky notes, markers and flip charts.
 - iii. Have each group apply the Framework for Agile Sustainability.
4. Discuss best practices to sustain and assimilate agile usage (10 minutes)
5. Facilitate activity where participants list the key factors that constrain sustained use and assimilation of agile practices (15 minutes)
6. Present best techniques and mechanisms that have helped other teams in overcoming constraints to achieve significant improvements in agile systems development outcomes (20 minutes)

7. Provide conclusions and contact details for participants who would like more detail on how to develop mechanisms to sustain and achieve assimilation in their organisations (5 minutes)
-

Investigators

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Appendix D – Additional Survey Material

D.1 – Example invitation letter sent to key contacts in NZ organisations

Hi _____,

Thanks for the positive response - it is truly appreciated.

Below, I have prepared for you a short text announcing the Agile Sustainability survey. It will be greatly appreciated if this request for participation can be made available to all agile practitioners in your organisation (e.g., BAs, SMs, PMs, Developers, ITDMs- anyone who is involved with the practice/use of agile methods).

Please feel free to make any necessary amendments before announcing it.

Hi _____,

Please see paragraph below as requested: (please note that I am using two different data collectors: one for NZ and another for respondents from all other countries), and no problem with sub-contractors/development partners. A report of final results/findings will be provided.

While the fields of IS/IT/Software engineering have been successful in developing new tools, methods, and techniques to improve the effectiveness of systems development, their sustained use has intrigued researchers for many years. Lack of a deeper understanding of how agile methods are actually used in practice and issues relating to their sustained and effective use have been recognised as major shortcomings in the field of agile research. This is the main issue that is explored in this research. The primary motivation is to better understand the issues described above, and use that understanding to better inform researchers and practitioners on how to sustain the effective use of beneficial methods such as agile in IS organisations.

Based on 40 in-depth interviews (1st phase) with agile practitioners, a model of factors that impact effective use of agile methods has been developed. The purpose of this survey (2nd and final phase) is to statistically test and validate this model. NZ is a geographically remote small country and so its experience may differ from other countries. Since there is not enough empirical evidence of effective usage of agile methods in general, and New Zealand in particular, research that investigates these issues in the local context is warranted. My hope is that the findings from the study will improve our understanding of how agile methods can be effectively used and sustained in New Zealand organisations.

Kind regards,

Mali

D.2 – Initial invitation letter sent to some industry contacts seeking their support

Hi _____,

My name is Mali Senapathi. I am a doctoral student at the University of Auckland in the Department of Information Systems and Operations Management. I am conducting research to develop a framework that would enable me to identify factors that might have an impact on the effectiveness of agile usage (i.e., post-adoption use) in organisations.

The main premise of my research is based on the fact that Agile Methodology research until today has mainly focused on the introduction, adoption, and adaptation of agile methods, and we have very limited understanding of agile methods beyond the adoption stage. NZ is a geographically remote small country and so its experience may differ from other countries. Since there is not enough empirical evidence of post-adoption usage of agile methods in general, and New Zealand in particular, research that investigates these issues is warranted.

I am now ready to start my preliminary interviews, and hence this email to seek your help/support. I am looking for interviewing IS developers/analysts/Project managers etc., who have been fully involved and completed at least one agile project.

Please email me at msenapat@aut.ac.nz if you/your team are willing to participate.

Best Regards,

Mali

D.3 – Letter sent to owner/organiser of agile groups (e.g. Agile Professional Network, Agile Auckland, IIBA NZ) seeking their support

To:

The Organiser/Founder, _____ Group, Auckland.

We would like to invite members of the _____ group to participate in a major research project on the effective use of agile methodologies. This is the final phase of a larger PhD study that involves a web-based questionnaire. It aims to validate a model and instrument for evaluating the Factors that impact effective agile (such as Scrum, XP, Kanban) usage in organisations. The responsible researcher is Mali Senapathi. The outcomes will help us understand the important factors that will influence sustained and effective usage of agile methodologies.

I would really appreciate if you could be involved in this. We will of course forward the survey details to you so that we don't need any of details of group members. Please let Mali know if you are interested in participating.

Background:

The main focus of Agile Methodologies (AM) AM research until today has been on the introduction, adoption, and adaptation of agile methods, and we have very limited understanding of agile methods beyond the adoption stage. NZ is a geographically remote small country with its own culture and so its experience may differ from other countries. Since there is not enough empirical evidence of agile usage and the effect of all influential factors on their effectiveness in general, and New Zealand in particular, research that investigates these issues is warranted. So, what exactly are the factors that drive its effective usage beyond just adoption? How satisfied are you as a practitioner with the use of agile practices? These questions and more are the center of a survey for practitioners of agile methodologies.

Ananth Srinivasan,

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Information Systems and Operations Management,
The University of Auckland Business School,
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Appendix D – Additional Survey Material

Table D1.1: Loadings and Cross-loadings for every indicator													
	ACoach	AMind	AUsage	Compat	Cussat	champ	Orgstruct	Orgsupp	Predict	Prod	Qual	Relad	tooleff
AC	0.8828	0.2003	0.32	0.0994	0.2929	0.5562	0.447	0.4382	0.1627	0.1341	0.1529	0.1752	0.0662
ACeff	0.9411	0.2177	0.4444	0.2322	0.3238	0.3753	0.4129	0.4533	0.3152	0.221	0.2182	0.29	0.2657
AM1	0.2178	0.8353	0.2944	0.2875	0.3518	0.3707	0.2129	0.3294	0.2907	0.3859	0.3111	0.3336	0.1122
AM2	0.2188	0.8693	0.1898	0.2722	0.3786	0.4569	0.3599	0.4587	0.3304	0.3665	0.3631	0.3087	0.0917
AM3	0.1526	0.8869	0.3189	0.3284	0.4342	0.3749	0.3665	0.4557	0.3643	0.374	0.3997	0.3706	0.2504
AM4	0.1962	0.7042	0.2249	0.2132	0.2342	0.2534	0.2034	0.3487	0.283	0.2543	0.2424	0.175	0.1485
AM5	0.1892	0.8739	0.2511	0.2287	0.2965	0.4184	0.3141	0.4463	0.2627	0.248	0.3107	0.2762	0.2329
Aghuse	0.1303	0.0955	0.5128	0.2973	0.1955	0.0821	0.1733	0.1419	0.3289	0.2602	0.3037	0.2405	0.1637
Agvuse1	0.4369	0.3345	0.8609	0.3623	0.3815	0.3451	0.3874	0.4002	0.4592	0.4184	0.4334	0.4613	0.2167
Agvuse2	0.2787	0.187	0.7362	0.3076	0.2928	0.1547	0.1402	0.1325	0.3546	0.4143	0.4406	0.3983	0.1658
Compat1	0.1958	0.2764	0.3785	0.8904	0.4659	0.1122	0.2965	0.2612	0.4721	0.5356	0.513	0.6149	0.157
Compat2	0.1542	0.3055	0.4223	0.913	0.5663	0.1607	0.2409	0.2693	0.4629	0.5267	0.5567	0.699	0.2368
Custsat1	0.3796	0.4214	0.442	0.573	0.9676	0.3827	0.4217	0.6019	0.5538	0.6411	0.6519	0.6181	0.234
Custsat2	0.3318	0.3852	0.4001	0.5505	0.9586	0.3399	0.3609	0.5809	0.5027	0.5907	0.5994	0.6177	0.2887
Custsat3	0.2407	0.3629	0.345	0.5127	0.9276	0.3497	0.3972	0.5456	0.4437	0.5773	0.5369	0.5612	0.1676
Mcham	0.4268	0.4162	0.3059	0.128	0.331	0.9605	0.4831	0.3438	0.1862	0.2759	0.3095	0.2553	0.1076
Mchameff	0.5189	0.4367	0.2746	0.166	0.392	0.9508	0.4252	0.4041	0.211	0.3218	0.2732	0.2279	0.1623
Orgstruc	0.466	0.3476	0.3531	0.2961	0.4136	0.4768	1	0.6185	0.2813	0.3054	0.3726	0.3653	0.2426
Orgsupp1	0.4166	0.4049	0.2905	0.2335	0.5403	0.2374	0.4933	0.8652	0.3496	0.3214	0.2852	0.414	0.2834
Orgsupp2	0.3867	0.3934	0.2917	0.2825	0.545	0.2819	0.4726	0.8646	0.3738	0.3751	0.3242	0.4337	0.2351
Orgsupp3	0.404	0.4539	0.2755	0.2602	0.5157	0.388	0.5909	0.855	0.3333	0.3673	0.3146	0.3987	0.2219
Orgsupp4	0.4723	0.4286	0.3403	0.2447	0.5046	0.4289	0.5809	0.8766	0.3803	0.3484	0.3235	0.3944	0.2115
Predict1	0.2779	0.2586	0.4955	0.4425	0.4103	0.0957	0.1895	0.3275	0.8842	0.5122	0.5521	0.578	0.2886
Predict2	0.1043	0.302	0.4354	0.44	0.4854	0.2269	0.2695	0.3451	0.8375	0.6316	0.7362	0.641	0.2942
Predict3	0.3192	0.397	0.4488	0.4581	0.4805	0.2234	0.2754	0.4076	0.8635	0.6111	0.6631	0.5736	0.2375
Prod1	0.179	0.3593	0.4588	0.5166	0.5373	0.2286	0.2242	0.3696	0.5882	0.9255	0.685	0.634	0.1605
Prod2	0.2371	0.37	0.5319	0.6204	0.6484	0.3629	0.3472	0.4249	0.6619	0.9123	0.8382	0.792	0.2353
Prod3	0.0982	0.3204	0.3537	0.4036	0.4954	0.2196	0.2286	0.2707	0.5428	0.8382	0.6458	0.5506	0.2047
Qual1	0.1902	0.3162	0.4279	0.578	0.6134	0.1543	0.2492	0.3851	0.6585	0.7844	0.8288	0.6291	0.1557
Qual2	0.1859	0.3266	0.5164	0.5102	0.5587	0.2803	0.3871	0.3298	0.6731	0.7027	0.9051	0.6835	0.2751
Qual3	0.1539	0.3531	0.5118	0.503	0.5458	0.3092	0.2853	0.3028	0.7348	0.7338	0.918	0.6564	0.2766
Qual4	0.1913	0.3558	0.405	0.4537	0.4443	0.2988	0.3569	0.217	0.4815	0.5901	0.7666	0.551	0.1326
Relad1	0.2281	0.2198	0.4571	0.4781	0.4795	0.1627	0.1905	0.4015	0.5581	0.6367	0.5257	0.7789	0.3056
Relad2	0.2092	0.3193	0.46	0.6287	0.5343	0.2392	0.3585	0.4188	0.6711	0.6798	0.7554	0.863	0.3301
Relad3	0.2767	0.3332	0.3558	0.4515	0.4318	0.2171	0.3349	0.3517	0.5056	0.4327	0.4907	0.7331	0.2928
Relad4	0.1838	0.3257	0.456	0.7375	0.5994	0.2533	0.3894	0.4194	0.564	0.6686	0.6458	0.8852	0.2691
Eelad5	0.2068	0.2916	0.433	0.6989	0.5482	0.1767	0.2423	0.3558	0.5454	0.6525	0.6056	0.8586	0.274
tool_effect	0.1987	0.2073	0.2543	0.2206	0.2447	0.1396	0.2426	0.2738	0.3173	0.2248	0.2521	0.356	1

Appendix E – Agile sustainability Survey

Agile Sustainability Survey

Researcher: Mahalakshmi Senapathi, **Department of Information Systems and Operations Management, University of Auckland Business School.**

This survey is the final phase of a larger PhD study that aims to validate a model and instrument for evaluating the factors that impact effective agile usage in organisations. Because you are a current practitioner of Agile methodologies, you are invited to participate in this study and complete a web-based questionnaire which will take approximately 20 minutes of your time.

Your decision to participate or decline participation in this study is completely voluntary and you have the right to withdraw your participation at any time without penalty. You may skip any questions you do not wish to answer.

All comments and responses are anonymous and will be treated confidentially. All responses will be stored electronically for a period of six years after which it will be destroyed. Data will be averaged and reported in aggregate form which will be incorporated into my PhD Thesis, announced through the group's website, and may be used in papers written for peer-reviewed journals and conferences.

Please confirm that you have read the following declaration by ticking this box:

I understand that by submitting this questionnaire electronically I agree to take part in this research under the terms indicated in the information supplied and I give consent to the following:

- i) *I have read and understood the information describing the aims and content of the following questionnaire.*
- ii) *I am aged 16 years or older.*

If you have any questions relating to the study or this questionnaire, please contact us:

- 1) The researcher: Mali Senapathi
Email: msen010@aucklanduni.ac.nz Tel: 09 627 4393.
- 2) Supervisor: Prof Ananth Srinivasan
Email: a.srinivasan@auckland.ac.nz, Tel: 373 7599 Ext. 85328.

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Subjects Ethics Committee, The University of Auckland, Research Office, Private Bag 92019, Auckland 1142. Telephone 09 373 7599 ext. 87830/83761. Email: humanethics@auckland.ac.nz

Some key words to note:

Agile Methodology ²²	For the purpose of this questionnaire, an Agile methodology is defined as a combination of the following: <ul style="list-style-type: none"> • agile practices • agile method/methods • agile technique/techniques Examples: Scrum, XP, Kanban, Scrum + XP, Scrumban
Agile Usage	Agile usage refers to both the i) maximum intensity of agile use (e.g., extent of adherence to a chosen agile method) and ii) its use across the organisation (e.g., number of projects, number of teams)
Agile Practitioner	Anyone who is involved in the practice of agile methodologies Examples: Developer, Tester, Scrum Master, Project Manager, Business Analyst, IT Delivery Manager
Agile Mindset	Agile mindset relates to the set of values and beliefs defined in Agile Manifesto ²³

There are eight sections in this survey. Please respond to all questions in Sections I through VII. The approximate time to complete the survey is 20 minutes.

Section I Background Information

1. What is your job title? _____
2. How long have you been involved with software development?
 - < 1 year
 - 1 - 3 years
 - 4 - 10 years
 - > 10 years
3. Age: _____years
4. Gender (please select one):
 - a. Male
 - b. Female
5. How long have you been using agile methods or agile practices?
 - < 1 year
 - 1 - 3 years
 - 4 - 10 years
 - > 10 years

²² Conboy(2009)

²³ <http://agilemanifesto.org>

6. How long have you been with your present organisation?

- < 1 year 1 - 3 years 4 - 10 years > 10 years

7. The training you have received in Agile includes: (please provide details, for example, level, duration, etc.). You may select more than one box.

- Formal/certified course (for example Scrum Certification)
- Internal Agile training
- Agile Academy (Software Education)
- Agile PMI
- PlanIT
- On the job training/coaching
- Other (please specify)

8. On how many projects have you used agile methods? _____ projects

9. How would you rate your understanding of agile methodologies?

- very limited limited Average Extensive Very Extensive

10. How is your organisation best described?

- Software Development Telecommunications
- Consulting Banking/Finance/Insurance
- Wholesale/Retail Trade Manufacturing
- Education Public Service/Local Government
- Health Central Government
- Research Military

Other (please specify) _____

11. What type(s) of applications are developed in your organisation?

- Management information systems (e.g. decision support)
- Transaction Processing Systems (e.g., payroll, POS, accounting, inventory)
- Real time applications (e.g., process control, manufacturing)
- E-commerce/web applications
- Embedded systems (e.g., software running in consumer devices or vehicles)
- Systems software (e.g., telecommunications software)
- Other (please specify)_____

12. What forms of agile methods/processes are most common in your organisation? You may select more than one box.

- Agile Unified Process
- Scrum
- Extreme Programming (XP)
- Scrum/XP Hybrid
- Agile Modelling
- Lean
- Kanban
- Feature Driven Development (FDD)
- Crystal Methods
- Dynamic Systems Development Methodology (DSDM)
- Other (Please specify if you have used a hybrid or customized process, please outline what aspects were used from each of the different paradigms)

Section II Agile Acceptance

The following questions relate to your assessment of agile methods based on your use of agile practices. Please read each question carefully and circle on the scale at the right the choice that best represents your belief.

Strongly Disagree	Disagree Slightly	Disagree	Neutral	Agree Slightly	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

1. Using agile enables me to accomplish my tasks quickly	SD	D	DS	N	AS	A	SA
2. Using agile improves the quality of work I do	SD	D	DS	N	AS	A	SA
3. Using agile methods/practices makes it easier to complete my tasks	SD	D	DS	N	AS	A	SA
4. Using agile enables increased flexibility in my tasks	SD	D	DS	N	AS	A	SA
5. Using agile enhances my effectiveness on the job	SD	D	DS	N	AS	A	SA
6. Using agile gives me greater control over my work	SD	D	DS	N	AS	A	SA
7. Using agile is compatible with all aspects of my work	SD	D	DS	N	AS	A	SA
8. I think that using agile fits well with the way I like to work	SD	D	DS	N	AS	A	SA

Section III. Sociological factors

Agile Coach²⁴: An Agile Coach is an expert in agile practices with advanced levels of both technical and domain expertise, and has advanced levels of coaching, facilitation, mentoring and/or training skills. The goal of an agile coach is to help teams become self-coaching and adept in applying agile practices to their work more effectively. While the role of an Agile Coach is compatible with roles such as Project Manager and Scrum Master, there are some key differences. For example, the scope of a Scrum Master is to ensure that the Scrum process is followed in terms of its values and practices and is linked with a particular project; the purview of an agile coach is agility (broader) which focuses on process improvement and usually involves multiple teams, and the wider organisation. It is a transitory role and not tied into project duration.

As you respond to this section, think about the team/s that you have worked with most of your time in the past 2 years. Please circle on the scale at the right the choice that best represents your belief.

²⁴ Definition adapted from <http://jxenter.com/agile-coach-understanding-the-role-35038.html> and <http://www.icagile.com/CoachingandFacilitationTrack.html>

to no extent	to a very little extent	to a little extent	to some extent	to a large extent	to a very large extent	to a great extent
NO	VLT	LT	SM	LG	VLG	GR

Section IV. Technological

Agile Coach							
1. To what extent was there an “agile coach” in your organisation?	NO	VLT	LT	SM	LG	VLG	GR
2. If you feel there was an “Agile Coach”, please indicate below whether this coach was ‘external’ or internal to your organisation? _____							
3. If ‘internal’ please indicate the main position that this person held in your organisation. _____							
4. If you feel there was an agile coach, how effective was the coach in enabling effective use of agile practices?	NO	VLT	LT	SM	LG	VLG	GR
Agile Mindset							
5. My team members have a strong sense of identification and commitment to the team	NO	VLT	LT	SM	LG	VLG	GR
6. My team members have the willingness to learn and change	NO	VLT	LT	SM	LG	VLG	GR
7. My team members have strong interpersonal and communication skills	NO	VLT	LT	SM	LG	VLG	GR
8. My team members are technically competent	NO	VLT	LT	SM	LG	VLG	GR
9. My team members have collaborative attitude	NO	VLT	LT	SM	LG	VLG	GR

The following questions relate to your assessment of the impact of using appropriate technical practices and tools on the effectiveness of agile methods. Please read each question carefully and circle on the scale at the right the choice that best represents your belief.

to no extent	to a very little extent	to a little extent	to some extent	to a large extent	to a very large extent	to a great extent
NO	VLT	LT	SM	LG	VLG	GR

1. Using appropriate tools to support agile practices enables effective use of agile methods	NO	VLT	LT	SM	LG	VLG	GR
--	----	-----	----	----	----	-----	----

Please identify any tools used to manage agile processes and activities during development.

Please select all that apply from the following:

- Manual – physical cards, task boards, charts, etc.
- Spreadsheets
- Wiki – an internal Wiki
- Internal – an internally developed custom tool
- Traditional – a tool used in non-agile processes such as requirements management, item workflow tracking, project management/Gantt charts, etc.
- Kanban boards
- Agile Project Management Tools
- Release Management
- Unit test tool
- Automated build tool
- Continuous Integration tool
- Release Management tool
- Requirements management tool
- Story mapping
- Automated acceptance test tool
- Refactoring tool
- Ideas Management tool
- Agile Tool – commercial agile tool such as ExtemePlanner, Rally, ScrumVSTS, ScrumWorks, Target Process, VersionOne or Planner
- collaboration tools (for example, tools used to support distributed teams/ off-shore teams unable to see physical boards or attend daily meetings)
- Any other (please specify) – please include any tools you believe are beneficial to effective management of agile processes and activities

Section V. Organisational

Methodology Champion: Methodology champions are characterized as bearers of persuasive and evaluative information about an innovation (Beath 1991) who are instrumental in

sustaining their effective use by mustering the necessary political, material and technical resources needed for their use (Rai & Howard 1994). Keeping this definition in mind, please circle on the scale at the right the choice that best represents your belief.

to no extent	to a very little extent	to a little extent	to some extent	to a large extent	to a very large extent	to a great extent
NO	VLT	LT	SM	LG	VLG	GR

Methodology Champion							
1) To what extent was there a “methodology champion” in your organisation?	NO	VLT	LT	SM	LG	VLG	GR
2) If you feel there was a “methodology champion”, please indicate the title or main position and the department of this champion? _____							
3) If you feel there was a methodology champion, how effective was the coach in promoting the use of agile practices?	NO	VLT	LT	SM	LG	VLG	GR

Top Management Support

Please circle on the scale at the right of each question the choice that best represents your belief.

Section VI Agile Usage

Strongly Disagree	Disagree Slightly	Disagree	Neutral	Agree Slightly	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

1. Management provided me with the time for training that I needed in order to use agile methods effectively.	SD	D	DS	N	AS	A	SA
2. Management provided me with funding for training that I needed in order to use agile methods effectively.	SD	D	DS	N	AS	A	SA
3. I had easy access to people of the necessary expertise to help me make the transition to agile methods	SD	D	DS	N	AS	A	SA
4. I had a solid “network of support” in the form of knowledgeable colleagues, internal support personnel, and/or outside consultants that helped me in the effective use of agile methods.	SD	D	DS	N	AS	A	SA
5. The organisation structure in the place I work enabled me in the effective use of agile methods. (e.g., informal procedures followed in activities such as tracking requirements changes, cost/size estimating, funding, scheduling, milestone tracking, and status reviews by senior management, flexible and participative structure which encouraged shared learning and collaborative decision making,).	SD	D	DS	N	AS	A	SA

For the purpose of this questionnaire, an agile methodology is defined as a combination of agile practices, agile method/methods, and agile technique/techniques (Examples: Scrum, XP, Kanban, Scrum + XP, Scrumban). For example, Scrum prescribes 3 roles (*Product Owner, Scrum Master, Development team*), 3 ceremonies (*sprint planning, daily scrum, and sprint retrospective.*), and 3 artefacts (*the product backlog, the sprint backlog, and burndown chart*) of Scrum. So, if you are using Scrum, to what extent do you adhere to the prescribed Scrum practices? Keeping the above in mind, please answer the following questions relating to the agile methodology that has been adopted by your teams/s or your IS department in general.

to no extent	to a very little extent	to a little extent	to some extent	to a large extent	to a very large extent	to a great extent
NO	VLT	LT	SM	LG	VLG	GR

To what extent is your department or organisation adhering to the following agile methods at present? You may select more than one box. Please select both the method/s below and also circle on the scale at the right the choice that best represents your belief	NO	VLT	LT	SM	LG	VLG	GR

- Agile Unified Process
- Scrum
- Extreme Programming (XP)
- Scrum/XP Hybrid
- Agile Modelling
- Lean
- Kanban
- Feature Driven Development (FDD)
- Crystal Methods
- Dynamic Systems Development Methodology (DSDM)
- Other (Please specify if you have used a hybrid or customized process, please outline what aspects were used from each of the different paradigms)

1) The proportion of projects I use agile methods/practices with (circle only one)

- None
 1 – 25%
 26 – 50%
 50 – 70%
 >75%

2) My use of agile methods/practices (circle only one)

- in initial projects only
- in mostly small projects, but not in large projects
- in a mixture of small and large projects
- in mostly large projects, but not in small projects
- completely routine (in all the projects)

3) The phases/activities that I typically use agile practices/principles in are (circle all that apply)

Appendix E – Agile sustainability Survey

- Requirements specification
- Software /system analysis
- Software/system design
- Development
- Testing
- Other (please specify)

Section VII. Impacts of Agile Methodologies

The following questions relate to your assessment of the impacts of agile methods on your work. Please read each question carefully and circle on the scale to the right of each question the choice that best represents your beliefs.

to no extent	to a very little extent	to a little extent	to some extent	to a large extent	to a very large extent	to a great extent
NO	VLT	LT	SM	LG	VLG	GR

1. To what extent does the use of agile methods/practices allow you or your teams to better predict the effort required for software development?	NO	VLT	LT	SM	LG	VLG	GR
2. To what extent does the use of agile methods/practices allow you to better predict the quality of software that you or your teams develop?	NO	VLT	LT	SM	LG	VLG	GR
3. To what extent does the use of agile methods/practices allow you to better predict the delivery of software you or your teams develop?	NO	VLT	LT	SM	LG	VLG	GR

Please read each question carefully and circle on the scale to the right of each question the choice that best represents your beliefs.

Strongly Disagree	Disagree Slightly	Disagree	Neutral	Agree Slightly	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

1. Use of agile methods/practices has enhanced the functionality of applications that we build.	SD	D	DS	N	AS	A	SA
2. Use of agile methods/practices has decreased the number of errors in the systems/software products we build	SD	D	DS	N	AS	A	SA
3. Use of agile methods/practices has improved the quality of the systems/software products we build.	SD	D	DS	N	AS	A	SA

4. Use of agile methods/practices has made me (us) more conscious of software quality.	SD	D	DS	N	AS	A	SA
5. Use of agile methods/practices has greatly speeded up my (our) development of new applications.	SD	D	DS	N	AS	A	SA
6. Use of agile methods/practices has definitely made me (my team/s) more productive.	SD	D	DS	N	AS	A	SA
7. Use of agile methods/practices has significantly reduced the time I (we) spend in software/systems development.	SD	D	DS	N	AS	A	SA
8. Our customer(s) have been satisfied with the usability of our products since we started using agile methods/practices.	SD	D	DS	N	AS	A	SA
9. Our customer(s) have been satisfied with the functionality of our products since we started using agile methods/practices.	SD	D	DS	N	AS	A	SA

Section VIII. Comments

Please use this page to provide us with any additional thoughts you may have regarding the use of agile methods/practices in your work environment. These comments may help us better understand your answers, or may provide us with future questions that need to be addressed in research. Again, we would like to thank you for your participation in this survey.

Appendix F – Participant Information and Consent Forms

F.1: Participant Information Sheet for Supervisor of Interviewees

Title: A framework for the investigation of factors affecting the effective usage of agile methodologies in organisations

To:

My name is Mahalakshmi Senapathi. I am a doctoral student at the University of Auckland in the Department of Information Systems and Operations Management. I am conducting research to develop a framework that would enable me to identify factors that might influence the effectiveness of Agile Systems Development Methodology (ASDM) usage in organisations. The current research will first use open-ended interviews to validate the theoretical research framework.

Your staff are invited to participate in this research and I would appreciate any assistance you can offer. **There will be no prejudice if they do not participate, and they need to be assured that their choice will not have any employment ramifications.**

I am conducting interviews at few organisations. My aim is to interview several Information Systems (IS) developers, analysts in an IS department in order to validate my theoretical framework, and gain feedback such as identifying any additional factors that might affect agile methodology usage. The data collected will be used to further refine the research model, and in the development of the survey instrument, which will be the second phase of this research.

Interviews would take about three-quarters of an hour to one hour and, I would be happy to conduct them during work time or work breaks. I would prefer to record the interview but this would be done only with the interviewee's consent and could be stopped at any time. Information may be withdrawn up to three months after the interview. Interview data in a highly summarised form will be provided to you, will be incorporated into my PhD Thesis, and may be used in papers written for peer-reviewed journals and conferences.

The interview data will be securely stored at the Department of Information Systems and Operations Management, University of Auckland, for six (6) years, after which they will be destroyed.

If you are willing for your staff to be interviewed please fill in a Consent Form. All information provided in interviews is confidential and names will not be used. Potential participants need to be assured that there will be no prejudice if they do not participate.

Thank you very much for your time and help. If you have any queries or wish to know more please email: mali.senapathi@aut.ac.nz or phone me at home: 09 627 4393.

My supervisor is: Dr. Ananth Srinivasan, email: a.srinivasan@auckland.ac.nz, Tel 373 7599 Ext. 85328.

For any queries regarding ethical concerns please contact:

The Chair, The University of Auckland Human Subjects Ethics Committee

The University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142.

Telephone 09 373 7599 Ext. 83711.

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON.....12th May 2010.....for (3) years, Reference Number ...2010.../...168.

F.2: Participant Information Sheet for Subjects

Title: A framework for the investigation of factors affecting the effective usage of agile methodologies in organisations.

To:

My name is Mahalakshmi Senapathi. I am a doctoral student at the University of Auckland in the Department of Information Systems and Operations Management. I am conducting research to develop a framework that would enable me to identify factors that might influence the effectiveness of Agile Systems Development Methodology (ASDM) usage in organisations. The current research will first use open-ended interviews to validate the theoretical research framework and avoid inadvertent exclusion of variables.

You are invited to participate in this research and I would appreciate any assistance you can offer. You are selected because you are either a developer or an analyst who has participated in a completed agile project. My aim is to interview several Information Systems (IS) developers, analysts in an IS department in order to validate my theoretical framework, and gain feedback such as identifying any additional factors that might affect agile methodology usage. The data collected will be used to further refine the research model, and in the development of the survey instrument, which will be the second phase of this research.

Interviews would take about three-quarters of an hour to one hour and, I would be happy to conduct them during work time or work breaks. I would prefer to record the interview but this would be done only with your consent and could be stopped at any time. Information may be withdrawn up to three months after the interview. Interview data in a highly summarised form will be provided to your supervisor, will be incorporated into my PhD Thesis, and may be used in papers written for peer-reviewed journals and conferences.

The interview data will be securely stored at the Department of Information Systems and Operations Management, University of Auckland, for six (6) years, after which they will be destroyed.

If you are willing to participate please fill in a Consent Form. All information you provide in an interview is confidential and your name will not be used.

Thank you very much for your time and help. If you have any queries or wish to know more please email: mali.senapathi@aut.ac.nz or phone me at home: 09 627 4393.

My supervisor is: Dr. Ananth Srinivasan, email: a.srinivasan@auckland.ac.nz, Tel 373 7599 Ext. 85328.

For any queries regarding ethical concerns please contact:

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Telephone 09 373 7599 Ext. 83711.

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F3: Participant Information Sheet for Focus Group Participants

Title: A framework for the investigation of factors affecting the effective usage of agile methodologies in organisations.

To:

My name is Mahalakshmi Senapathi. I am a doctoral student at the University of Auckland in the Department of Information Systems and Operations Management. I am conducting research to develop a framework that would enable me to identify critical success factors that might influence the effectiveness of Agile Systems Development Methodology (ASDM) usage in organisations.

The aim is to conduct focus groups with agile practitioners to learn about their experiences, and perceptions relating to the various factors that affect successful usage of agile methods. You are invited to participate because you are either a developer/analyst/project manager/ who has been involved in a complete agile project. Your participation will play a crucial role for this part of the study. The data collected will be used to further refine the research model, and in the development of the survey instrument, which will be the second phase of this research.

The plan is to conduct about 7-8 focus groups, each with 7- 10 participants. Each session will run approximately for about ninety minutes. All willing participants will be notified well in advance before the actual session, and sufficient time will be given to join the group. Data collected from the focus groups will be provided to you in a summarized form, will be incorporated into my PhD Thesis, and may be used in papers written for peer-reviewed journals and conferences.

There are no anticipated risks in participating in this study. If you are willing to participate please fill in a Consent Form. **All data collected from the focus groups will be handled in a highly confidential manner, and the names of the participants will not be used.** No individual will be referred to (except through the use of pseudonyms) while reporting the results. The data will be securely stored at the Department of Information Systems and Operations Management, University of Auckland, for six (6) years, after which they will be destroyed.

Your participation is purely voluntary and a subsequent decision to withdraw from the focus group will involve no penalty and you may discontinue participation at any time.

Thank you very much for your time and help. If you have any queries or wish to know more please email: mali.senapathi@aut.ac.nz or phone me at home: 09 627 4393.

My supervisor is: Dr. Ananth Srinivasan, email: a.srinivasan@auckland.ac.nz, Tel 373 7599 Ext. 85328.

For any queries regarding ethical concerns please contact:

The Chair, The University of Auckland Human Subjects Ethics Committee

The University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142.

Telephone 09 373 7599 Ext. 83711.

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON...12th May 2010....for (3) years, Reference Number 2010/168

F4: Participant Information Sheet for Survey

Project Title: A framework for the investigation of factors affecting the effective usage of agile methodologies in organisations.

Name of Researcher: Mahalakshmi (Mali) Senapathi

Researcher Introduction

My name is Mahalakshmi (Mali) Senapathi. I am a doctoral student at the University of Auckland Business School in the Department of Information Systems and Operations Management.

Project description and invitation

Agile methodologies (AM), which emphasize iterative and incremental development with just-in-time processes and documentation, have been adopted by an increasing number of organisations. Despite this progress there is lack of clarity on their effective use after initial adoption, and there is very limited understanding on the critical factors that impact their continued and effective usage. The aim of my PhD study is to identify the main factors that impact the effective and sustained use of agile methodologies. The survey is the final phase of my study that aims to validate a model and instrument for evaluating the factors that impact effective agile usage in organisations. Because you are a current practitioner of agile methodologies, you are invited to participate in this study and complete a web-based questionnaire.

Project procedures

The questionnaire seeks your perceptions and insights on the impact of a set of influential factors on the effective usage of agile methodologies. It will take approximately 20 minutes to complete. Participation is completely voluntary and if you do not wish to complete the questionnaire just close your browser.

Data storage and use

All responses will be stored electronically for a period of six years after which it will be destroyed. Data will be averaged and reported in aggregate form which will be incorporated into my PhD Thesis, announced through the group's website, and may be used in papers written for peer-reviewed journals and conferences.

Right to withdraw from participation

Participants have the right to withdraw from participation at any time without penalty.

Anonymity and Confidentiality

All comments and responses are anonymous and will be treated confidentially. The names of individual persons are not required in any of the responses. All responses will be stored electronically without reference to names of individual persons. Participants will not be identifiable from any outcomes of this study.

Contact details

- 3) The researcher: Mali Senapathi
Email: msen010@aucklanduni.ac.nz Tel: 09 627 4393.
- 4) Supervisor: Prof Ananth Srinivasan
Email: a.srinivasan@auckland.ac.nz, Tel: 373 7599 Ext. 85328.
- 5) Head of the Department: Prof Michael Myers
Email: m.myers@auckland.ac.nz, Tel: 373 7599 Ext. 87468

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Subjects Ethics Committee, The University of Auckland, Research Office, Private Bag 92019, Auckland 1142. Telephone 09 373 7599 ext. 87830/83761. Email: humanethics@auckland.ac.nz

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F5: Consent Form - Interviews

CONSENT FORM FOR CHIEF INFORMATION OFFICER (CIO)

THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF SIX YEARS

Title: A framework for the investigation of factors affecting the effective usage of agile methodologies in organisations

Researcher: Mahalakshmi Senapathi

I have been given and understand an explanation of this research study. I have had an opportunity to ask questions and have them answered to my satisfaction.

I give consent to my staff taking part in this research, and the choice of the staff member does not have any employment ramifications.

I understand that I may withdraw my staff and any information traceable to them at any time up to three months after an interview without giving a reason.

I agree that my staff may participate in this research.

Signed:

Name:

(please print clearly)

Date:

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F6: CONSENT FORM – Interview Participants

THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF SIX YEARS

Title: A framework for the investigation of factors affecting the effective usage of agile methodologies in organisations

Researcher: Mahalakshmi Senapathi

I have been given and understand an explanation of this research study. I have had an opportunity to ask questions and have them answered to my satisfaction.

I understand that I am free to withdraw participation at any time, and to withdraw any data traceable to me any time up to three months after an interview without giving a reason. **I understand that my choice will not have any employment ramifications.**

I agree for my interview to be recorded.

I agree to take part in this research.

Signed:

Name:

(please print clearly)

Date:

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON...12th May 2010....for (3) years, Reference Number ...2010.../168

F7: Consent Form – Focus Group Participants

CONSENT FORM

THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF SIX YEARS

Title: A framework for the investigation of factors affecting the effective usage of agile methodologies in organisations

Researcher: Mahalakshmi Senapathi

I have been given and understand an explanation of this research study. I have had an opportunity to ask questions and have them answered to my satisfaction.

I understand that I am free to withdraw participation at any time, and to withdraw any data traceable to me any time up to three months after my participation in the focus group without giving a reason.

I agree to take part in this research

I agree that my contribution to the focus group be used as data in the study.

Signed:

Name:

(please print clearly)

Date:

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON...12th May 2010....for (3) years, Reference Number ...2010.../168

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