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AGILE USAGE: REFINING A THEORETICAL MODEL

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Abstract

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. While there is much research on the use of various agile methods and practices, there is very limited understanding on the critical factors that impact their continued and effective usage. To address this gap, an integrated model called the Agile Usage Model (AUM) was developed, by coalescing insights from organisational level Information Systems implementation, traditional innovation diffusion models, and post-adoptive agile usage. The objective of this study is to use multiple data collection methods to further evaluate and refine the AUM. The final refined conceptual model of Agile Usage is presented along with implications for research and practice.

Keywords: Agile usage, agile sustainability, agile usage and effectiveness

1 INTRODUCTION

Agile methodologies (AM) emerged during the last decade in response to the unprecedented rate of change in business and technological environments. The use of AM in information systems development (ISD) has grown dramatically in recent years. Though agile methods have continued to evolve with newer ones emerging (Williams 2012), there is no sound basis for evaluating their effective use after initial adoption. There is very limited evidence of their actual use, effectiveness, and penetration in organisations (Begel; and Nagappan 2007). Though there is an increasing number of empirical studies on AM in real-world contexts, the research on AM in practice is yet to yield significant systematic and insightful knowledge that can either guide future research or provide credible advice to organisations (Wang, Conboy et al. 2012). There are very few studies that have examined the factors that impact the effective use of agile methods (Vijayasarathy and Turk 2012). (Wang, Conboy et al. 2012) highlight two main issues related to this branch of research: i) lack of strong theoretical and conceptual foundation (Abrahamsson, Conboy et al. 2009) and ii) superficial judgement of agile method use as used or not used without evaluating the effectiveness of their actual implementation (Conboy and Fitzgerald 2010).

Correspondingly, one of the key challenges in agile research has been to use a sound theoretical basis to explain the effective use of AM by exploring the degree or extent of agile practice use (Wang, Conboy et al. 2012). To address this gap in the literature, an *a priori* model of agile usage was developed called the Agile Usage Model (AUM) by drawing from well-known and established theories such as diffusion of innovations and IS implementation literature (Senapathi & Srinivasan, 2012). The model identified a set of critical factors impacting agile usage and examined the relationship between agile usage and agile usage effectiveness. Usage is not an alien concept in the IS literature and has been studied under the notions of assimilation, implementation, and routinization. In organisational-level process and stage research models, it refers to how extensively and deeply the innovation is used rather than its adoption, per se, and is referred to as the innovation's degree of assimilation into the organisation (Gallivan 2001).

The objective of this study is to use a combination of an innovative focus group and qualitative interviews to evaluate and refine the AUM. It is believed that such constant comparison across different types of evidence, cases, and the literature, has the ability to generate less biased theory (Eisenhardt 1989). The study aim is to derive a valid and reliable conceptual model to be later operationalized to test a survey instrument. In the following sections, we first describe the AUM followed by the multiple research design employed. Next, we describe our findings and analyses, followed by study contributions, limitations, and implications for future research and practice.

2 THEORETICAL BACKGROUND AND THE AGILE USAGE MODEL

The usage of Systems Development Methodologies (SDMs) in general is a versatile concept (Iivari and Huisman 2007) and, given the lack of strong theoretical and conceptual base in AM research, the AUM was developed by drawing insights from the theoretical foundations of diffusion of innovations, IS implementation research, and AM. The diffusion of innovation and IS implementation models have been tested and validated extensively in the IS literature (Kwon and Zmud 1987; Davis, Bagozzi et al. 1989; Raghavan and Chand 1989; Cooper and Zmud 1990; Fichman and Kemerer 1993; Iivari 1996; Gallivan 2001) to explain the constructs of the adoption and implementation of new IS innovations (Gallivan 2001). Recently, they have generated interest in the agile research community (Pikkarainen, Wang et al. 2007).

According to Kwon & Zmud (1987), diffusion of innovations is a six-staged process comprising *initiation, adoption, adaptation, acceptance, routinization,* and *infusion* phases. While the initial three phases (*initiation, adoption, adaptation*) relate to 'adoptive' behavior of an innovation, the last three

phases *(acceptance, routinization, infusion*) relate to the innovation's post-adoptive use and implementation. The post-adoptive stages are defined as: **acceptance:** use of the innovation, **routinization:** usage of the innovation is encouraged as a normal activity, and **infusion** refers to the innovation penetrating deeply into an organisation (Gallivan 2001). Infusion is described using three facets: 1) Extensive use: extent of use of an innovation, 2) Integrated use: using the innovation to accommodate a more comprehensive set of work tasks, and 3) Emergent use: using the innovation beyond its original intended scope.

2.1 Agile Usage

Adapting the concepts of post-adoptive stages to the context of agile assimilation, Wang et al (Wang, Conboy 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 customized use: an agile practice is adapted at a deep level to suit the need of the adopting team. In the AUM, '*vertical usage'* refers to any combination of the above infusion facets, and '*horizontal usage*' 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 called *'*A*gile Usage'*.

2.1.1 Agile Usage Model

The AUM identifies nine critical factors (two innovation, three sociological, two technological, and two organisational) that impact agile usage in organisations. It proposes a relationship between agile usage and agile usage effectiveness. The AUM is set out in Fig. 1: (1) Agile innovation factors (*Relative Advantage*, *Compatibility*) adopted from the innovation diffusion literature (Rogers 2003), (2) Sociological factors (*Attitude*, *Experience*, *Technical Expertise*), (3) Technological factors (*Agile Practices, Tool Support*) adopted from the XP evaluation framework (Williams, Krebs et al. 2004), and (4) Organisational factors (*Top Management Support (TMS), Methodology Champion (MC)*) adopted from the IS implementation literature (Iivari 1996; Iivari and Huisman 2007). The model is briefly described in the following section.

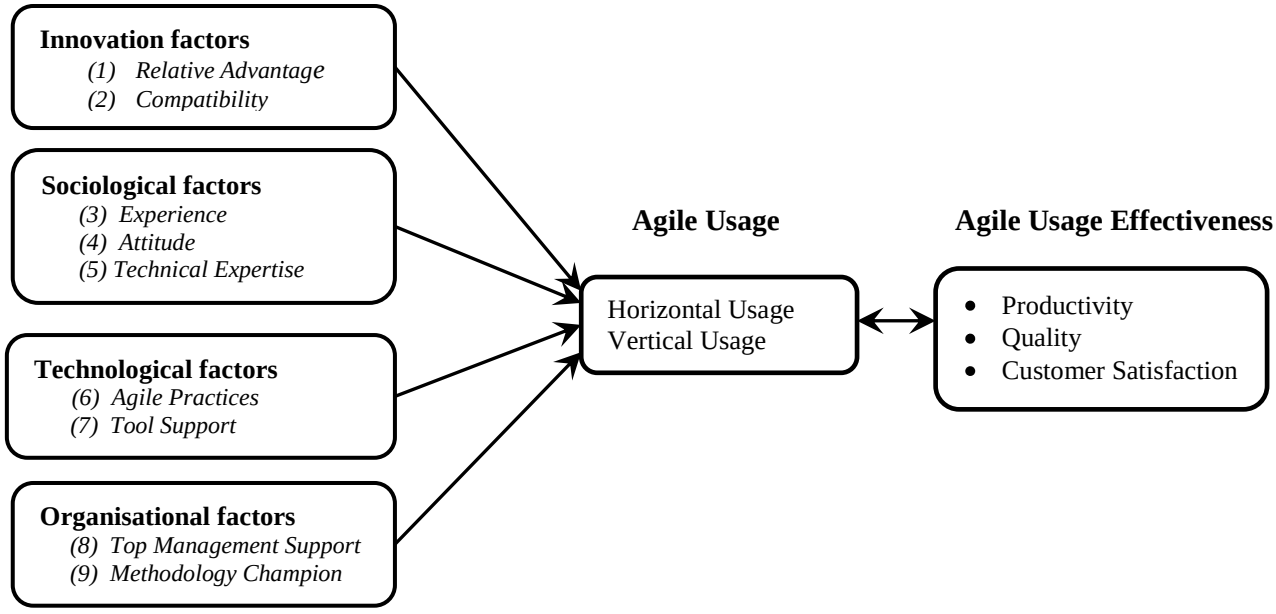

Figure 1 Agile Usage Model

Innovation	*Relative advantage:* the degree to which agile is perceived better than its precursor methods/practices
	Compatability: the degree to which agile practices are perceived as being consistent with the existing practices, values, and past experiences
Sociological	*Experience:* Number of years of working experience in systems development and agile
	Attitude: prominent positive or negative beliefs about the continued use of agile methods
	Technical Competence: technical knowledge and expertise, domain expertise
Technological	*Agile Practices:* use of engineering practices such as continuous integration and refactoring
	Tool Support: incorporating tools to support effective use of engineering practices
Organisational	*Top Management Support*: a balanced approach where management provides ongoing support at appropriate points through all stages of assimilation.
	Methodology Champion:a championship role instrumental in the effective assimilation of agile methods throughout the organisation.

Table 1: Factors that impact Agile Usage

2.2 Agile Usage Effectiveness

While effectiveness in general refers to the capability of producing an intended outcome, it is more commonly associated with improvements in specific outcomes such as productivity of systems development or quality of development systems in the IS literature (Iivari 1995). Three measures have been recognized as key measures in the agile literature for assessing effectiveness of Agile Usage 1) improved productivity, 2) improved quality, and 3) customer satisfaction (Cockburn and Highsmith 2001; Misra, Kumar et al. 2009). This list of measures is not exhaustive and may include other important measures Improved Employee Morale, Faster Time to market, and Predictability. The underlying premise of the AUM is that effectiveness benefits cannot be realized until they are used deeply and extensively. For example, Iivari (Iivari 1996) examined the impacts of Computer Aided Software Engineering (CASE) usage on developer perceptions of quality and productivity based on the rationale that CASE tools cannot be effective unless they reach the infusion stage. Therefore, analyzing 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 the concept of *Agile Usage* in organisations. This is reflected in the AUM by the bi-directional arrow in Figure 1 that links Agile Usage to Agile Usage Effectiveness.

2.3 Related research

Some recent studies have focused on identifying 'success' factors relating to the use of agile methodologies (Chow and Cao 2007; Chan and Thong 2009; Misra, Kumar et al. 2009). While Chow et al. (2009) and Misra et al. (2009) focus on success factors relating to agile adoption, Chan & Thong (2009) develop a framework for agile 'acceptance' from a knowledge management perspective. However, the use of the term 'acceptance' in Chan & Thong's study implies more an 'adoption' perspective, and does not differentiate between 'adoptive' and 'post-adoptive' stages of diffusion which is the focus of the current study. More comprehensive frameworks such as the Agile Adoption and Improvement Framework (Qumer and Henderson-Sellers 2008) are aimed at adoption, assessment, and improvement of agile software development processes in organisations. Other studies that have specifically focused on later stages of implementation include studies conducted by (Pikkarainen, Wang et al. 2007) and (Mangalaraj, Mahapatra et al. 2009). While Pikkarainen et al.

focus on the assimilation of XP/Scrum practices using three case studies, Mangalaraj et al. investigate the acceptance of XP practices across different teams within the same organisation. While these studies have added value to the extant agile literature, most of them have paid more attention to examining factors that drive organisations to initially adopt AM rather than on those that affect their continued usage. However, the factors which drive an innovation across the adoptive phases differ from those that affect the post-adoptive phases (Karahanna 1999). Therefore, the aim of the current study is to derive a sound and comprehensive framework that identifies the factors affecting the post-adoption usage of agile methodologies in organisations.

3 RESEARCH DESIGN

An innovative focus group (FG) which comprised of 29 practitioners from 21 different companies, and 20 qualitative interviews with participants from five organisations were employed in this research, the primary goal being to validate and refine the AUM. The two research methods are described in the following sub-sections.

3.1 Phase 1: Focus Group

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 and 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).

The theoretical elements of FGs are their topical focus, group interaction, in-depth data, and humanistic character (Stewart, Shamdasani et al. 2007). The main attribute of focus groups is the group interaction where discussion allows insights and less accessible data to emerge that may not otherwise emerge in collective or focused interviews (Kitzinger 1997; Kidd and Parshall 2000). This 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). Some have termed this "introspective retrospection" (Merton and Kendall 1946) and others refer to it as participants' ability to "articulate those normally unarticulated normative assumptions" (Bloor, Frankland et al. 2001). 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 et al. 2012).

Some limitations of the FG method include (O'hEocha, Conboy et al. 2010): 1) opinions expressed may reflect those of a particular group context rather than a collection of the individuals' opinions (Stewart, Shamdasani et al. 2007), and 2) more subtle information that might emerge in a more 'private' context can be missed. However, the method has also been advocated for "formative evaluation, for programme improvement" (Patton 2002), and since, the focus of the current study was specifically to evaluate the AUM while leveraging group interaction, it matched the requirements of this study.

Moreover, 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, Conboy et al. 2010). Additionally, this FG provided the researchers with an opportunity to explore the varying viewpoints of practitioners who worked on different agile software development (ASD) teams to validate the AUM. FGs not only collect rich data from a varied group in a short amount of time (Morgan 1997; Stewart, Shamdasani et al. 2007), but they allow participants to probe other participant's reasons for their viewpoints, even challenging other's viewpoints. This allows

issues to surface that the researcher might not have asked (Bryman 2008), which makes them appropriate for evaluating the AUM in this study.

This FG consisted of a group of 29 software industry agile practitioners. This is a relatively large FG as they usually consist of six to 12 participants (Johnson and 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 this research was to validate the AUM and the factors for agile usage, a larger group was preferred to obtain multiple brief descriptions of the factors. The larger group was also divided into smaller groups of 5-6 participants to provide detailed discussion on the complexities of the factors of the AUM. This data was further validated in phase two of this research design in the qualitative interviews.

Well-designed FGs are generally one to two hours in length (Morgan 1997) and this FG lasted 90 minutes. Participants were attendees at a professional software development conference with 1700+ attendees. They self-selected to attend this FG with a choice of 19 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 AUM. As can be seen from Table 2, the participants have a range of experience as some were beginners with agile methods while others have been working with agile for up to 25 years. They have 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, Agile Coaches and customer representatives, e.g. product owners and business analysts. But the researchers did not ask the participants to differentiate themselves based on role, or organize by role. Participants listed agile methodologies they use as Scrum, XP, Kanban, Lean or a combination of these four methods.

The structure of the FG was an exercise and open discussion on agile usage via horizontal and vertical usage. We used the term "sustainability" in the FG to label the four factors that affect agile usage as "Sustainability Factors": Innovation, Sociological, Technological and Organisational factors that affect agile usage. The researchers first described the stages of how innovations diffuse in an organisation, followed by an overview of the AUM, the framework for agile usage. Specifically, the following topics were covered:

- Five stages of diffusion of innovation (adoption, adaptation, acceptance, routinization and infusion)
- Framework for Agile Usage (AUM):
    - Sustainability Factors (innovation, sociological, technological and organisational factors)
    - Agile Usage (horizontal and vertical)
    - Improvement Outcomes (quality, productivity and customer satisfaction)

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 practices. 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 practices.

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 AUM

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 People in Organisation	1,542 employees
Smallest Number of IT/Systems/Development People in Organisation	1 employees
Largest Number of IT/Systems/Development People in Organisation	16,000 employees
Industry Segments	Consulting Defense Financial Services (e.g. Banking, Insurance) Government Health Care IT Manufacturing Transportation Travel

Table 2.Profile of Focus Group Participants

factor or they had discussed a new, more appropriate factor, they presented this finding as well. 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 (Wengraf 2001; Rubin and Rubin 2005) and reflexive (Trauth and 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.

3.2 Phase 2: Interviews

To provide further illustration of the AUM factors that were validated in the FG, the factors were explored in more detail by conducting 20 face-to-face semi-structured interviews. 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). Semi-structured interviews are one of the most important data collection techniques in qualitative research (Myers and Newman 2007), and is particularly appropriate for theory building and development studies in the IS discipline (Benbasat, Goldstein et al. 1987). The design of semi-structured interviews can be classified into three main categories: *descriptive*, *exploratory* or *explanatory* (Gable 1994). While descriptive interviews are mainly used to provide a rich description of a phenomenon as perceived by individuals, and explanatory interviews to determine or confirm postulated relationships and causal links between concepts or constructs in causal studies, exploratory interviews are typically employed to propose new theory constructs and/or build or refine theories. In the current study, semi-structured interviews were used in an exploratory manner to validate the constructs in the Agile Usage Model, and also to uncover notions and concepts relevant to real-life practice about the post-adoptive implementation of agile practices.

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 (Yin 2003; Myers and Newman 2007). There are a number of guidelines to improve the validity and overcome the weaknesses associated with interviews. According to (Leedy and Ormrod 2001), *validity* is concerned with whether the data collected really measures the proposed theoretical constructs whereas *reliability* relates to the consistency with which the data collection methods are conducted. In the present study, construct validity was ensured by using two specific measures: 1) deriving the factors and constructs in the Agile Usage Model 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 interviewed. To ensure reliability of the data collected, the theoretical framework of Agile Usage Model was used to derive an interview protocol, and multiple interviewees from multiple organisations were selected to overcome single case bias.

The interview design consisted of five organisations and overall twenty interviews. 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). These participants were separate to the FG attendees, and the purpose was to elaborate on the FG findings and improve the validity of those findings with new research participants in a more detailed manner. The participants were purposefully drawn from a pool of agile teams from a range of organisations with which the research team were working with at the time. Participants from a wide range of roles such as developers, business analysts, project managers, Scrum masters (SMs), and IT service delivery managers were targeted, including stakeholders from the business unit and management. All participants had a minimum of two years' experience of working with agile methods, and their overall experience ranged from two to five 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 20 interviews were conducted in person by one researcher. 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. 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 affecting agile usage beyond the factors 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. In any cases of ambiguity, clarification was sought from the corresponding interviewee, either via telephone or e-mail. Table 3 shows the profile of the interviewees.

Industry Sector	Roles Interviewed
Independent Agile Practitioners (Org A)	Agile Coach (2)
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)

Table 3 Profile of Interview Participants

4 DATA COLLECTION AND ANALYSIS

For phase 1, a FG protocol was prepared based on the AUM. These 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 AUM: innovation (2 teams), sociological (1 team), technological (1 team), and organisational (1 team). There were two teams assigned to the innovation factor because we had enough participants for an additional team. We felt the innovation factor was the most challenging and

so assigned the second team to this factor. The goal was for each team to discuss examples from their own agile teams/organisations that illustrate each factor assigned to their group. If their examples did not fit their AUM 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 13 pages of data that were then proof-read, annotated and coded by the researchers using Nvivo[1] 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 AUM to understand the factors that impact effective usage of agile methods.

For phase 2, with the interviews, an interview protocol based on the AUM was developed 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 agile usage. 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 post-adoption agile usage. As interview results accumulated, analytical induction methods (Miles and 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 and 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 and 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 agile usage 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 AUM 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 RESULTS

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

[1] Qualitative Data Analysis Software Package (http://www.qsrinternational.com/)

5.1 Innovation

Both *Relative Advantage* and *Compatibility* were consistently cited across both FG participants and interviewees. One interviewee (Developer, Org E) described how the use of real data and positive information that compared agile to previous projects had a significant impact on agile usage in their organisation. 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. So, while there was consensus on the impact of these two factors on effective agile usage from both the interviewees and FG participants, there was ambiguity in the use of the term "innovation" for this category. The term 'innovation" was interpreted as "*innovating the innovation*" or "*continuing to innovate"* rather than the continual acceptance of an agile method based on its perceived continual benefits and compatibility with its predecessor practices as prescribed by the AUM. The team highlighted that the term "innovation" in an agile context referred 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. Advantages of new design techniques using agile architectural practices and technical practices were highlighted by one interviewee.

5.2 Sociological

A number of characteristics such as innovativeness, resilience, whole team involvement and ownership by adhering 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 as sociological attributes by FG participants. Attributes relating to people's attitude and motivation were also repeatedly mentioned by many interviewees using different terminologies such as "*Agile Mindset", "Agile Mentality", "inclusiveness, unselfishness and emotional intelligent awareness", "team sport", "team spirit".* The role of experience was also highlighted by some interviewees. One lead developer (Org C) commented on how losing experienced agile staff for newer members with no agile experience had a negative impact on sustaining agile behaviors in a number of different teams and projects in their organisation.

The role of an *Agile Coach* was repeatedly cited as a key sociological factor in creating and sustaining well-balanced high performance teams at an organisational level. A coach was identified as someone who has both technical and business expertise, and the ability to challenge teams' perceptions of what they're capable of and allowing them to find their self-organizing behavior. An *Agile Coach* could be someone external to the organisation who temporarily becomes part of the team or someone internal who has the energy and enthusiasm to actually take it forward.

5.3 Technological

The participants in this FG team identified two practices as particularly important in facilitating the effective use of agile practices: automated testing and continuous integration. 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 to success. Developers from Org C stated that in spite of using agile for more than 5 years, practices such as automated testing were not widely used and were "*still quite reliant on manual progression tests which are quite labor intensive and have a breaking effect on success, so that has quite an important factor to play".* So, ineffective use of engineering practices and lack of supporting tools was perceived to have a negative impact on effectiveness of agile usage.

5.4 Organisational

Top Management Support (TMS) was consistently cited across both interviewees and FG participants. FG participants discussed aspects of TMS such as leadership, and unwillingness of middle managers to let go of the "*command and control*" attitude that impact effective agile usage. Interview data suggested that TMS aspects such as funding and management participation, and support in changing the organisational structure and culture that reflects the agile way of working, played a substantial role in successful organisational transformation.

The significance of establishing a championship role at the organisational level was deemed critical for sustained and effective agile usage. Interview data highlighted differences between various agile roles such as organisational champion, Agile Coach, and Scrum Master. While a Scrum Master may facilitate the appropriate use of Scrum practices for a team, an Agile coach has a broader scope and may work with many teams and projects whose primary focus is on helping teams to effectively apply agile practices, manage change, and facilitate their self-managing behavior. On the other hand, a Methodology Champion is someone who is instrumental in the effective assimilation of agile methods throughout the organisation. He may use a variety of influences (e.g., social, political) to eliminate barriers to successful diffusion of agile methods, and facilitate and encourage their on-going usage.

The role of TMS in establishing these various roles was highlighted by the FG. An example of management recognizing the need for an external coach was given, "*what really enhanced agile sustainability was that management recognizing 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*".

For the Organisational factor, the need for an *Organisation Structure* that supports the agile way of working was cited by many interviewees. One independent practitioner gave examples of how organisations using agile methods (which support a flat structure and low need for control) for more than 5 years but still working in a hierarchical structure 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 better suit agile than their formal reporting system, "*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".*

6 DISCUSSION

Our findings from both the FG and interview data provided some valuable insights on the various factors and constructs in the AUM. Closer analysis and interpretation, through use of the constant comparison method across both data sets (Strauss and Corbin 2007) was critical to identifying the key factors in the refined AUM. This was done by the process of renaming and regrouping some existing constructs in the AUM, and adding some new constructs which helped hone in on the factors that are critical in sustaining effective usage of agile methodologies in organisations. The sections below evaluate all the constructs in each of the four AUM factors, and explain how we arrived at the final set of constructs in the refined AUM.

6.1 Innovation

Agile methods are information systems development process innovations, and since innovation characteristics can also be used to explain an innovation's **acceptance** (which refers to post-adoptive or continued use) (Agarwal and Prasad 1997), the term "innovation" was used to represent this factor in the AUM. The innovation characteristics, *Relative Advantage* and *Compatibility*, which are used to

explain post-adoptive usage of agile methodologies (Overhage and Schlauderer 2012; Senapathi and Srinivasan 2012) were included as sub-constructs. However, as described in 5.1, both FG participants and interviewees questioned the appropriateness of the term 'innovation' to represent post-adoptive or sustained usage. Therefore, on re-evaluating its meaning and after closely analysing both data sets, it was found that the term "acceptance**"** was more appropriate than "innovation", as this factor referred to the continual acceptance of an agile method based on its perceived continual benefits and compatibility with its predecessor methods or practices. Moreover, as per the IS implementation literature, acceptance is a post-adoptive stage which refers to users committing to use an innovation. Commitment to continue using an innovation occurs only after it matches a given context and successfully integrated into the organisation, and specific benefits or improvement outcomes are experienced consistently over a period of time. Therefore, the factor "innovation" was renamed as "acceptance", but no changes were made to the sub-constructs, *Relative Advantage* and *Compatibility.*

6.2 Sociological

All three constructs in the sociological factor (*Experience, Attitude,* and I) were validated across both the FG and interviews. Closer analysis of data revealed that the participants were specifically referring to '*Agile Experience'* rather than just *'Experience'*. *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 sometimes might have a negative impact on agile usage. This is well reflected in the words of an interviewee (Developer, Org D): "the *more experienced people are, its 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*". In terms of agile experience, (Salo and Abrahamsson 2008) found that people who had experience with XP and/or Scrum had more favorable opinions about their usefulness, and (Laanti, Salo et al. 2010) discovered a positive association between length of agile experience and attitudes towards its usefulness. Therefore, the construct *Experience* was renamed to '*Agile Experience'* in the refined AUM to better reflect the type of experience participants referred to with this factor.

While there is strong evidence in the agile literature for the significance of *Technical Expertise* on the effective usage of agile methods (Chow and Cao 2008; Misra, Kumar et al. 2009; Franca, Silva et al. 2010; Senapathi and Srinivasan 2012), analysis of both the FG and interview data highlighted that 'people' characteristics such as attitude, motivation, trust, and respect, were more important in a team than technical knowledge and expertise. This finding is closely related to another key theme that emerged from the findings called the "*Agile Mindset*", defined 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). It encompasses a number of sociological characteristics such as positive attitude, willingness to learn and change, team beliefs (norms and consensus across different definitions), and team spirit (team members display a strong sense of identification and commitment with the team). It believes 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)*. Since the main underlying philosophy of agile systems development is based on continuous improvement, we decided it would be more appropriate to combine the two constructs, i.e. *Attitude* and *Technical Knowledge and Expertise* into one construct called "*Agile Mindset*", because an agile mindset is nothing but a combination of attributes such as attitude, technical knowledge, motivation, and commitment to succeed.

Data from both the FG and the interviews provided strong evidence for the need of the construct *Agile Coach.* Interviewees from a large organisation (Org C) shared experiences of how many of their teams

degraded by 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"*. Since the main goal of coaching is to help teams which are already using agile practices to sustain and improve their effectiveness and performance, it was deemed as a key factor to be included in the AUM whose main focus is on post-adoptive agile usage. Therefore, *Agile Coach* was included as a sociological construct in the AUM.

6.3 Technological

Teams which focus on continuously improving their existing practices and incorporated supporting tools such as Cucumber, TeamCity achieve significant improvements in their systems development outcomes (Senapathi and Srinivasan 2012). Analysis of data from both the FG and interviews confirmed that both the constructs, *Agile Engineering Practices* and *Tool Suppor*t, played a substantial role in effective usage of agile methodologies. Agile methods and its associated practices are not substitutes for professional systems development practice. Identification of appropriate engineering practices and relevant tools to support such practices, for example, source control, bug tracking, testing, release, and deployment, were perceived as critical enablers for their effective and sustained usage. Therefore, there was no change made to this factor in the refined AUM.

Lack of a good collaboration tool was seen as a big hindrance to effective agile usage and was consistently raised by both FG and interview participants. It should be noted that *'Tool Support'* construct incorporates all tools that support various systems development tasks, i.e., requirements gathering and analysis, design, engineering practices such as automated testing, project management, and collaboration.

6.4 Organisational

Top Management Support (TMS) emerged as a key factor affecting effective agile usage in both FG and interview findings. 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 Agile Methodologies, *Methodology Champion*s (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, Pikkarainen et al. 2007). MC was consistently cited by both FG participants and interviewees, though some overlap was perceived with the sociological construct, *Agile Coach*. While the MC role is crucial for effective agile dissemination throughout the organisation, an AC relates more to the facilitation of effective application of agile practices by a thorough understanding of the social aspects of teams. Therefore, MC was included as an organisational factor whereas AC was included under the sociological factor.

There was strong evidence for the construct *Organisation Structure* within the interview data, which highlighted the significance of a structure that was more compatible with agile systems development. For example, respondents explained how some of their current models such as funding models, project management structure, and formal reporting systems based on hierarchical structure were against the agile way of working. So, it was perceived that agile systems development in a non-agile working structure had a significant impact on sustaining agile usage in many projects. Therefore, the construct *Organisation Structure* was added to this factor.

6.5 Summary

This section has described how multiple research methods were used to evaluate the AUM, and how the final factors and constructs in the refined AUM were derived. The name of the Innovation factor was changed to Acceptance. For the Sociological factor, the constructs *Attitude* and *Technical Knowledge and Expertise* were combined to form a new construct called *Agile Mindse*t. A new

construct called *Agile Coach* was added, and *Experienc*e was changed to *Agile Experience.* No changes were required for the Technological factor. For the Organisational factor, the constructs *TMS* and *MC* were retained, and a new construct *Organisation Structure* was added. The final refined model is shown in Figure 2: Acceptance factors (*Relative Advantage, Compatibility*), Sociological factors (*Agile Experience, Agile Mindset, Agile Coach*), Technological factors (*Agile Practice, Tool Support),* and Organisational factors (*Top Management Support, Methodology Champion,*

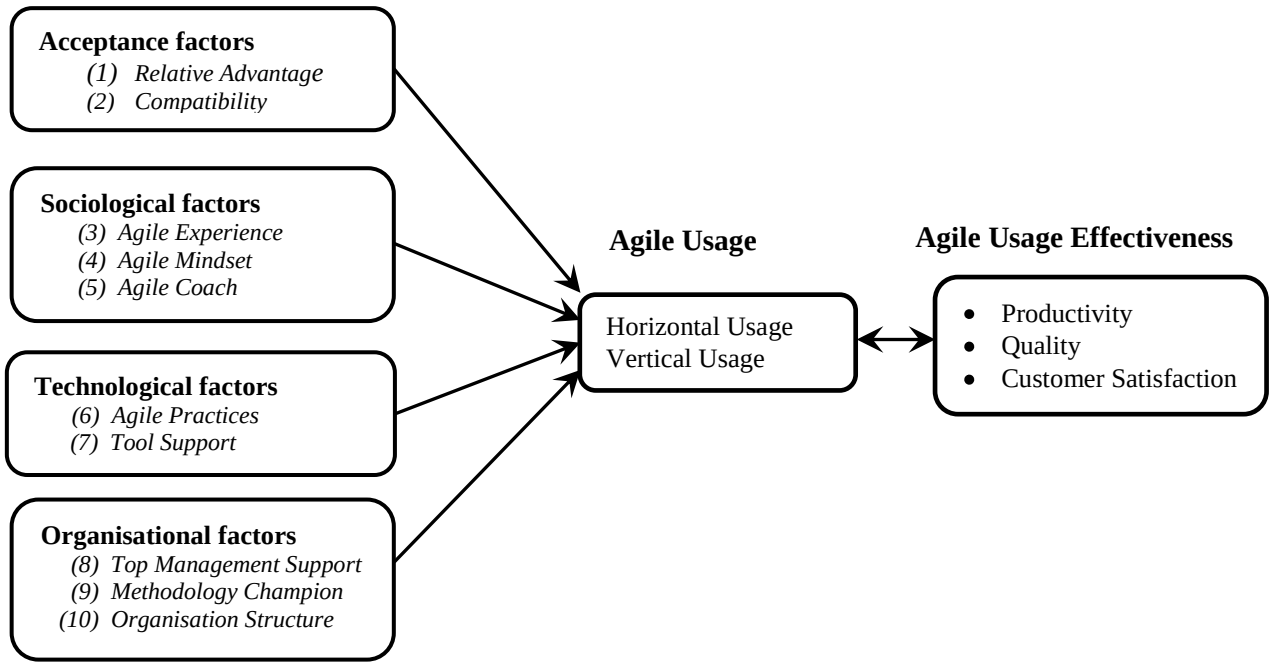

Figure 2 Refined Agile Usage Model

Organisation Structure).

7 CONCLUSIONS

While research into the post-adoptive use of agile practices is growing, there is lack of understanding of critical factors that influence sustained usage of agile methodologies (Wang, Conboy et al. 2012). To address this gap, the Agile Usage Model was developed which identifies a set of critical factors that impact effective usage of agile methodologies. In this study, we used a multiple research design by employing an innovative FG and qualitative interviews to evaluate and refine the AUM. Though the findings from this study confirm that the various factors identified in the framework have a significant impact on post-adoptive agile usage, it should be noted that they represent factors conducive to agile usage. Given that the primary objective of our research was to derive a final set of validated constructs, we have focused our efforts toward this purpose. However, usage effectiveness or success 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. A large scale survey could be used to statistically confirm and validate the usage framework's propositions at a more general level. Studies in different organisational settings and for different types of agile practices would potentially increase the applicability of the framework.

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