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Antecedents of Project Agility in Analytics Projects

Research-in-progress

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ABSTRACT

Agile project management methods have been widely adopted since the publication of the Agile manifesto. However, the nature of project agility needs further theoretical development and empirical support. Consequently, this study defines project agility and then explores the factors that influence project teams' achievement of agility. Complex Adaptive Systems (CAS) theory is adopted as a theoretical lens suitable to address the emerging, co-evolving nature of projects. A case-based research methodology is used to examine several analytics projects, the activities and interactions associated with each project, and the outcomes. Overall, the proposed study is designed to contribute to the project agility literature by applying CAS theory in the context of business analytics.

Keywords

Agile project management, analytics projects, project agility, complex adaptive systems theory

INTRODUCTION

Agile project management methods are widely adopted in IT projects (Collab.net & VersionOne.com, 2018). The methodology originated largely from the "Manifesto for Agile Software Development" (Agile Manifesto 2001), published online by a group of ISD engineers (Beck et al., 2001). The authors of the manifesto promoted the core values and principles of agility (e.g., individual empowerment, incremental and iterative development cycles, and customer involvement throughout the development process). Since the publication of the manifesto and the consequent increasing popularity, some researchers have emphasized the challenges (Mcavoy & Butler, 2009) and benefits (Lee & Xia, 2010) that characterize the adoption of agile methodologies.

Agility itself is described as "dynamic, context-specific, aggressively change embracing, and growth-oriented" by Highsmith and Cockburn (2001, p. 122). Further, the authors define agility in terms of "creating and responding to change". In our study, combining their definitions with how other researchers have defined project agility (e.g., Highsmith and Cockburn (2001), Vial and Rivard (2015)), we define project agility as the capacity to sense and respond to changes that are external or internal in an appropriate amount of time using the least possible resources, via adaptation, learning, and cooperation. We will further expand on project agility and the derivation of our definition in the next section.

A review of the empirical literature on agile ISD projects by Vial and Rivard (2015) emphasizes an implicit assumption linking the use of agile methodologies (e.g., Scrum: Schwaber and Beedle 2002 and eXtreme Programming: Beck and Andres 2004) to the achievement of agility. As an implementation of sophisticated IS does not always lead to improved organizational performance (e.g., Delone & McLean, 2003), the mere adoption of a particular agile project management methodology may not necessarily lead to agility and project success. The authors argue that this assumption impedes further understanding of the fundamental nature of agility in project teams. They also suggest that the contribution of individual actors and overall group dynamics has received limited attention in the existing literature (Vial & Rivard, 2015). Existing research on agile methods also has limited theoretical grounding (Dingsøyr, Nerur, Balijepally, & Moe, 2012). As described below, we suggest that complex adaptive systems (CAS) theory has the potential to help us understand the dynamics of project agility and this is the theoretical lens for our study. CAS theory also allows us to focus on institutional and social aspect of projects, something that Marchand and Pepper (2013) argue is needed.

We have chosen to focus our study of project agility on Business Intelligence and Analytics (BI&A) projects for several reasons. Authors have suggested that these analytics projects represent special cases of IT projects, often due to uncertainties related to data quality (e.g., Eckerson, 2012; Marchand & Peppard, 2013a) and may require different management approaches. That, combined with the rapid growth of analytics initiatives in organizations, provides strong motivation to study how to manage these types of projects effectively. In comparison to some IT department led initiatives, requirements for BI&A projects are often challenging to fully define at the start of the project, implying an experimental, iterative approach could be beneficial (Eckerson, 2012). Although business users and analytics teams may be able to define some initial requirements, the process of extracting, consolidation, cleaning and testing the data may result in the emergence of new ideas or force the search for and pursuit of alternative routes. Such situations would require certain degrees of flexibility from project members, suggesting an agile approach may be well-suited to these types of projects. Studying if and how project agility benefits BI&A projects will potentially contribute to both practice and research knowledge. While we bound our study by focusing on analytics projects, other IT projects (and non-IT projects) that have high levels of uncertainty may also benefit from the findings.

Accordingly, the research questions for our study are:

- What factors influence the achievement of agility in analytics project teams?
- How do these factors influence the achievement of agility in analytics project teams?
- What sets of unique combinations of factors enable project agility?

In order to address the proposed research questions, we are conducting multiple case studies of analytics projects. The rest of this paper will describe our study's theoretical background and methodology. We conclude by explaining potential contributions to the workshop audience and the existing body of knowledge.

THEORETICAL BACKGROUND

A few empirical studies show that the adoption of agile methods results in improved project performance (e.g., Schlauderer & Overhage, 2013). However, despite a number of empirical studies (Sarker, Munson, Sarker, & Chakraborty, 2009), conceptual studies (Conboy, 2009), and literature reviews (Dybala, 2002; Hummel, 2014) on agile ISD, the concept of project agility offers very little clarity. While agile ISD literature has matured over the years (Dingsøyr et al., 2012), most studies define project agility in terms of features and processes prescribed by a particular agile methodology (Hummel, 2014). The lack of conceptual clarity is considered to be one of the main challenges for building a cumulative knowledge on the topic (Conboy, 2009). Therefore, we discuss how to define project agility below.

Project agility

There is great variety among projects and organizations that adopt agile methods (Collab.net & VersionOne.com, 2018). Furthermore, agile methods vary in terms of focus on particular principles from the Agile Manifesto. That is natural as the Manifesto does not offer a clear prescription as to how to apply agile methods to different software development contexts (e.g., analytics projects vs. developing an accounting application system). While it is assumed that adopting agile methods would lead to reaching higher levels of agility, there are no clear guidelines as to whether it would work equally well for different types of IT projects (i.e., beyond software development projects) and, more importantly, which methods are more universal across different context than others and what are the theoretical perspectives that can help us to explain how they operate.

Consequently, in this paper we aim to define and explore project agility in a more general sense (i.e., beyond the context of software development). Based on extant definitions from the literature (see Appendix 1), we define project agility as the capacity to sense and respond to changes that are external (e.g., a change in customer requirements) or internal (e.g., discovering a different technical solution) in an appropriate amount of time using the least possible resources, via adaptation, learning, and cooperation. Agility encompasses the team's increased flexibility to cope with the changing environment (e.g., customer requirements). Further, it acknowledges the need to respond to changes in

an appropriate amount of time, as needless rapid responding would require excessive resources and slow responses could result in inferior performance. We now describe the justification for our definition.

Vial and Rivard (2015) classified agility in ISD projects in terms of different facets: flexibility, cooperation, learning, leanness (see Table 1) and we draw heavily on their work for our definition and focus. The facets are conceptually grounded in definitions of agility in the extant literature (see the middle column of Table 1). We suggest that the facet of flexibility can be further divided into sensing and responding similarly to how Overby defined agility (Overby, Bharadwaj, & Sambamurthy, 2006). While one can argue that flexibility is an outcome of sensing and responding, distinguishing between them allows for clearer identification of the factors leading to flexibility as low flexibility can be a result of insufficient sensing, responding or combinations of varying degrees of both.

Furthermore, we argue that facet of leanness can be further separated into effectiveness and efficiency when describing project agility. Iterative nature of ISD projects using agile PM methodology often dictates strict adherence to the timeline as the time frame for each iteration is set (e.g., 2-3 weeks per sprint). Consequently, the simplicity of tools and methods, low overhead per each iteration can be resulting in time frame restrictions and team capacity to produce output within the given timeline. Therefore, we argue that similar to Lee and Xia (2010) agility can be viewed in terms of both effectiveness and efficiency. Such a view of project agility reflects focus on delivering most business value while keeping track of the resources spent on the project. We intend to use the facets of agility adopted from Vial and Rivard (2015) in order to assess and distinguish among different levels of agility reached by a project (see the right-hand column of Table 1). Next, we will discuss the theoretical perspective chosen for our study: complex adaptive systems theory.

Facet (Vial & Rivard, 2015)	Corresponding concepts found in other definitions	Facet/dimension ¹ used in our definition and study
Flexibility: ability for a group of individuals involved in an ISD project to sense the need for change and respond to it promptly	<ul style="list-style-type: none"> • Adaptive (able to make last moment changes) (Abrahamsson et al. 2002) • Early recognition of the need for changes (Wufka 2013) • Flexibility (Conboy 2009) • Flexibility (Qumer and Henderson-Sellers 2006) • Speed (Qumer and Henderson-Sellers 2006) 	Sensing: ability of a group of individuals involved in ISD project to sense the need for change promptly.
	<ul style="list-style-type: none"> • Quick response to recognized required changed (Wufka 2013) • Take advantage of unexpected opportunities (Boehm and Turner 2004) • React and adapt (Boehm and Turner 2004) • Responsiveness (Qumer and Henderson-Sellers 2006) 	Responding: ability of a group of individuals involved in ISD project to respond to the change promptly.
Cooperation: ability for a group of individuals involved in an ISD project to work together	<ul style="list-style-type: none"> • Cooperative (customer and developers working constantly together with close communication) (Abrahamsson et al. 2002) 	Cooperation: ability for a group of individuals involved in an ISD project to work together
Learning: ability for a group of individuals involved in an ISD project to build on	<ul style="list-style-type: none"> • Agility applies memory and history to adjust to new environments (Boehm and Turner 2004) • Update the experience base for the future (Boehm and Turner 2004) 	Learning: ability for a group of individuals involved in an ISD project to build on past experience

¹ We understand Vial and Rivard's (2015) use the term "facet" to be synonymous with "dimension". We will use that term from this point forward in the paper.

past experience to adjust their internal processes	<ul style="list-style-type: none"> • Learning (Qumer and Henderson-Sellers 2006) • Process agility (Wufka 2013) 	to adjust their internal processes
Leanness: ability for a group of individuals involved in an ISD project to produce software using principles of economy, simplicity and quality	<ul style="list-style-type: none"> • Incremental (small software releases, with rapid cycles) (Abrahamsson et al. 2002) • Leanness (Conboy 2009) • Leanness (Qumer and Henderson-Sellers 2006) • Low overhead/leanness (Wufka 2013) 	Efficiency: ability for a group of individuals involved in an ISD project to produce output using principles of economy, simplicity and quality
	<ul style="list-style-type: none"> • High degree of tangibility of intermediate results (Wufka 2013) • Straightforward (the method itself is easy to learn and to modify, well documented) 	Effectiveness: ability for a group of individuals involved in an ISD project to produce output that satisfies customer needs/maximizes business value;

Table 1. Specifying the Facets of Agility in ISD (from Vial & Rivard, 2015)

Complex Adaptive Systems

Dingsøyr et al. (2012, p. 1217) points out that while “agile development evolved from the personal experiences and collective wisdom of the consultants and thought leaders of the software community” and “most individual agile practices have intuitive appeal”, theoretical foundations are certainly deficient and only a few manuscripts that applied theoretical perspectives. Among them, knowledge management, personality, organizational learning perspectives were used the most. Use of knowledge management and organizational learning perspectives is based on the view that the software development process is a knowledge development effort and, thus, represents logical choice. Similarly, use of personality perspectives (e.g., Big Five personality theory) appears to be a good fit when explaining the in-group dynamics of project teams. Our review of the literature identified a number of antecedents of project agility; however, a theoretical understanding of the mechanisms that create a better fit between project characteristics and agile project management methodologies is very limited. Consequently, in this study, we aim to apply a theoretical perspective (Complex Adaptive System theory) to potentially enable us to explain how adherence to the agile methods leads to the achievement of higher levels of agility.

A complex adaptive system is characterized by the presence of loosely interconnected autonomous parts (agents). Agents possess the capacity to intervene meaningfully over the course of events (Choi, Dooley, & Rungtusanatham, 2001) as they operate based on their own local principles (schemata – “changeable cognitive structures used to make sense of the environment and determine what actions to take”: (Vidgen & Wang, 2009, p. 357). Consequential interaction of agents in complex adaptive systems may result in complex behaviours.

Supporting our choice of Complex Adaptive Systems (CAS) theory, proponents of agile project management methodology have argued that the CAS perspective fits appropriately in the explanation of ISD project agility (e.g., J. Highsmith, 2000; Schwaber, 1996) and is “the only way to make sense of the world” (J. A. Highsmith, 2002, p. 48). Our review of the literature found three studies that have used CAS in an IS context. Meso and Jain (2006) identified seven complex adaptive systems principles (e.g., the principle of growth and evolution) and matched them with agile practices (e.g., frequent releases, continuous learning, and limited planning). Although it yields some conceptual insights, the model has not been empirically tested and validated (to the best of our knowledge). Vidgen and Wang (2009) used complex adaptive systems theory to examine two ISD teams: an agile (eXtreme Programming) and a plan-based (waterfall). Choi et al.’s (2001) conceptual paper characterized complex adaptive systems as having three underlying dynamics: 1) internal mechanisms (agents, self-organization and emergence, connectivity, dimensionality), 2) co-evolution (quasi-equilibrium and state change, non-linear changes, non-random future), and 3) environment (dynamism, rugged landscape). Consequently, the complex adaptive systems perspective appears to be an appropriate framework for explaining underlying mechanisms of project agility that is characterized by self-organization within agile project teams, close connections (e.g., interdependence in modular software or pair programming in eXtreme Programming), and frequent communication with customers. Furthermore, agile principles

as schemata can be seen as examples of the generative mechanisms in complex adaptive systems (e.g., agile principles stated in the Agile Manifesto). Finally, the external environment of agile project teams is characterized by dynamism and rugged landscapes as complex adaptive systems evolve to maximize some measure of fit with the surrounding dynamic environment (Aritua, Smith, & Bower, 2009). Based on this perspective, Figure 1 outlines our conceptual model.

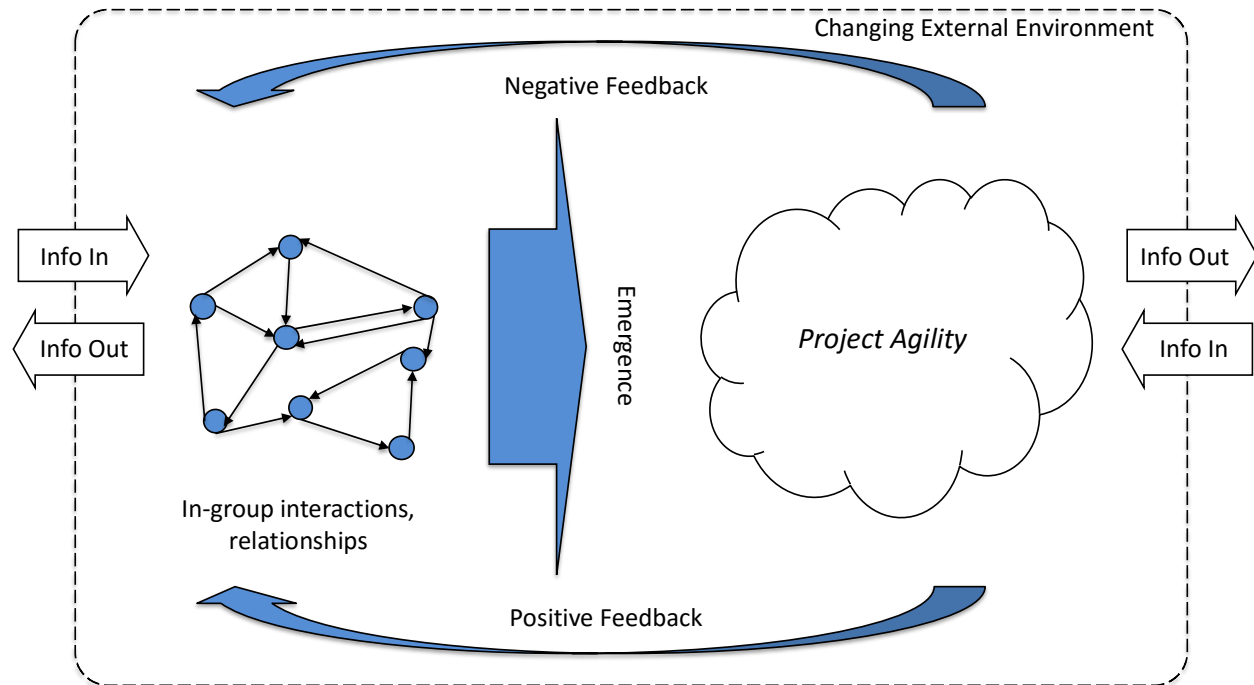


Figure 1. CAS Conceptual Model of Project Agility (adapted from Aritua et al., 2009)

Complex adaptive systems theory has been used in several organizational studies (e.g., Anderson, 1999; Eisenhardt & Brown, 1998; Haeckel, 1999; Mitleton-Kelly, 1997; Stacey, 2003) and Anderson (1999) suggests that this theory may no longer be counted as a new theory in organizational studies. However, Vidgen and Wang (2009) posit that there have been very few empirical studies using this theory in IS due to the challenging nature of adopting abstract ideas of complex adaptive systems theory to empirical research. Therefore, we have adopted a case study methodology (explained further below) as this will allow us to explore the three dynamics identified by Choi. Our study will demonstrate whether complex adaptive systems theory fits the context of project agility and can be helpful in explaining which facets of agility, within the context of analytics projects. Therefore, we adopt complex adaptive systems theory as the theoretical lens for our project agility study.

METHODOLOGY

This study uses a case-based research strategy to study projects throughout their life cycle. This strategy is appropriate as it fits our research questions and allows us to examine contemporary events that have complex contextual conditions, as almost all projects do. In any project, there are many practices and factors that interact with the setting of the project. For example, the stakeholders involved and their power within the organization could affect the outcomes, the core team skills and their interaction patterns could affect productivity, and the organizational (or departmental) culture could affect the support received for the project and the role of project leadership. The case-based research strategy allows us to examine the dynamics suggested by CAS theory. A multiple-case design is appropriate also for the following reasons. The case study approach allows us to study project agility in “a natural setting, learn about state of the art, and generate theories from practice” (Benbasat, Goldstein, & Mead, 1987, p. 370). In this situation, it will further our understanding of the nature of the relationship among the factors, discover new factors or see than concepts emerged from literature-based theorization are not relevant in given context. The case

study approach also allows us to better understand the “nature and complexity of processes taking place” (p. 370). Therefore, a small number of cases will be able to provide rich insights. Furthermore, multiple-case designs allow for “cross-case analysis and theory extension” (Benbasat et al., 1987, p. 373). As much as possible, Yin’s (2002) suggestions for establishing reliability and validity, and analyzing case study evidence is followed (e.g., developing a detailed case study protocol, case study database, interview script, coding and pattern matching, etc.). Our unit of analysis is the project.

Sample

Theoretical sampling and replication logic are being used to select analytics projects that have variation in the project management practices employed and the degree of project uncertainty. Data collection for each project is done by interviewing key project stakeholders. This includes members of the project team (all if possible), the project leadership (e.g., sponsors, senior executives affected by the project, people involved in project selection and approval), and the project clients (those who will use the outcome of the project).

The recruitment process involved several steps. Companies on our university’s Analytics advisory board were invited to contact the researchers if potentially interested in the study. Four companies expressed initial interest, leading to discussions with executives and directors of various analytics departments. These discussions (which are on-going with some organizations) resulted in two companies giving us access to projects. We worked with the analytics directors to choose projects that were on-going and where we could access key stakeholders.

Initial data collection, as of the end of August, has been completed for four projects. All four projects are analytics projects in large financial institutions. Interviews lasted about 1.5 hours with each participant, and 23 interviews have been completed in total for the four projects. We plan to revisit these four case sites to update our information on how the projects are performing, as well as start studying additional projects between September and December. Project A is at the testing stage and has been running for over a year. Project B is in the implementation stage and started about a year ago. Project C has been running for six months and currently at the proof of concept (POC) stage. Finally, Project D is at the data cleaning and searching for additional data sources and has been running since June 2018.

Construct Measurement and Analysis

The semi-structured interview protocol asks questions covering the following topic areas: project objectives, project performance to-date, project selection activities, project initiation and planning activities, project execution and monitoring/controlling activities, project closing (referring to PMI’s traditional process groups) and product transition activities (if appropriate – depending on the stage of the project), the analytics environment (using Eckerson’s (2012) framework), project leadership activities (based on Cross and Brohman’s (2015) Project Leadership model), project agility activities (based on Conforto, Amaral, da Silva, Di Felippo, & Kamikawachi, 2016), and views on the challenges and rewards of analytics projects. The interview protocol was pilot-tested with an experienced project manager and doctoral student.

All interviews are recorded, transcribed, and entered into NVIVO 12 for analyses. Initial coding is being done on interview question topics, as well as open coding to capture the dimensions of agility and the dynamics suggested by CAS theory. Axial coding will be done to identify relationships among the open codes and explore our research questions.

We plan to also study project agility using a configuration theory approach. Whitworth and Biddle (2007) suggest that the “study of diverse configurations of agile practices, management styles, and team membership is required in order to understand the resultant and underlying effects on individuals and teams” (p. 8). They argue that such study will further the identification of the critical success factors and benefit practitioners with applicable configurations of various factors. According to El Sawy et al. (2010), configuration theories facilitate an understanding of how different patterns and combinations of elements and their configurations lead to specific outcomes. They resonate with complex adaptive systems theory as configuration theories view phenomena as “clusters of interconnected elements” (El Sawy, Malhotra, Park, & Pavlou, 2010, p. 838) and facilitate inquiries of complex interconnectedness of elements and nonlinearities (Meyer et al., 1993). Furthermore, as configuration theories view elements as a part of combinations, they may result in models that can parsimoniously capture inherent complexity of the phenomena of interest. One of

the advantages of the configuration theory method is that a relatively small number of responses is sufficient for data analysis. Qualitative comparative analysis (QCA) will be done used to examine configurations in our data using fsQCA analytical software.

Potential contributions to Workshop Audience

The results of this study should contribute to our understanding of what project agility is, the antecedents of project agility and subsequent underlying mechanisms in analytics projects. The case studies will allow for the observation and investigation of the phenomenon of interest in natural settings, and the collection of context-rich data. Overall, the proposed study is designed to contribute to the project agility literature by applying a complex adaptive systems perspective in the context of business analytics. Although there are some factors that are specific to the nature of the project, we expect that some of the explanations might be useful in contexts beyond BI&A or IT projects.

As this is research-in-progress, data analyses are underway, and results will be presented at the workshop. We anticipate that we will present, at a minimum, the results of the analyses of the four cases that we currently have data for, as well as any updates we get to those projects before December. This will comprise of within-case analyses as well as across-case analyses. We hope to also have preliminary results of our fsQCA. In case of fsQCA results, we expect them to be helpful in terms of identifying potential combination of project agility antecedents some of which can be relevant for various agile projects.

APPENDIX 1

Source	Definition	Source/Context
(Chan & Thong, 2007)	Systems development methodology (SDM), defined as a documented collection of policies, processes, and procedures used by a development team or an organization to practice software engineering, can help improve the software development process in terms of productivity and quality (Iivari et al., 2000).	Context: ISD
Diegmann & Rosenkranz (2017)	Agile practices entailing communication practices or practices aiming at exchanging knowledge and facilitating interpersonal interaction (e.g., daily scrums or pair programming).	Hummel et al. (2015)
Lee and Xia (2010)	ISD agility dimensions: 1) software team extensiveness (% of requirements incorporated in the final product); 2) ISD teams efficiency (minimization of resource use). Definition of team agility: software development agility, which is defined in this research as a software team's ability to efficiently and effectively respond to user requirement changes (p. 88).	
Conboy & Fitzgerald (2004)	Agility is defined as the continual readiness of an entity to rapidly or inherently, proactively or reactively, embrace change , through high-quality, simplistic, economical components and relationships with its environment .	Software development agility
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.	
Larman (2004)	Agility is rapid and flexible response to change.	
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-Seller & 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 (2007)	Agility is being light, barely sufficient , and maneuverable.	
Qumer & HendersonSellers (2008)	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.	
Abrahamsson et al. (2002)	“What makes a development method an agile one? This is the case when software development is incremental (small software releases, with rapid cycles), cooperative(customer and developers constantly working together with close communication), straightforward(the method itself is easy to learn and to modify, well documented), and adaptive (able to make last moment changes)”.	Existing agile ISD methods
Boehm and 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 the future.”	Unspecified
Qumer and HendersonSellers (2006)	“Agility is a persistent behaviour or ability of a sensitive entity that exhibits flexibility to accommodate expected or unexpected changes rapidly, follows the shortest time span, uses economical, simple and quality instruments in a dynamic environment and applies updated prior knowledge and experience to learn from the internal and external environment.”	Unspecified
Conboy (2009)	“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.”	Other disciplines and previous work on the topic (Conboy & Fitzgerald, 2004)

Appendix 1. Extant Definitions of Agility in ISD

APPENDIX 2

Interview question topic	Interview questions subtopics
Project characteristics	<ol style="list-style-type: none"> 1. Project identity 2. Project success metrics and goals 3. Project uncertainty
Project processes and activities	<ol style="list-style-type: none"> 1. Project selection 2. Project initiation 3. Project planning 4. Project execution

	<ol style="list-style-type: none"> 5. Project monitoring and controlling 6. Project closing 7. Project use and transition 8. Project benefit realization 9. Project agility
Org. environment, culture and leadership	<ol style="list-style-type: none"> 1. Org. environment 2. Project leadership
General comments on analytics projects	<ol style="list-style-type: none"> 1. Most significant challenges of BI&A projects 2. Critical issues in BI&A projects
Project performance	<ol style="list-style-type: none"> 1. Project effectiveness 2. Project team effectiveness

Appendix 2. List of interview question topics

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