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Agile Methods and the Links to Customer Satisfaction and Firm Performance

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ABSTRACT

The purpose of this document is to serve as a research proposal to recommend a study to examine the effects of using agile methods to manage the development of Internet products and services on customer satisfaction and firm performance. Agile methods are an approach to developing Internet software, which are characterized by early customer involvement, iterative development, self organizing teams, and flexibility. Agile methods are posited as the best approach for developing Internet products and services as opposed to traditional methods characterized by firm fixed price contracts, voluminous documentation, rigid processes, and formal project plans. A survey of 400 managers is suggested to test the hypotheses that the use of agile methods for managing the development of Internet products and services is linked to better customer satisfaction and firm performance. The results of this study may help managers better understand the business effects of adopting or failing to adopt agile methods.

Keywords. Agile methods, early customer involvement, iterative development, self organizing teams, flexibility, customer satisfaction, firm performance.

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INTRODUCTION AND OVERVIEW

Agile methods are approaches to managing the development of Internet products and services based on principles of flexible manufacturing and lean development. Agile methods were a reaction to the rise of traditional software development methods, which were too large, expensive, rigid, and fraught with failure. Downsizing was the norm and traditional methods were being used by large corporations in decline, rather than young, energetic firms on the rise. Millions of websites were created overnight by anyone with a computer and a modicum of curiosity. Agile methods marked the end of traditional methods in the mind of their creators.

Traditional methods for managing software development were created when the first commercial computers began emerging in the 1950s. Scientists and engineers began creating increasingly more powerful and complex computers, and inordinately complex computer programs beyond the comprehension of a single human. These early computer programs had millions of components to perform the simplest of operations giving rise to traditional methods. Traditional methods consisted of rigidly formal project plans, customer requirements etched in stone, infinitely bureaucratic processes, hundreds of paper documents, and squeaky clean testing processes similar to those used in microbe free semiconductor manufacturing clean rooms.

Agile methods emerged with a focus on early customer involvement, iterative development, self organizing teams, and flexibility. Internet technologies such as HTML and Java were powerful new prototyping languages, enabling smaller teams to build bigger software products in record time. Because they could be built faster, customers could see the finished product sooner and provide earlier feedback, and developers could rapidly refine their products. This gave rise to closed-loop, circular, highly recursive, and tightly knit processes for rapidly creating Internet products, leading to increased customer satisfaction and firm performance.

Purpose of Study

The purpose of this study is to determine whether the use of agile methods by Internet firms is more effective than traditional approaches based on scientific management principles. Since both agile and traditional methods are currently in widespread use by Internet firms, this study may help them determine whether agile methods have any impact at all on their performance. So, the basic purpose is to examine the links between the use of agile methods and firm-level outcomes. Or, at least determine the nature and magnitude of those relationships (e.g., better products, satisfied customers, profitability, shareholder value, market share, etc.). Not only is the purpose to examine the links between agile methods and firm outcomes, but to determine what these so called firm-level outcomes are and the best way to measure them. In addition, the purpose of this study is to determine what the overall affects of using agile methods are, if any.

Scope of Study

The scope of this study will be limited to an analysis of using agile methods for managing the development of Internet products on customer satisfaction and firm performance. Only the major factors of agile methods will be examined by this study (e.g., early customer involvement, iterative development, self organizing teams, and flexibility). Furthermore, the scope of this study will be limited to an empirical analysis of the links between these factors of agile methods and scholarly models of customer satisfaction and firm performance. There are many important topics within the fields of computer science and software engineering. Examples include supplier selection standards, software documentation standards, software process standards, and software project management standards. And, still, others include operating systems, programming languages, artificial intelligence, architecture, and many others. It is not the purpose of this study to minimize the relevance of these topics, but to help determine the relevance of agile methods.

Rationale and Justification

The top 500 U.S. firms spend \$140 billion per year on information technology (“Masters of Technology,” 2004) and much of the annual \$400 billion U.S. defense budget is devoted to information technology as well (Fulghum & Wall, 2004). Furthermore, there are more than 250,000 software projects in the U.S. of which more than 72% have failed or are failing (Standish Group, 2000). By some estimates, two-thirds of all Internet projects in the U.S. use agile methods to produce their wares, which amount to nearly 167,000 projects (Sliwa, 2002). Therefore, executives and managers of Fortune 500 firms may benefit from the knowledge that agile methods may be linked to better customer satisfaction and firm performance. And, a wide variety of Internet firms and traditional organizations are adapting agile methods in increasing numbers. There has never been a greater need for scholarly studies of agility. However, there is a dearth of scholarship on the analysis of the principles of agility for Internet firms.

Relevance and Importance

Firms may also garner many substantial indirect economic benefits from using agile methods to develop Internet products as well. For instance, it is a well established fact that the stock market rewards firms with higher market valuations for publicly committing to the use of approaches to quality management techniques such as agile methods (Przasnyski & Tai, 1999). Furthermore, the stock market also rewards firms with higher market valuations for renovating information technology infrastructures with greater investments (Davis, Dehning, & Stratopoulos, 2003). What these studies mean is that a firm’s investors may simply reward companies with higher market valuations for simply adopting the use of agile methods. Understanding the strategic implications of using agile methods for developing Internet products is extremely relevant and important to managers engaged in business development as well.

Significance and Interest

Agile methods are significant and interesting to a number of stakeholders. These stakeholders may include developers of Internet products, computer scientists, software engineers, and management scientists. Developers may want to use software development approaches that are ideally suited for Internet technologies. Developers want to focus on creating the best possible Internet products with the least amount of pain, bureaucracy, or rigid detail associated with traditional methods. Computer scientists, who are responsible for creating Internet technologies, are interested in software development approaches that enable them to exploit their creations easily, more fully, and without the unnecessary burden of mastering bureaucratic traditional methods. Software engineers, on the other hand, are responsible for creating traditional methods for software development. So this study may help software engineers understand the dynamics of creating Internet products and services.

Organization and Outline

This proposal is organized into eight sections: introduction and overview, research problem, literature review, research framework, research methodology, plan for work and deliverables, summary and contributions to the field, and references. The introduction describes the context for using agile methods. The research problem describes the major issues and delineates the boundaries of this study. The literature review describes the history of software methods and describes why this study of agile methods is necessary. The research framework graphically depicts the conceptual model along with a scholarly exhibit of the major factors of using agile methods. The research methodology describes the use of a quantitative research approach for studying the use of agile methods. The plan of work and deliverables exhibits a timeline for this study. And, the summary describes the major contributions of this study.

RESEARCH PROBLEM

The Internet is a powerful new communication medium for conducting free market style business transactions involving the instant exchange of billions of dollars on a worldwide scale. Primarily due the Internet industry's low market entry requirements, the 21st century suddenly shifted the balance of power away from industrial age organizations in favor of Internet firms. This enabled them to monopolize market share and achieve unprecedented levels of profitability. Likewise, it presented rather formidable challenges for managing the development of Internet products and services. Some firms manage the development of Internet products and services using principles of flexibility and agility, while other firms continue to use traditional methods.

The problem is to investigate, examine, and determine whether the use of agile methods for managing the development of Internet products and services is linked to firm-level outcomes. There is some scant literature that investigates the linkages between the use of agile methods and organizational outcomes, such as customer satisfaction and firm performance. And, there is even some literature that links the development of superior Internet products and services to improved customer satisfaction and firm performance.

However, the major tenets, principles, and factors of agile methods had yet to fully evolve and emerge at the time of some of these writings. And, few studies, if any, examine the effects of all four factors or principles associated with agile methods: (a) early customer involvement, (b) iterative development, (c) self organizing teams, and (d) flexibility. Furthermore, few studies link any of these factors associated with agile methods to outcome measures, such as customer satisfaction and firm performance in a scholarly manner. Therefore, this study proposes to analyze the effects of all four factors of agile methods and then empirically link these factors to scholarly models of customer satisfaction and firm performance.

Research Background

The research background is characterized by numerous attempts to link the use of software methods to improved customer satisfaction and firm performance. Computer programmers, computer scientists, software engineers, and management scientists have been trying to solve computer programming problems such as productivity, quality, reliability, customer satisfaction, cost effectiveness, and time-to-market for more than five decades. Knuth (1963) and Dijkstra (1968) introduced flowcharts and stepwise refinement to help ease the process of creating complex computer programs in the 1960s. Fagan (1976) introduced software inspections to increase quality and productivity by an order of magnitude in the 1970s. Madden and Rone (1984) used iterative releases to develop the software for NASA's space shuttle in the 1980s. Sulack, Lindner, and Dietz (1989) used early customer involvement to produce 30 billion lines of application software and garner IBM \$14 billion in revenue in the 1980s as well. Hewlett Packard saved \$350 million using a myriad of software methods in the 1990s (Grady, 1997). Motorola successfully produced an error free paging system at 25 times the normal productivity levels (Ferguson, Humphrey, Khajenoori, Macke, & Matvya, 1997). And, Electronic Brokering Services designed a 65,000 line of code Java system using team processes that conducted \$1 billion worth of online trades per day without error in record time (Goth, 2000). General Dynamics has even noted order of magnitude improvements in productivity, quality, cycle time, and cost reductions using the capability maturity model (Diaz & Sligo, 1997). Yet, all of these isolated breakthroughs linking software methods to better customer satisfaction and firm performance have left skeptics demanding more evidence (Sassenburg, 2002). This is the background, which establishes the context for seeking empirical evidence that may link the use of agile methods for developing Internet products to customer satisfaction and firm performance.

Research Questions

The basic research area to be explored is whether the use of agile methods by Internet firms is more effective than traditional approaches based on scientific management principles. A closely related question is how firms manage the development of Internet products and services for the \$140B information technology industry? Another closely related question is what management approaches are linked to firm-level outcomes for Internet firms? And, of course, what factors are motivating the use of new management approaches such as agile methods?

Specific questions include whether the major factors or principles of agile methods are linked to firm-level outcomes among Internet firms. Is the use of early customer involvement linked to firm-level outcomes among Internet firms? Is the use of iterative development linked to firm-level outcomes among Internet firms? Is the use of self organizing teams linked to firm-level outcomes among Internet firms? Is the use of flexibility linked to firm-level outcomes among Internet firms? Equally important is whether the answer to these questions is no.

Goals and Objectives

The research goals and objectives are to gather information that might determine if a link exists between the use of agile methods for managing the development Internet products and customer satisfaction and firm performance. Therefore, the research goals and objectives are to examine the empirical links between the theoretical factors of agile methods, scholarly constructs of customer satisfaction, and significant determinants of firm performance. Conversely, the research goals and objectives of this study are also to determine if early customer involvement, iterative development, self organizing teams, and flexibility are not linked to scholarly models of customer satisfaction and firm performance. Positive correlations between the factors of agile methods, customer satisfaction, and firm performance are just as important as negative ones.

Terms and Definitions

Agile methods are approaches to managing the development of Internet products and services based on principles of early customer involvement, iterative development, self organizing teams, and flexibility (Agile Manifesto, 2001). Early customer involvement is the solicitation of market feedback by including end users in the product development process to achieve higher satisfaction (Kaulio, 1998). Iterative development is the act of creating a skeletal computer program followed by the gradual enhancement of successive software implementations (Basili & Turner, 1975). Self organizing teams are non-hierarchical groups with different and complementary skills, who are responsible and accountable for organizational outcomes (Zarraga & Bonache, 2005). Flexibility is a development process that is tolerant to design changes, late product changes, or change altogether due to flexible designs (Thomke & Reinertsen, 1998).

Assumptions and Constraints

The first assumption is that the use of agile methods is a measurable phenomenon (e.g., is this a dead end study?). Another assumption is whether agile methods will continue to be relevant in the near future (e.g., will they become obsolete?). A subtle assumption is whether or not agile methods are linked to Internet technologies (e.g., will they become obsolete when Internet technologies become obsolete?). And, of course, an overriding assumption is whether scholarship on agility is already mature (e.g., are they still ripe for further scholarly analysis?). The first constraint is choosing a representative set of scholarly principles that define agile methods. The second constraint is selecting a representative industry sector and cross section of firms to analyze. Another constraint is selecting a scholarly methodology that supports the goals of studying agile methods. Yet other constraints are consistently addressing viewpoints of agility across academic disciplines and generalizing the results across industry sectors.

LITERATURE REVIEW

The literature review provides a basis for studying the links between agile methods, customer satisfaction, and firm performance. The goals of the literature review were to simultaneously identify seminal as well as the scholarly antecedents of agile methods. A short history of software methods is provided under the guise of predecessors of agile methods. A section called undercurrents of agile methods represented trends, which precipitated the emergence of agile methods. More importantly, a section called the antecedents of agile methods describes software methods leading directly to agile methods. The values and principles of agile methods follow next. Simple examples of agile methods were provided next. Every effort was made to identify only the best scholarly empirical results. Another major goal of the literature review was to gather enough data to identify the gaps in the literature and a need for a new study.

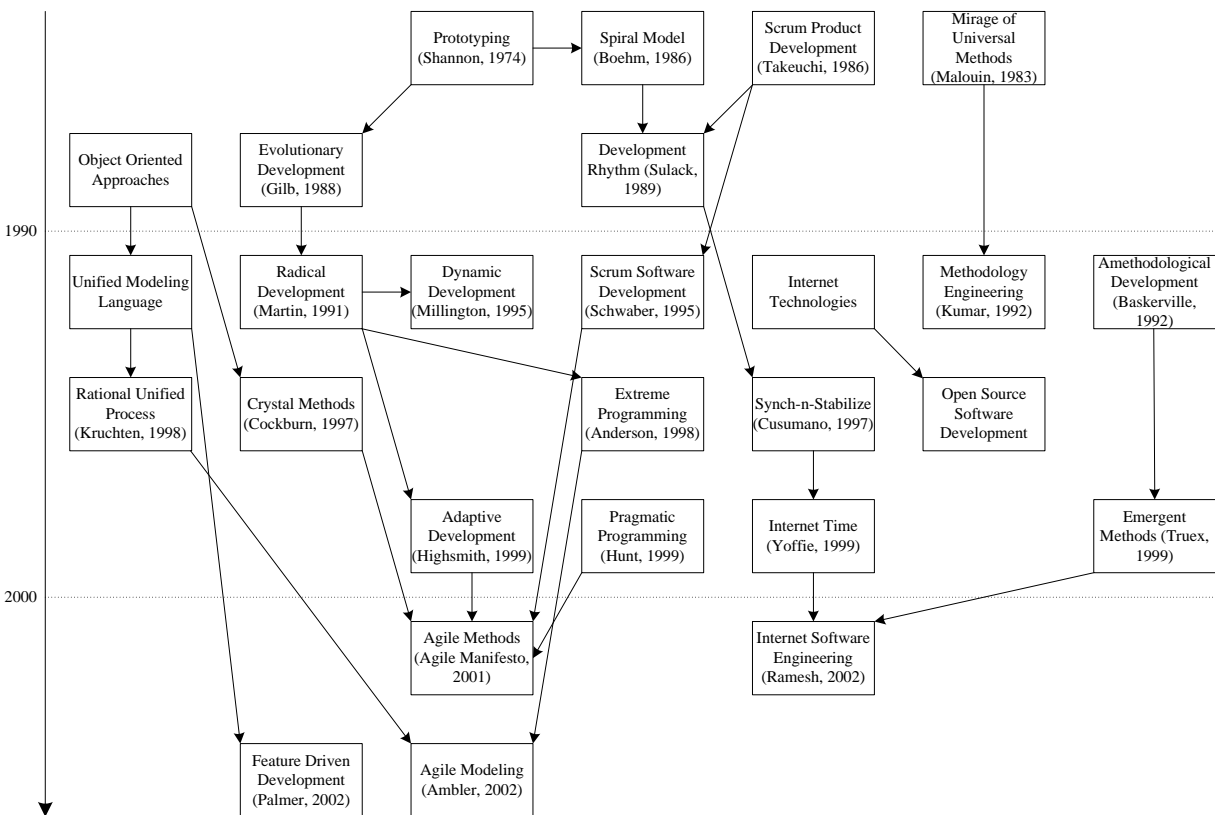


Figure 1. Timeline and history of agile methods (Abrahamsson, Warsta, Siponen, & Ronkainen, 2003).

Predecessors of Agile Methods

Mainframe era. The 1960s were a defining period for the world of computers giving rise to what we now know as mainframe computers (Solomon, 1966). Flowcharting was adapted by programmers to document software written in primitive computer languages (Knuth, 1963). And, structured design emerged to help programmers organize computer programs into a functionally decomposed hierarchy of larger algorithmic abstractions called subroutines (Dijkstra, 1968).

Midrange era. The 1970s completely redefined the face of technology resulting in the creation of what we now know as midrange or mini computer systems (Eckhouse, 1975). Configuration management was adapted by programmers to help maintain an inventory of computer programs and their associated documents (Bersoff, Henderson, & Siegel, 1978). Quality assurance was adapted by programmers to ensure customer needs were satisfied by the use of structured computer programming activities and documentation (Benson & Saib, 1978).

Microcomputer era. The microcomputer era of the 1980s ushered in revolutionary new technology in the form of better, faster, smaller, and cheaper personal computers (Ahlers, 1981). The software methods of the mainframe and midrange era were embodied in software process standards known as traditional software methods (Radice, Harding, Munnis, & Phillips, 1985). Object oriented programming (Booch, 1986), software reuse (Owen, Gagliano, & Honkanen, 1987), and domain analysis (Arango, 1989) marked the emergence of non-traditional methods.

Internet era. The Internet era of the 1990s was a profound decade for the field of computer programming as the World Wide Web exploded onto the global scene (Reid, 1997). Software architectures emerged to serve as blueprints to help programmers create better software designs (Lange & Schwanke, 1991). Product lines also emerged to help programmers efficiently create architectural families or derivatives of computer programs (Klingler & Creps, 1996).

Undercurrents of Agile Methods

Supplier selection standards. Supplier selection standards were a common method of using contracts to ensure suppliers could manage the development of their products and services. The European Union helped steward the creation of an international supplier selection standard to regulate trade with its states (International Organization for Standardization, 1987). The U.S. Department of Defense also created a supplier selection standard to qualify corporations to provide large weapon systems (Software Engineering Institute, 1993).

Software documentation standards. Software documentation standards were created with the notion that the more documentation the better it would be. The U.S. Department of Defense evolved a software documentation standard with a set of 22 documents (Department of Defense, 1994). Fourteen of the U.S. Department of Defense documents were adopted as a commercial software documentation standard (International Organization for Standardization, 1995).

Software process standards. As an outgrowth of the total quality management movement, software process standards were adapted from Philip Crosby's Maturity Grid (Crosby, 1979). Amidst dozens of competing models the international community banded together to create a single unified software process standard (International Organization for Standardization, 1998). Not to be outdone, hundreds of U.S. Department of Defense contractors banded together to create their own software process standard (Software Engineering Institute, 2002).

Software project management standards. Henry L. Gantt invented the bar chart to track tasks, forming the basis for software project management standards (Gantt, 1910). These techniques caught up with the field of system development in 1960s to help NASA put the first man on the moon (Paige, 1963). Today, there are over 185,000 people certified in the administration of project management standards (Project Management Institute, 2004, 2005).

Antecedents of Agile Methods

Early customer involvement. Early customer involvement is rooted in the human relations school of management (Shafritz & Ott, 2001). However, early customer involvement is more directly rooted in the employee participation movement (Holter, 1965). During latter half of the 1960s early user involvement was cited as a success factor for information system development (Orlicky, 1969). By, the 1980s nearly 100 studies extolled the benefits of early user involvement in system development (Ives & Olson, 1984). However, little evidence has ever been produced.

Iterative development. Iterative development has its earliest roots in the microbiology and chemistry experiments carried out by Louis Pasteur in the late 1880s (Thomke, 2003, p. 21). However, it is Thomas Edison who is credited with the earliest forms of systematic iterative development, otherwise known as “rapid experimentation” (p. 12-13). Iterative development was rediscovered and applied to software development in the 1970s (Basili & Turner, 1975). A high number of frequent iterations are credited with project success (Allen, 1966).

Self organizing teams. Self organizing teams are rooted in the human relations school of management (Shafritz & Ott, 2001). An early study of self organizing teams shows responsibility without authority or inability to affect resources may be fruitless (Babchuk & Goode, 1951). An early comprehensive case study indicates only nominal productivity gains for self organizing teams and little historical evidence among many scholarly references (Herbst, 1962).

Flexibility. Flexibility originated in the goals of satisfying customer needs by tailoring manufacturing processes, with most of its antecedents appearing before 1970 (MacBeth, 1985). One of the most convincing studies of flexibility showed that flexible product architectures result in greater project success (Thomke & Reinertsen, 1998). And, Scholars realized very early that flexibility was a key to successful software projects (Ahituv, Hadass, & Neumann, 1984).

Values of Agile Methods

With the limitations and promises of the undercurrents and antecedents of agile methods, Kent Beck led 17 visionaries to develop the values for agile methods (Agile Manifesto, 2001). The four values were “(a) customer collaboration over contract negotiation, (b) working software over comprehensive documentation, (c) individuals and interactions over processes and tools, and (d) responding to change over following a plan.” Another way of expressing these values is early customer involvement, iterative development, self organizing teams, and flexibility.

Customer collaboration over contract negotiation. Customers should be included in software development to satisfy their needs rather than supplier selection standards (Beck, 1999). Customers help plan projects, establish needs, perform testing, and quickly evaluate prototypes rather than impose multimillion dollar supplier selection standards over a period of decades.

Working software over comprehensive documentation. Developers should produce bi-weekly releases for customers to see rather than software documentation standards (Beck, 1999). Developers produce designs, unit tests, and the computer programs themselves on a daily basis rather than multimillion dollar suites of software documentation standards over a period of years.

Individuals and interactions over processes and tools. Developers should form small informal teams to rapidly develop software rather than software process standards (Beck, 1999). Developers should be empowered to form small teams of highly talented computer programmers to design and code software rather than use software process standards with thousands of steps.

Responding to change over following a plan. Developers should adapt to change with new designs and software rather than software project management standards (Beck, 1999). Developers should use lightweight processes to rapidly reprioritize customer needs and redesign and recode software rather than unrealistic plans from software project management standards.

Principles of Agile Methods

Customer collaboration over contract negotiation. The three principles associated with early customer involvement are “(a) business people and developers must work together daily throughout the project, (b) our highest priority is to satisfy the customer through early and continuous delivery of valuable software, and (c) welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage” (Agile Manifesto, 2001).

Working software over comprehensive documentation. The three principles associated with iterative development are “(a) working software is the primary measure of progress, (b) at regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly, and (c) deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale” (Agile Manifesto, 2001).

Individuals and interactions over processes and tools. The three principles associated with self organizing teams are “(a) the best architectures, requirements, and designs emerge from self-organizing teams, (b) the most efficient and effective method of conveying information to and within a development team is face-to-face conversation, and (c) build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done” (Agile Manifesto, 2001).

Responding to change over following a plan. The three principles associated with flexibility are “(a) art of maximizing the amount of work not done--is essential, (b) continuous attention to technical excellence and good design enhances agility, and (c) agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely” (Agile Manifesto, 2001).

Examples of Agile Methods

Dynamic systems development method. The dynamic systems development method or DSDM was created in 1994 (Millington & Stapleton, 1995). DSDM emphasized two major values of agile methods (e.g., self organizing teams and flexibility). DSDM consisted of five phases: feasibility report, business study, functional model iteration, design and build iteration, and implementation. DSDM had a focus on business objectives versus quality, product versus process, configuration management, teams, testing, risk assessment, and high level requirements.

Scrum software development process. Scrum, created circa 1995, is one of the first agile methods (Schwaber, 1995). Scrum embraces three major values of agile methods (e.g., iterative development, self organizing teams, and flexibility). As originally designed, Scrum consisted of three major phases: pregame, game, and postgame. Pregame consisted of planning, system architecture, and high level design. Game consisted of development sprints or iterations. And, postgame consisted of closure or project closeout procedures.

Extreme programming. Extreme programming or XP, created circa 1996, is one of the first full featured agile methods (Anderson et al., 1998). XP embraces the four major values of agile methods (e.g., early customer involvement, iterative development, self organizing teams, and flexibility). Originally, XP consisted of 13 practices: planning game, small releases, metaphor, simple design, tests, refactoring, pair programming, continuous integration, collective ownership, onsite customer, 40 hour workweek, open workspace, and just rules (Beck, 1999).

Other agile methods. There are varieties of agile methods: crystal methods, feature driven development, lean development, adaptive software development, and others. A description, classification, taxonomy, and comparison of agile methods is available from multiple sources (Abrahamsson, Salo, Ronkainen, & Warsta, 2002; Highsmith, 2002; Boehm & Turner, 2004).

Studies of Agile Methods

Early customer involvement. A case study of two firms found customers who did not like early customer involvement and its associated transparency (Murru, Deias, & Mugheddu, 2003). In a small experiment, customers hesitated to maintain the level of commitment and resources required for early customer involvement in agile methods (Back, Hirkman, & Milovanov, 2004). In a case study of three projects, customers complained of the excessive time requirements associated with early customer involvement in agile projects (Martin, Biddle, & Noble, 2004).

Iterative development. In an experiment of 20 programming teams, iterative development was as productive as traditional methods, but no more (Macias, Holcombe, & Gheorghe, 2003). Data from a case study of four programmers using iterative development revealed estimates progressively became four times more accurate in six releases (Abrahamsson & Koskela, 2004). An iterative development case study in four projects exhibited productivity levels 200% to 400% greater than traditional methods and large increases in quality (Drobka, Noftz, & Raghu, 2004).

Self organizing teams. One of the earliest experiments of agile methods found that self organizing teams use 60% more resources, but complete their tasks 40% sooner (Nosek, 1998). In an experiment involving 40 programmers, the use of self organizing teams nearly doubled resource requirements, but markedly improved quality, cycle time, and morale (Williams, 1999). In a new experiment of 40 programmers, productivity declines rapidly using self organizing teams, when experience levels with a problem begin to increase (Lui & Chan, 2006).

Flexibility. In a study of 29 Internet projects, flexibility expressed as “greater investments in architectural design” proved to be very significant (MacCormack, Verganti, & Iansiti, 2001). In a study of 43 programmers, processes were not flexible enough (Hazzan & Dubinsky, 2005). Internet firms must use flexible architectures to respond to change (Verganti & Buganza, 2005).

Greenfields of Agile Methods

Technology acceptance. The technology acceptance model was created in the 1980s to explain whether end users will or will not use newly developed computer systems (Davis, 1986). It was based on theory of reasoned action, which posits that actual human behavior is determined by the basic beliefs, attitudes, and intentions about a possible behavior (Fishbein & Ajzen, 1975). The technology acceptance model, though widely used, has never been applied to agile methods.

Web satisfaction. The first scholarly instrument for measuring customer satisfaction with newly developed computer systems appeared in the early 1980s (Ives, Olson, & Baroudi, 1983). However, one of the most scholarly instruments for measuring customer satisfaction with Internet commerce and online shopping appeared in this decade (Torkzadeh & Dhillon, 2002). To-date, scholarly instruments of Internet satisfaction have not been applied to agile methods.

Online trust. Kicking off the Internet age, the first model of trust for Internet commerce, e-commerce, and variants of online shopping appeared at the turn of the century (Gefen, 2000). However, the web trust model is one of the most scholarly instruments for measuring Internet trust and provides a comprehensive history of trust (McKnight, Choudhury, & Kacmar, 2002). Though agile methods are synonymous with e-commerce, no known studies link them to trust.

Firm performance. The balanced scorecard was one of the first models to suggest links between customer satisfaction measurement and firm performance (Kaplan & Norton, 1992). Eventually, studies began to appear linking operational notions of total quality management to financial measures and firm performance (Przasnyski & Tai, 2002). Until recently, however, few studies have attempted to authoritatively link customer satisfaction itself to firm and market performance (Fornell, Mithas, Morgeson, & Krishnan, 2006). Though the stated objectives of agile methods are to achieve customer satisfaction, no studies have ever attempted to do so.

RESEARCH FRAMEWORK

The research framework has been designed to examine the links between the use of agile methods for managing the development of Internet products and customer satisfaction and firm performance. In particular, it is designed to test the nomological network among the dimensions of agile methods, customer satisfaction, and firm performance. This section consists of a conceptual model with nine major constructs: a) early customer involvement, b), iterative development, c) self organizing teams, d) flexibility, e) technology acceptance, f) web satisfaction, g) online trust, h) firm size, and i) firm performance. This section also consists of a description of each of these factors along with a scholarly examination of their antecedents. Finally, this section identifies 16 hypotheses for examining the relationships between the nine major factors or constructs, along with a scholarly examination of the links between these factors. The research framework establishes the context for the research methodology to follow. The conceptual model in Figure 2 shows the possible links between the use of agile methods for managing internet product development, customer satisfaction, and firm performance.

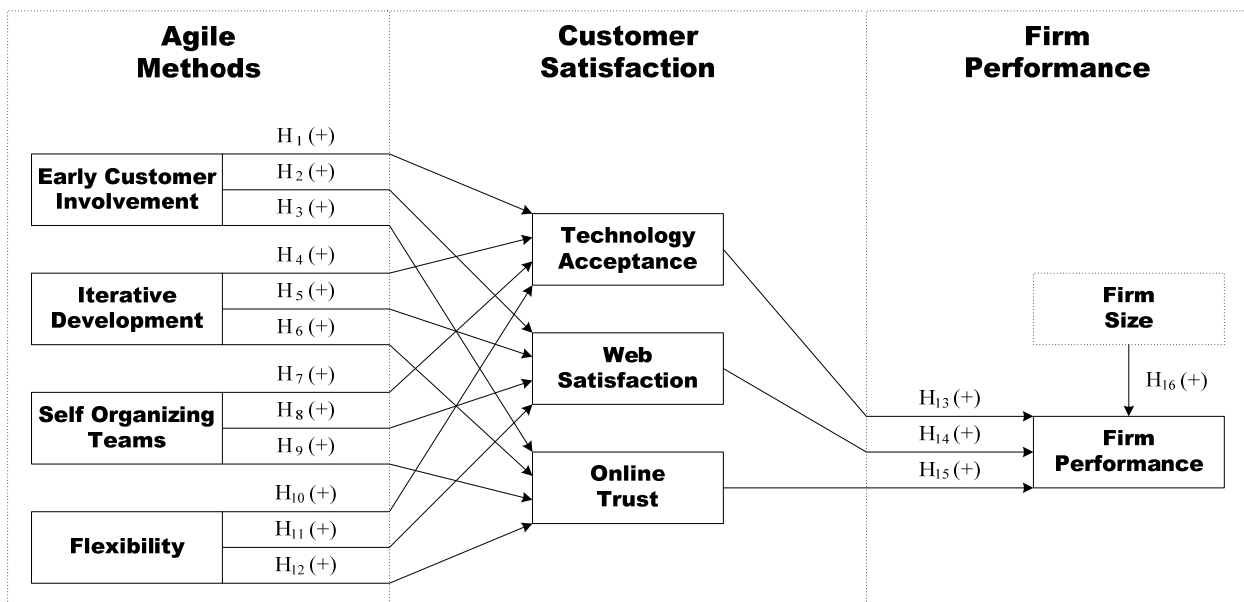


Figure 2. Conceptual model of agile methods.

Factors for Agile Methods

Early customer involvement. The suggested subfactors for early customer involvement will be based upon the information system user participation model (Hunton & Beeler, 1997). The information system user participation model is based upon prior scholarly research and was tested in a survey of 516 end users and validated using the structural equation model approach. It is based upon four subfactors: (a) involvement, (b) attitude, (c) efficacy, and (d) participation. This model was chosen for its scholarly relationship to contemporary information systems.

Iterative development. The suggested subfactors for iterative development will be based upon a model of prototyping, evolutionary, and spiral development (Beck, Jiang, & Klein, 2006). The prototyping, evolutionary and spiral development model was tested in a survey of 286 software professionals and validated using confirmatory factor analysis and analysis of variance. It is based upon three subfactors: (a) iterative approach, (b) learning, and (c) interaction. This model was chosen for its direct applicability to iterative development for information systems.

Self organizing teams. The suggested subfactors for self organizing teams will be based on the task interdependence model for studying high technology teams (Taggar & Haines, 2006). The task interdependence model is based on scholarly research and was tested in a survey of 267 team members and validated using structural equation modeling. It is based upon five subfactors: (a) collectivism, (b) past performance, (c) interdependence, (d) belief, and (e) efficacy.

Flexibility. The suggested subfactors for flexibility will be based upon the product development flexibility model for global marketplace products (Singh & Sushil, 2004). The product development flexibility model is rooted in scholarly research in flexibility and was tested in a survey of 162 development projects and validated using linear regression. It is based upon four subfactors: (a) technology, (b) architecture, (c) supplier, and (d) process flexibility.

Factors for Customer Satisfaction

Technology acceptance. The suggested subfactors for technology acceptance will be based upon the model of technology user acceptance for e-shopping on the web (Shih, 2004). The technology user acceptance model is based upon the technology acceptance model and theory of reasoned action and tested in a survey of 212 Internet shoppers using linear regression. It is based upon three categories of subfactors: (a) perceptions, (b) attitude, and (c) intentions. The technology acceptance model is an adaptation of the theory of reasoned action.

Web satisfaction. The suggested subfactors for web satisfaction will be based on a model for measurement of e-commerce success among Internet shoppers (Torkzadeh & Dhillon, 2002). The e-commerce success model is based upon the value focused thinking model and was tested in multiple surveys of 620 Internet shoppers and validated using confirmatory factor analysis. It is based upon two broad categories of subfactors: (a) means and (b) fundamental objectives.

Online trust. The suggested subfactors for online trust will be based upon the model of web trust for e-commerce among Internet shoppers (McKnight, Choudhury, & Kacmar, 2002). The web trust model is based upon 32 scholarly models of trust and was tested in a survey of 1,420 Internet shoppers and it was validated using confirmatory factor and nomological analysis. It is based upon four subfactors: (a) disposition, (b) institution, (c) beliefs, and (c) intentions.

Factors for Firm Performance

Firm performance. The suggested subfactors for firm performance will be based on a mapping of satisfied customers to market value (Fornell, Mithas, Morgeson, & Krishnan, 2006). The customer satisfaction model is based upon the American Customer Satisfaction Index and a correlation of 20 firms to Dow Jones Industrial Index, NASDAQ, and S&P 500 performance. It is based upon three subfactors: (a) satisfaction, (b) total assets, and (c) total liabilities.

Hypotheses for Agile Methods

Early customer involvement. A study of 105 information system users found correlations between early customer involvement and technology acceptance (Hartwick & Barki, 1994).

Another study of 172 information systems managers showed relationships between early customer involvement and success factors related to customer satisfaction (Lu & Wang, 1997).

Another study of 505 end users found relationships between early customer involvement and factors of customer satisfaction (Bili, Raymond, & Rivard, 1998).

H₁: Early customer involvement is linked to technology acceptance.

H₂: Early customer involvement is linked to web satisfaction.

H₃: Early customer involvement is linked to online trust.

Iterative development. A very early study of 61 information system professionals found strong correlations between iterative development and customer satisfaction (Mahmood, 1987).

A scholarly analysis of 34 case studies revealed consistently reported relationships between the use of iterative development in software and customer satisfaction (Gordon & Bieman, 1993).

And, an impressive study of 133 information system managers exhibited correlations between iterative development and customer satisfaction as well (Hardgrave, Wilson, & Eastman, 1999).

H₄: Iterative development is linked to technology acceptance.

H₅: Iterative development is linked to web satisfaction.

H₆: Iterative development is linked to online trust.

Self organizing teams. A recent study of 62 respondents exhibits very high correlations between the use of self organizing teams and customer satisfaction (Power & Waddell, 2004). A

recent study of 452 respondents shows similar relationships (Mathieu, Gilson, & Ruddy, 2006).

Another study of 326 respondents showed the same (Kirkman, Rosen, Tesluk, & Gibson, 2006).

H₇: Self organizing teams are linked to technology acceptance.

H₈: Self organizing teams are linked to web satisfaction.

H₉: Self organizing teams are linked to online trust.

Flexibility. In a study involving 529 respondents, flexibility in buyer-seller relationships was correlated to customer satisfaction (Homburg, Krohmer, Cannon, & Kiedaisch, 2002). From a study of 71 respondents, flexibility in engineering consulting service firms showed correlations to customer satisfaction (Aranda, 2003). Finally, from a study of 232 respondents, flexibility in service relationships was correlated to customer satisfaction (Ivens, 2005).

H_{10} : Flexibility is linked to technology acceptance.

H_{11} : Flexibility is linked to web satisfaction.

H_{12} : Flexibility is linked to online trust.

Hypotheses for Customer Satisfaction

Customer satisfaction. In a seven year study of firm performance from 1990 to 1997, customer satisfaction appeared to be a nearly perfect predictor of stock price (Hoisington, 1998). Customer satisfaction, revenues, profits, and market performance were related using firm and business unit data from telecommunications and financial service firms (Ittner & Larcker, 1998). In a study of financial data from 80 firms from 1996 to 2003, data from the American Customer Satisfaction Index was correlated to stock prices (Fornell, Mithas, Morgeson, & Krishnan, 2006).

H_{13} : Technology acceptance is linked to firm performance.

H_{14} : Web satisfaction is linked to firm performance.

H_{15} : Online trust is linked to firm performance.

Hypotheses for Firm Performance

Firm performance. A study of 260 firms linked firm size among Internet firms to improved firm performance (Zhu and Kraemer, 2002). In a study of 114 firms, size among information technology firms was correlated to performance (Zhu, 2004). In another study of 181 firms, size was related to firm performance as well (Yang, Yang, & Wu, 2005).

H_{16} : Firm size is linked to firm performance.

RESEARCH METHODOLOGY

A survey is recommended for examining the links between the use of agile methods for managing the development of Internet products and customer satisfaction and firm performance. Survey research is recommended because of the short timeframe available for this study, and because it will allow the collection of a large quantity of data from which to draw inferences. Johnson (2002), Maurer and Martel (2002), and Succi, Pedrycz, Marchesi, and Williams (2002) have already demonstrated the feasibility of conducting large scale survey research in the domain of agile methods. A sample size of 400 information system managers will be sought for this study, in order to administer a measurement instrument with 32 items. The first 28 items will consist of a seven point Likert scale: (a) strongly agree, (b) agree, (c) somewhat agree, (d) neutral, (e) somewhat disagree, (f) disagree, and (g) strongly disagree. The sample may be drawn from one of the previous studies or a new one will be used.

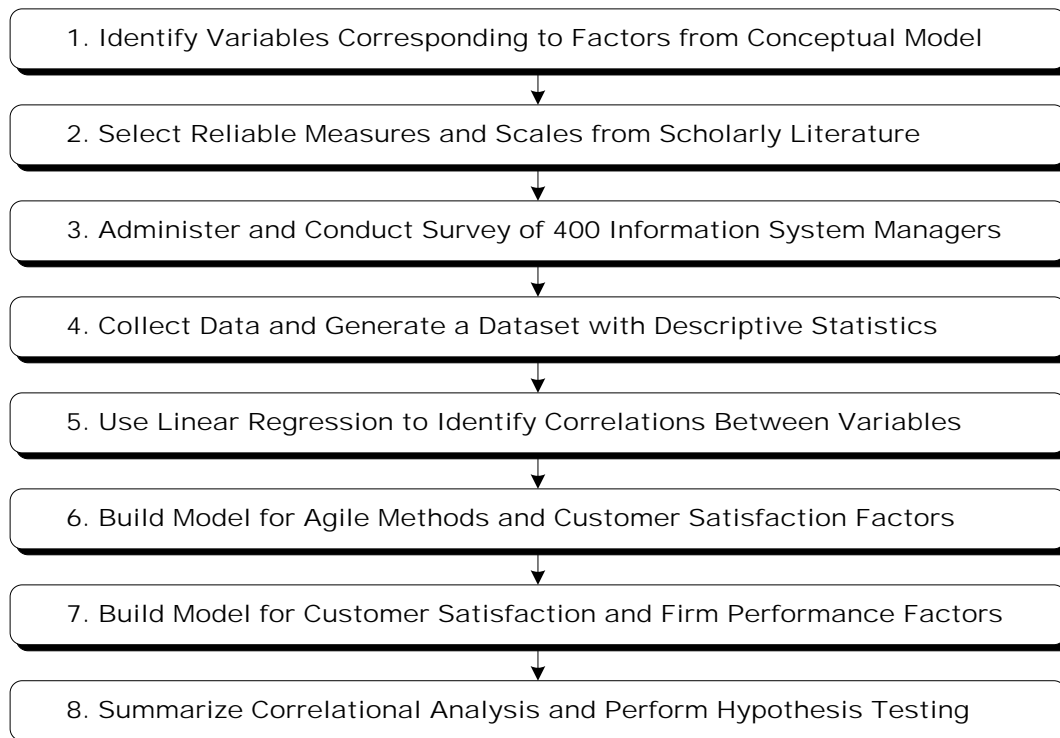


Figure 3. Research methodology for agile methods.

Variables for Agile Methods

There are five variables for early customer involvement corresponding to an instrument item in the next section based on Hunton and Beeler (1997): system importance (sysimp), system attitude (sysatt), system contribution potential (syspot), system contribution desired (sysdes), and system contribution realized (sysrea). There are three variables for iterative development based on Beck, Jiang, and Klein (2006): iterative used (iteruse), iterative information (iterinf), and iterative involvement (iterinv). There are five variables for self organizing teams based on Taggar and Haines (2006): team aversion (teamave), team rating (teamrat), team dependence (teamdep), team contribution (teamcon), and team effectiveness (teameff). There are four variables for flexibility based on Singh and Sushil (2004): flexible technologies (flextec), flexible products (flexpro), flexible contracts (flexcon), and flexible processes (flexpro).

Variables for Customer Satisfaction

There are three variables for technology acceptance corresponding to an instrument item in the next section based on Shih (2004): technology ease of use (techeas), technology like (techlik), and technology willing (techwil). There are four variables for web satisfaction based on Torkzadeh and Dhillon (2002): web value (webval), web errors (weberr), web convenience (webcon), and web service (webser). There are four variables for online trust based on McKnight, Choudhury, and Kacmar (2002): online disposition (ondis), online institution (onins), online belief (onbel), and online intention (onint).

Variables for Firm Performance

There are four variables for firm performance corresponding to an instrument item in the next section based on Fornell, Mithas, Morgeson, and Krishnan (2006): firm name (firmnam), firm revenue (firmrev), firm size (firmsiz), and firm industry (firmind).

Measures for Agile Methods

Early customer involvement. The measures for early customer involvement will be based upon the information system user participation model (Hunton & Beeler, 1997). All of the questions will be used, because there is only one question for each subfactor.

- I₁*: To what extent did you believe the new system was important?
- I₂*: To what extent would you describe your attitude toward the new system?
- I₃*: To what extent could you have contributed to the development of the new system?
- I₄*: To what extent did you want to contribute to the development of the new system?
- I₅*: To what extent did you actually contribute to the development of the new system?

Iterative development. The measures for iterative development will be based upon a model of prototyping, evolutionary, and spiral development (Beck, Jiang, & Klein, 2006). The questions for each of the three factors were combined into one.

- I₆*: To what extent were prototypes, spirals, or iterations used to develop new systems?
- I₇*: To what extent were customer mission, business, and technical needs obtained?
- I₈*: To what extent were training, communication, and interactions provided to end users?

Self organizing teams. The measures for self organizing teams will be based on the task interdependence model for studying high technology teams (Taggar & Haines, 2006). The questions for each of the five factors were combined into one.

- I₉*: To what extent did you prefer to work alone on the new system?
- I₁₀*: To what extent did your team supervisor rate your performance on the new system?
- I₁₁*: To what extent did your colleagues depend on you to develop the new system?
- I₁₂*: To what extent did you believe teamwork contributed to the new system?
- I₁₃*: To what extent were you effective as part of the team developing the new system?

Flexibility. The measures for flexibility will be based upon the product development flexibility model for firms with global marketplace products (Singh & Sushil, 2004). All of the questions will be used, because there is only one question for each subfactor.

- I₁₄*: To what extent were flexible technologies used to develop new system?
- I₁₅*: To what extent were flexible product designs used to develop the new system?
- I₁₆*: To what extent were flexible contracts used to develop the new system?
- I₁₇*: To what extent were flexible processes used to develop the new system?

Measures for Customer Satisfaction

Technology acceptance. The measures for technology acceptance will be based upon the model of technology user acceptance for e-shopping on the web (Shih, 2004). The questions for each of the three factors were combined into one.

I₁₈: To what extent did you feel the new system was easy to access, use, and get value?

I₁₉: To what extent did you like to use the new system to perform its functions?

I₂₀: To what extent were you willing to use the new system to perform its functions?

Web satisfaction. The measures for web satisfaction will be based on a model for measurement of e-commerce success among Internet shoppers (Torkzadeh & Dhillon, 2002).

The most statistically significant questions from four of the nine subcategories were selected.

I₂₁: To what extent did the system provide a lot of valuable products and services?

I₂₂: To what extent did the system minimize errors receiving products and services?

I₂₃: To what extent did the system make getting products and services convenient?

I₂₄: To what extent did the system make getting customer service available?

Online trust. The measures for online trust will be based upon the model of web trust for e-commerce among Internet shoppers (McKnight, Choudhury, & Kacmar, 2002). The questions for each of the four factors were combined into one.

I₂₅: To what extent did you believe developers were caring, reliable, and competent?

I₂₆: To what extent did you feel good about using the new system to do its functions?

I₂₇: To what extent did you believe developers were willing and able to rectify problems?

I₂₈: To what extent did you want to use the new system to perform important functions?

Measures for Firm Performance

Firm performance. The measures for firm performance will be based on a model to map customer satisfaction to firm performance (Fornell, Mithas, Morgeson, & Krishnan, 2006). All of the questions will be used, because there is only one question for each subfactor.

I₂₉: What is the name of the firm or business unit to which the new system belongs?

I₃₀: What are the revenues of the firm or business unit to which the new system belongs?

I₃₁: How many people are in the firm or business unit to which the new system belongs?

I₃₂: What is the industry of the firm or business unit to which the new system belongs?

Analysis Plan for Agile Methods

Generate dataset. The first step is to generate a usable data set from the survey of 400 managers. There is likely to be around a 10% to 15% rate of response. Therefore, we can expect 40 to 50 responses to the 32 survey questions. Not all of the respondents will fill out all 32 questions. Therefore, we will generate a dataset from usable responses and code the responses.

Analysis of agile methods and customer satisfaction. The second step will be to conduct a correlational analysis between agile methods and customer satisfaction. A total of 340 individual databases will be constructed. These will support correlational analyses corresponding to the product of variables for agile methods and customer satisfaction.

Analysis of customer satisfaction and firm performance. The third step will be to conduct a correlational analysis between customer satisfaction and firm performance. A total of 44 individual databases will be constructed. These will support correlational analyses corresponding to the product of variables for customer satisfaction and firm performance.

Model of agile methods and customer satisfaction. The fourth step will be to build a model of agile methods to customer satisfaction factors. A total of 12 individual databases will be constructed in order to analyze the individual models.

Model of customer satisfaction and firm performance. The fifth step will be to build a model of customer satisfaction to firm performance factors. A total of three individual databases will be constructed in order to analyze the individual models.

Hypothesis testing. The sixth and final step will be to transpose the β values onto the conceptual model. An initial scan of the β and R^2 values will reveal significant correlations to justify any of the 16 hypotheses. A summary table of the hypothesis tests will also be produced with cross reference of factors, hypotheses, adjusted R^2 values, β s, t -values, and p -values.

Interpretation of Agile Methods

The information from the correlational analysis will be used to construct a summary table as shown in Table 1 and test each of the 16 hypotheses. The results of these tests cannot be known in advance. It is not the intention of the study to advocate the use of agile methods for managing the development of Internet products. And, this study does not assume that early customer involvement, iterative development, self organizing teams, and flexibility are related to customer satisfaction and firm performance. Instead, it is the intention of this study to determine whether these relationships do in fact exist. These results will be relevant, important, significant, and interesting regardless of whether the outcome or conceptual model are valid.

Table 1
Research Results for Agile Methods

Factors		Hypotheses	β	<i>t-value</i>	<i>p</i>
Early customer involvement	H ₁	Early customer involvement → technology acceptance	+/-	+/-	<i>p</i> < 0.05
	H ₂	Early customer involvement → web satisfaction	+/-	+/-	<i>p</i> < 0.05
	H ₃	Early customer involvement → online trust	+/-	+/-	<i>p</i> < 0.05
Iterative development	H ₄	Iterative development → technology acceptance	+/-	+/-	<i>p</i> < 0.05
	H ₅	Iterative development → web satisfaction	+/-	+/-	<i>p</i> < 0.05
	H ₆	Iterative development → online trust	+/-	+/-	<i>p</i> < 0.05
Self organizing teams	H ₇	Self organizing teams → technology acceptance	+/-	+/-	<i>p</i> < 0.05
	H ₈	Self organizing teams → web satisfaction	+/-	+/-	<i>p</i> < 0.05
	H ₉	Self organizing teams → online trust	+/-	+/-	<i>p</i> < 0.05
Flexibility	H ₁₀	Flexibility → technology acceptance	+/-	+/-	<i>p</i> < 0.05
	H ₁₁	Flexibility → web satisfaction	+/-	+/-	<i>p</i> < 0.05
	H ₁₂	Flexibility → online trust	+/-	+/-	<i>p</i> < 0.05
Technology acceptance	H ₁₃	Technology acceptance → firm performance	+/-	+/-	<i>p</i> < 0.05
Web satisfaction	H ₁₄	Web satisfaction → firm performance	+/-	+/-	<i>p</i> < 0.05
Online trust	H ₁₅	Online trust → firm performance	+/-	+/-	<i>p</i> < 0.05
Firm size	H ₁₆	Firm size → firm performance	+/-	+/-	<i>p</i> < 0.05

PLAN OF WORK AND DELIVERABLES

The research timeline for examining the links between the use of agile methods for managing the development of Internet products and customer satisfaction and firm performance is shown in Figure 4. Three major groups of activities over a one year period are proposed: candidate prepares proposal (e.g., Fall 2006), candidate prepares concept paper (e.g., Spring 2007), and candidate prepares dissertation (e.g., Summer and Fall 2007). The first period (e.g., candidate prepares proposal) will be used to explore the design of a draft dissertation proposal with a committee. The second period (e.g., candidate prepares concept paper) will be used to prepare a robust multidisciplinary management oriented research design. The third period (e.g., candidate prepares dissertation) will be used to administer the proposed survey to the sample of 400 managers and organize the draft dissertation. The fourth period (e.g., not depicted) will be used to defend the dissertation and organize the final dissertation.

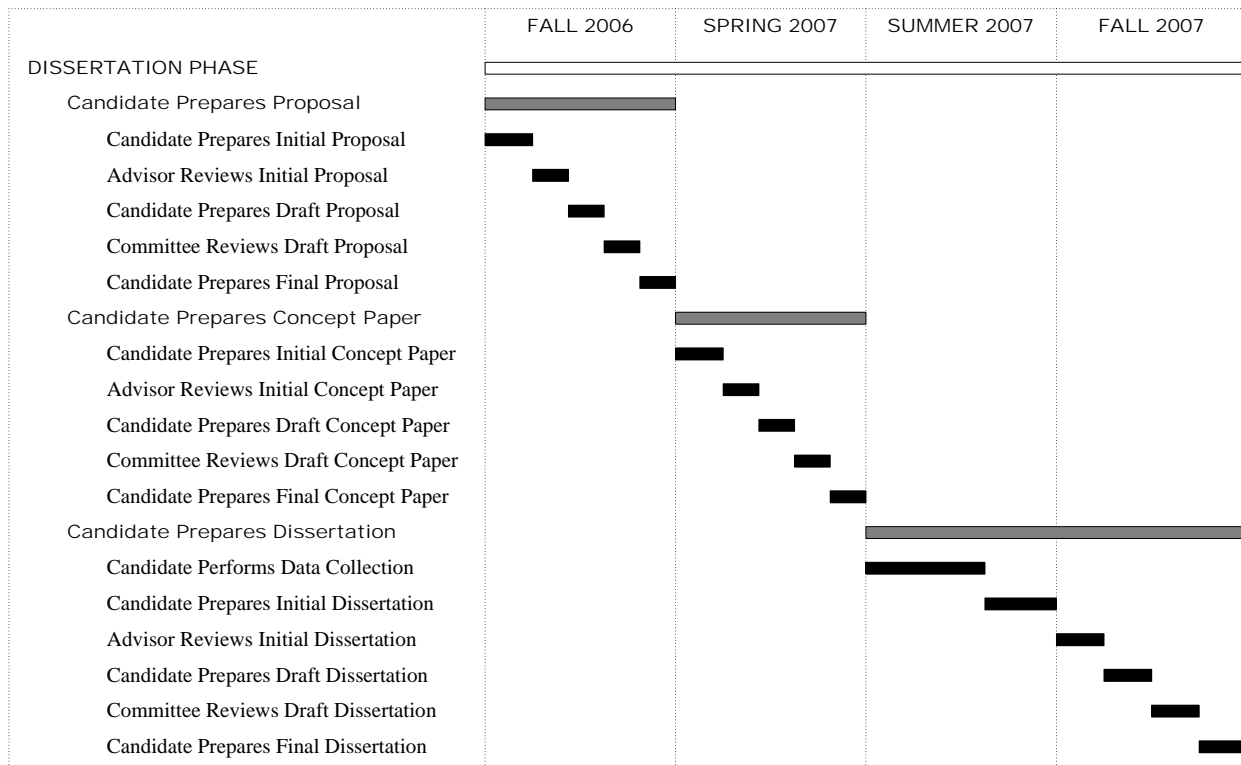


Figure 4. Research timeline for study of agile methods.

SUMMARY AND CONTRIBUTIONS TO THE FIELD

Erdogmus and Favaro (2003) imply that the use of agile methods is associated with greater business value using real options. Erdogmus and Williams (2003) link the use of agile methods to significant increases in productivity. Favaro (2003) indicates the use of agile methods is linked to improved economic value added (EVA), which is a contemporary measure of firm performance. Both Maurer and Martel (2002) and Muller and Padberg (2002) link the use of agile methods to significantly higher programming productivity. Cusumano and Selby (1995) and Cusumano and Yoffie (1998) linked Microsoft's and Netscape's use of agile methods to their stellar firm performance. And, MacCormack (1998) linked the use of agile methods for developing Internet products to increases in product performance, usability, and reliability. These studies indicate agile methods may help alleviate the high U.S. project failure rates and contribute to business value with respect to public and private investments in technology.

Similar, but not identical, studies have empirically examined the use of agile methods for developing Internet products. These studies have implied or even shown limited and indirect linkages between the use of agile methods and primitive constructs of Internet product quality, reliability, and robustness. Some have even gone as far as to link the use of agile methods to basic notions of customer satisfaction and firm performance. In doing so, these studies have demonstrated some empirical evidence of the reliability and validity of these hypothesized inferences and knowledge claims. These studies may reduce the risks associated with attempting to link the use of agile methods to customer satisfaction and firm performance. The uniqueness of this study is a holistic focus on all of the major tenets of agile methods. This study proposes to link the use of agile methods to scholarly models of customer satisfaction and firm performance. Thus, this may be one of the first holistic studies of agile methods.

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