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Critical Success Factors for Agile Project Management in Non-Software Related Product Development Teams

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CRITICAL SUCCESS FACTORS FOR AGILE PROJECT MANAGEMENT IN NON-SOFTWARE RELATED PRODUCT DEVELOPMENT TEAMS

by

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The use of agile project management methods in the software development industry is well established and researched. The purpose of this study is to understand whether agile project management methods (Scrum in particular) used successfully in the software industry are also being used in full, or in part, in non-software development industries when managing product development projects.

Using an online survey instrument, data was collected from 329 non-software/IT global practitioners to identify in what industries and work functions agile project management methods are used, to find the independent variables that have a significant relationship with project success, and to determine the reasons why agile project management methods may not be used in non-software development industries. Project success was defined by 11 separate dependent variables. Of the respondents, 238 (72%) used agile project management methods to some degree, and of those, 150 (63%) used the Scrum Framework.

Results from this survey show that agile project management is used in industries other than software development, mainly in manufacturing, training and consulting, research and development, and education. Four independent variables that showed significance with project success included: (1) the commitment by management with a clear vision, (2) holding daily stand-up meetings, (3) keeping task sizes small, and (4) using visual management. The main

reason for not using agile project management is insufficient time to change from current methods. These findings suggest that agile project management methods are being used in industries outside of software development. Further, a small number of significant independent variables can be used to predict multiple dependent variables of project success.

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CHAPTER 1

INTRODUCTION

As a result of increased project complexity, increased stakeholder power, large capital investment, and other dynamic factors, the conventional approach to project management may require a change in strategy to achieve project success (Raheem, Olawale, & Olawale, 2012). Traditional project management processes such as the linear stage-gate process lack support for the iterative cycles and external collaboration often required in the current project environment. Hybrid processes combining elements of agile and stage-gate models offer a more flexible alternative to conventional systems (Sommer, Hedegaare, Dukovska-Popovska, & Steger-Jensen, 2015). These dynamics are increasing the importance of product innovation signaling organizations to redefine the methods behind their innovation strategy and project management processes.

Background

Traditionally, project success has been measured with three relatively simple categories. Tatikonda and Rosenthal (2000) defined these categories as product performance, unit-cost, and time-to-market, while others simplified the terms further by referring to the golden triangle of quality, cost, and timing (Drury-Grogan, 2014; Westerveld, 2003).

Such traditional project management methods often encompass the movement of a project through a structured series of stages, followed by a gate where a decision is made to stop or continue to the next stage. This process, called stage-gate, maps out in detail what needs to be completed and how (Cooper, 2008). Typical phases in Cooper's (2008) stage-gate model included defining the project scope, developing the solution, testing, and launching. While this model can be successful for seasoned project teams with a predictable development pathway, the up-front planning and structured sequences of traditional project management methods have the potential to result in teams completing projects that miss the mark due to goals and requirements that changed somewhere along the development process. Traditional front-end methods encourage thorough planning activities with structured processes that allow development to take place in an efficient and predictable manner (Boehm, 2002). However, the lack of an efficient method of managing the need for project flexibility, excessive rework, customer dissatisfaction, and changing technological needs can result in project failure (Serrador & Pinto, 2015). In addition, defining project requirements can be so intensive and time consuming that technological needs change before the project gets under way (Cervone, 2011).

Serrador and Pinto (2015) explained that downstream problems, often caused by traditional front-end planning methods, have been countered in recent years by the use of agile project management methodologies. They discussed how issues such as a changing work scope, early part design freeze, infrequent customer interaction, and a rigid development process can result in excessive rework and a dissatisfied customer due to missing the moving target. Collyer, Warren, Hemsley, and Stevens (2010) agreed by noting that there are issues with not adjusting to what was being learned about the changing business environment. When changes take place, a complex project plan will likely need to be revised. Dyba and Dingsoyr (2008) suggested that less initial planning would be more efficient by allowing for a more evolutionary process. In this case, reacting and planning would take place throughout the project.

With project timing being part of the golden triangle, late or incomplete projects can result in a variety of consequences such as lost sales, increased development costs, and dissatisfied customers. By understanding what barriers lead to delays, process changes could give firms the ability to address identified problem areas with solutions, and to facilitate an environment that allows employees to contribute to improved productivity and performance. Although project management teams have long used a variety of techniques to reduce finished product lead times, Takeuchi and Nonaka (1986) applied the rugby term "Scrum" to the practice of moving from the sequential approach for project management to a more holistic one. With this approach, instead of a product development team passing a project from one person to the next until completion, a Scrum team, just as in rugby, works together to pass the ball between team members as they move their way up the field. Cervone (2011) explained that the purpose of a Scrum in rugby is to have a way to restart the game after an interruption has taken place.

According to Takeuchi and Nonaka (1986), Scrum teams are more effective and efficient because they are self-organized with overlapping project phases, they learn together as well as transfer learning to the organization, and they receive limited management direction while maintaining subtle control of the project. This method was discussed by Moe et al. (2010) as a new approach for managing projects by providing decision-making authority to the Scrum team members who will be experiencing problems and uncertainties. They further stated that this transition to self-managing teams requires a reorientation by team members as well as by management. Indeed, a decade after Takeuchi and Nonaka introduced the concept of Scrum in the workplace, the first agile project management activities gained traction after being introduced by Sutherland and Schwaber at the 1995 OOPSLA conference (Cervone, 2011).

Project success can also be altered by a number of other situational dynamics. A weak project team structure, unclear goals, a lack of team expertise, and a lack of senior management involvement are just a few factors that can contribute to a lack of performance (Drury-Grogan, 2014). The software development industry has used agile methodologies to counter problems such as project uncertainty, frequent changes, high costs, and low productivity (Mishra &

Mishra, 2011). As teams continued to develop ways of efficiently working together, the term "agile" became a common way to describe project activity. According to Conforto, Salum, Amaral, da Silva, and de Almeida (2014), agile project management is a method used to simplify project execution by instilling flexibility and enabling iterative cycles as ways to improve project quality, timing, and cost. Conforto, Amaral, da Silva, Di Felippo, and Kamikawachi (2016) describe "agility" as the way a project team reacts quickly to changes in customer and stakeholder needs in order to achieve a better product for the market. The authors made a clear distinction of agility describing the team's performance, not simply an adjective that describes a method used to manage the project. They explained that internal and external factors such as management practices and techniques contribute to whether a team is agile, rather than the practices and techniques themselves being described as agile.

According to Sheffield and Lemétayer (2013), important factors for project success in an agile environment include both performance management and a social context. Setting up employees for success requires a defined project management protocol, as well as relevant leadership techniques. The social context relates to team dynamics and interactions with stakeholders and other contributors, while the significance of the performance portion relates to the methods in which projects are managed. Moe et al. (2010) suggested that individuals cannot simply be placed in a self-managing situation with the expectation that they will automatically function as an agile team. Project procedures and methodologies can have a big impact on how employees function and manage their daily activities. If associates are not productive in a way that contributes to the success of an organization, process changes may be required.

Agile project management methods first emerged as an alternative to traditional methodologies as a new way for engineering software, fueling their popularity in the software development industry (Chow & Cao, 2008). Agile methodologies allow teams to continually plan their work as they go, allowing them to react quickly to changes in product needs. And, instead of delivering one large project at the end of the time cycle, agile teams are able to provide early delivery of products with frequent iterative improvements.

Advantages of agile project management include: lower costs, better productivity, better quality and better business satisfaction (Mishra & Mishra, 2011). Others also encourage tactical vs. strategic decisions, less structure and more improvisational focus, and a reduction in downstream product and planning changes (Drury, Conboy, & Power, 2012; Leybourne, 2009; Serrador & Pinto, 2015). Chakravorty, Chakraborty, and Jigeesh (2014) summarized the benefits by stating that the attributes of agile project management include prioritization of features according to customer requirements, early customer involvement, incremental and iterative sprints, and flexible development environments with less documentation and complexity management.

One change that is offered by agile project management techniques is to break a large seemingly unbearable task into small do-able tasks, allowing the team to gain success in an additive nature. Misra, Kumar, and Kumar (2009) suggested that scaling-down requirements and breaking them into smaller tasks is important for team success. When faced with a large, complex project, it can seem overwhelming when imagining how the assignment as a whole will be completed. However, large projects can most likely be divided into smaller pieces, permitting the practitioner to complete the work one step at a time. Splitting work into small, easily managed packages allows teams to focus, reduce confusion, and provides a sense of having control of their work (Karlström & Runeson, 2005). By breaking a project into small work packets and then prioritizing these items, software development teams are able to release programs that include minimally working solutions with a satisfactory level of high functioning characteristics for their customers. These solutions are called minimum viable products, where resources are used efficiently to quickly introduce a product into the marketplace in order to collect feedback and determine growth projections (Moogk, 2012). The software team then identifies the next set of priority tasks until they have enough code to complete and release another level of the software. The team continues to iterate their way through work packets until the scope of the project has been met. Software teams have found this method to be successful in reducing the overall development time thus allowing the generation of income at an earlier date (Chakravorty et al., 2014).

Utilizing agile methods to develop and implement systems has improved the speed in which companies meet market demands (Chakravorty et al., 2014). Given the relative newness of the agile project management approach, some research exists, but much more is needed to understand how the backbone components of agile project management can be used in a non-software product development process.

Problem Statement

Traditional project management methods, commonly described as "waterfall," are often used when processes are well structured, have systematic milestones, and follow a linear development approach (Conforto & Amaral, 2016). In this case, a team can work through the project in an orderly manner with a focus on completing the project as a single, large-scale task. When a team is faced with a large work scope, the completion of work on-time, within budget and at acceptable quality standards can be difficult. According to Conforto and Amaral (2010), innovative and complex products require new tools and methods in order to fulfill the need for flexibility and increased flow of information. Gill (2014) explained that when project requirements are well-established and consistent, traditional software development tools can be used. Serrador and Pinto (2015) also noted that there are certain circumstances when traditional up-front planning is preferred, such as the case for safety factors and large projects with known futures, but when projects are turbulent and have a high-change environment, agile methods are best suited. This same notion can be applied to any project, whether it is in technology, or other fields. When frequent change in product requirements takes place, there is a need for a more adaptive and flexible approach.

Although there is an increasing amount of literature available on the topic of agile project management, the majority of research has been conducted in the software development field (e.g., Chow & Cao, 2008; Gill, 2014; Drury et al., 2012; Hoda, Noble, & Marshall, 2013; Laanti, Salo, & Abrahamsson, 2011; Lei, Ganjeizadeh, Jayachandran, & Ozcan, 2015; Mishra & Mishra, 2011; Misra et al., 2009; Misra, Kumar, & Kumar, 2010; Moe et al., 2010; Persson, Mathiassen, & Aaen, 2011; Pikkarainen, Salo, Kuusela, & Abrahamsson, 2012; Sheffield & Lemétayer, 2013; Stankovic, Nikolic, Djordjevic, & Cao, 2013). While agile techniques are relevant for software development, collecting more data may help determine if many of the tools and processes might also be used in non-software product development industries.

However, the requirements of some non-IT projects do not fit naturally within the typical agile project management methodology. Stare (2014) suggested that the expense of frequent changes, the lack of feasibility for partial deliveries, and the dilution of team members into multiple projects are reasons agile project management has not grown in popularity for non-IT projects. For example, a firm may need to fabricate expensive tooling in order to manufacture a product. The tooling must be completed in its entirety in order to produce a part and any change to the tooling is likely to require significant expense. Frequent, iterative product releases are not possible in this case. Further, the team working on this tooling project may also be working on several other tooling projects; therefore, reducing their ability to focus effort on a single tool for any length of time.

These factors do not align well with agile project management methods. For agile projects, the desire is to identify a subset of the project requirements that can be released as a minimally working solution. The concept of partial deliveries is equated with minimum viable products, where a product is complete enough to determine whether it brings the desired value to end users (Moogk, 2012). However, Stare (2014) noted that partial products in non-IT capacities may not be marketable. With this in mind, it is of interest to learn whether firms are finding ways to utilize agile project management processes in non-IT applications.

Indeed, it is unclear as to what the most significant variables are, if any, that lead to project success in non-software product development industries while using agile project management methods. Of particular interest are the variables utilized by Scrum teams, such as breaking projects into small tasks, communicating frequently with stakeholders, using iterative development cycles, and embracing change. As mentioned above, Scrum methods are not always suitable for use in all phases of product development. The problem being addressed in this study was the lack of information to determine whether agile project management methods and the Scrum Framework might offer value in some or all aspects of the product development cycle that in turn contribute to the cost control, timing, and quality of the project outcome.

Purpose Statement and Research Questions

The purpose of this research study was to understand whether agile project management methods (Scrum in particular) used successfully in the software industry are also being used in full, or in part, in non-software development industries when managing product development projects. Where these methods were used, I sought to understand the critical success factors that significantly contributed to project success as perceived by agile practitioners. For the purposes of this research study, critical success factors are defined as organizational, human resource, and technical variables that make a positive contribution to project success. Project success will be defined as meeting the project scope within the time allotted, under the budget provided, and at an acceptable level of quality. My specific research questions were as follows:

RQ1: To what extent, and how, are companies using agile project management methods to develop products other than software?

RQ2: To what extent do organizational, human resource, and technical factors predict the perceived level of success when using agile project management methods?

RQ3: If companies are not using agile project management, why not?

Conceptual Framework and Narrative

The overall premise of my research study was to provide insight on how a well-established and successful project management technique used in the software development industry might be applied to non-software related product development industries. This section summarizes the core aspects of agile project management as a result of previous research, and how they conceptually apply to key elements examined in my study.

Conforto et al. (2014) offered ideas surrounding these topics based on two key elements: practices and enablers, where practices are the tools, actions, and techniques used to carry out agile project management methods, and enablers are the internal and external factors that are necessary to allow the agile management methods to be utilized within the organization. Conforto et al. provided examples of factors using iterative planning and frequent plan monitoring and process updating, while examples of enablers were the organizational structure and culture, and a collaborative work environment. The framework indicates that the application of an agile management approach is linked to the use of practices, tools, and techniques based on agile project management theory; however, its use will depend on the existing enablers that provide for favorable conditions for the proper application of agile practices.

There may be several factors that contribute to a successful project as it relates to quality, scope, cost, and timing. Chow and Cao (2008) conducted a survey to analyze 12 possible critical success factors for each success category and by using multiple regression techniques found only six to be significantly related. Their study reduced the multitude of factors down to three critical ones that included the selection of a high caliber team, the practice of rigorous agile software engineering techniques, and an agile-style project delivery strategy. In an attempt to duplicate the result of the study from Chow and Cao, Stankovic et al. (2013) conducted their own survey of Yugoslavian companies to determine critical success factors that influence project success of agile software projects. Although their study confirmed that strong executive support, organizational environment and agile appropriate project types were not significant for project success, their study did not duplicate support for any of the success factors. Instead, Stankovic et al. found that the project definition process, the nature of the project, and the project schedule were significant factors. Misra et al. (2009) analyzed 14 hypothesized factors with the potential of having a positive relationship with project success and found nine to be significant. They were: customer satisfaction, customer collaboration, customer commitment, decision time, corporate culture, personal characteristics, societal culture, and training and learning. This misalignment of survey results is an indication that further work in this area was warranted. Stankovic et al. recommend that future work should try to formulate different success factors in determining positive association with project success.

Although these studies did not find consistent and complimentary results, I utilized information from these studies as a basis for developing my survey instrument. I also used practical information obtained from presentations and conversations during a week of agile training for Scrum in all domains. These courses were developed to gather practitioners from around the world to learn and teach how Scrum is used in non-software related industries. The training clearly listed factors such as having small dedicated teams, having T-shaped people (meaning people that can do more than one job), having a ready backlog of projects, and other items as important for obtaining successful project results. Information from the literature along with practical information from training participants was used to develop the questions on my survey instrument.

The concept of iterative development processes is important to the framework of agile project management. Cooper (2014) described these iterations as spiral development, where each spiral consists of building a working version of the product, testing and gathering feedback, and then revising the design concept and starting again. In their book, *Balancing Agility and Discipline* (2003), Boehm and Turner acknowledged that some projects will need both agility and discipline to be completed within tight schedules and budgets. Cooper suggested that this blend can be achieved by embedding the agile development methodology inside a stage-gate model.

In the book *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* (2013), the Project Management Institute (PMI) explains that program management is accomplished by completing 47 project management processes grouped into five major groups. These five groups are initiating, planning, executing, monitoring and controlling, and closing. Other authors utilize different naming schemes to describe the various groups. Cooper (2014) used the stages of idea scoping, building the business case, development, testing and validation, and launch as the system for his model. Other models include a design and prototype stage followed by a production tooling stage.

In response to the deficiencies of the theoretical foundations of project management, Koskela and Howell (2002) found that the Scrum Framework addresses the unpredictability of software project requirements and technology. The theoretical framework of my study suggests that agile project management methods, such as Scrum, might be utilized for non-software related development projects. However, the factors associated with success in software development projects needed to be tested to determine if they had a significant association with success in non-software related projects. For the purposes of this study, I categorized the inputs, or independent variables, into three categories labeled as organizational, human resource, and technical factors, and an output variable as perceived project success.

Organizational Factors

Examples of organizational factors include the industry and the organizational area the respondent worked in, and the level of agile use in their area. These items provided descriptive information of how and where agile project management was used in non-software related industries. Variables such as years using agile, and the usage of agile in a stage gate process are also input variables that could affect the successful outcome of the project. The Scrum Framework may not be appropriate for all stages of the development process. An iterative agile process may be well suited for the design and prototyping stage of a project, but for other stages of the development process, iterative development may not be the best approach. For example, iterations in the production tooling stage may require large amounts of time and money due to the high cost of materials and the complexity of the tool build. In this case the production tooling stage may be better-off managed using a traditional project planning technique until this equipment was completed. Then, once the tooling was ready for validation, an agile technique may once again be the right method to use.

Human Resource Factors

Human resource factors include variables such as team dynamics and team facilitation characteristics. Examples of team dynamics are T-shaped people, a stable team, and dedicated team members. These items are associated with the capability and structure of the employees involved with the project as well as the environment they complete their project work in. The notion of a T-shaped person is understood as someone that has deep knowledge in at least one area, and working knowledge of several other areas thus allowing the team to swarm and help complete tasks efficiently (Demirkan & Spohrer, 2015). This group of factors tested the significance of team dynamics and their effects on project success.

Technical Factors

These factors include agile methodology and Scrum tools which make-up the majority of the variables under study. One example of an agile method is described by Karlström and Runeson (2005) as the ability of engineers to gain earlier feedback on projects when they work on the most important features first. Using this feedback loop to complete iterative cycles can decrease development time by immediately integrating the learning into the next cycle. Variables such as agile usage overall, agile framework, sprint duration, Scrum meeting frequency, agile methods, Scrum tools, and time reduction techniques were used to learn what items helped achieve project success.

Perceived Project Success

The outcome, or dependent variable for my study is perceived project success, taking into consideration quality, cost, and timing. Success was associated with factors such as on-time delivery, improved quality, customer satisfaction, staying within budget, increased revenue, improved moral, reduced project risk, and the ability to react to change.

Figure 1 illustrates how organizational, human resource, and technical factors may have an influence on perceived project success as measured through the impacts of project timing, finances, quality, and customer satisfaction. If it is determined that agile project management methods do lead to project success, this model will provide a method for measuring the independent variables and factors that have a significant relationship to success.

The context of using Scrum methods, within the stage-gate model, to create an agile project management environment goes beyond the use of iterative development techniques. Factors such as breaking the project into smaller tasks, increasing communication with stakeholders, and being receptive to change are all characteristics that need to be evaluated for fit within each stage of the product development process for non-software related industries. The notion of having unique stages within a project prompted the study of the use of agile project management techniques at various stages of a project, and thus was added to the survey instrument.

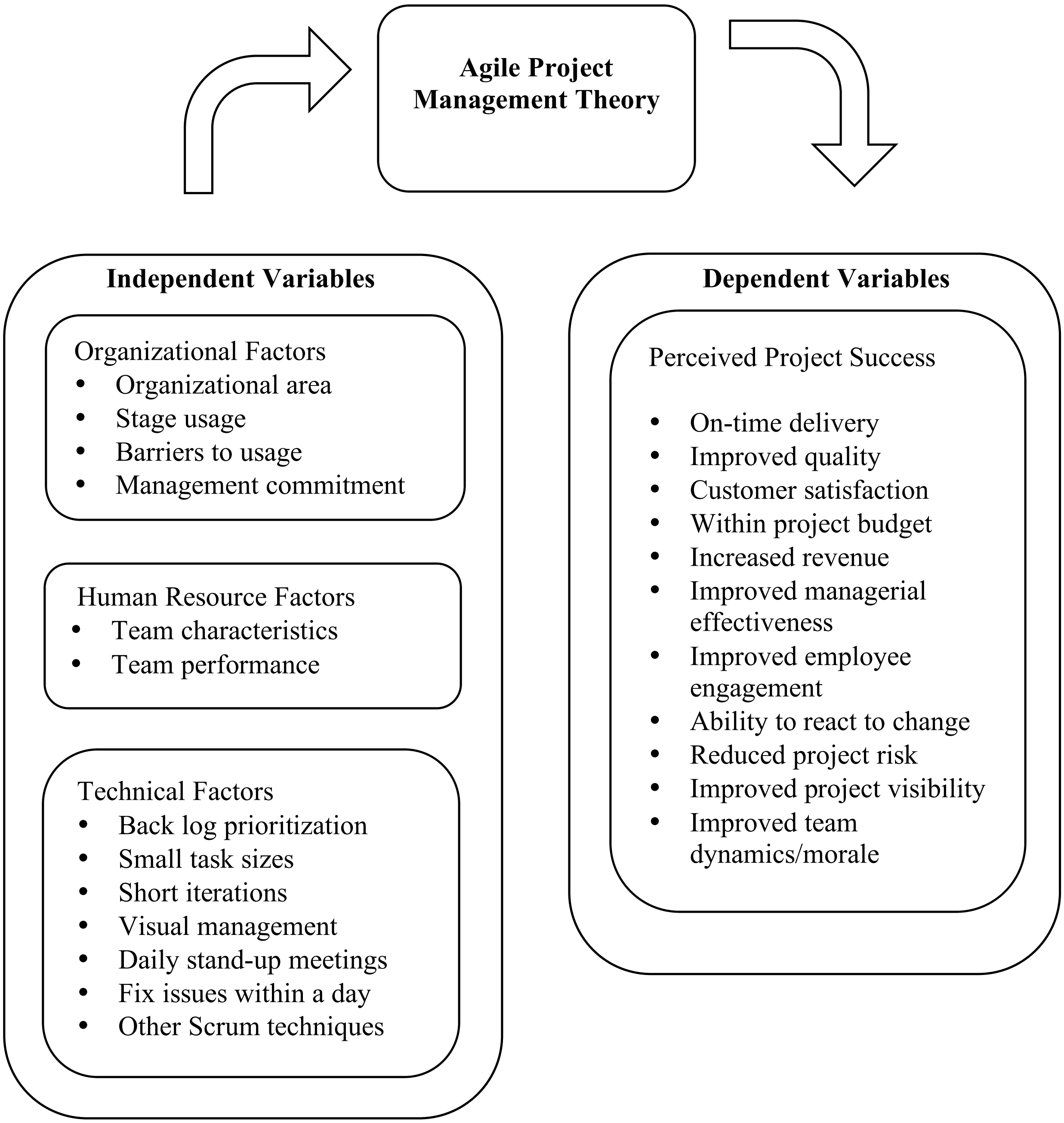

Figure 1. Agile project management theory (Totten, 2017).

Methods Overview

I utilized a researcher-developed survey instrument to conduct a quantitative study to determine whether project management professionals use agile project management methods and Scrum tools and techniques in any part or in all of their non-software product development process. The survey was administered through a number of professional organizations with them sending an email on my behalf, or allowing me to send an email to their membership, that explained the purpose of the survey and provided a link to the online survey service from Survey Monkey. These organizations have a global outreach to over 650,000 agile practitioners with the majority residing in software development industries. The target population includes employees of companies developing products other than software while using agile methods in all or part of their project management processes. Although it is difficult to estimate the number of practitioners using agile project management in non-software industries, an email list provided to me by Scrum Inc. included over 7,000 participants in Scrum training outside of software applications. Data was analyzed and interpreted using descriptive statistics and multiple regression techniques.

Significance of Study

Agile project management methods benefit organizations by increasing knowledge and learning, improving employee satisfaction, and building social skills and confidence (Solinski & Petersen, 2014). Having a unified vision and an adaptable set of tools enables teams to work in harmony to achieve organizational goals. The acceleration of time to market and the ability to manage and prioritize changing requirements are the most significant benefits gained through the adoption of agile project management methods in the software industry (Papatheocharous & Andreou, 2014).

Agile project management methods are beginning to gain the interest of project managers outside the software and information technology industries. The project management methods used by teams can have a big impact on project success and team performance. Responding to problems and challenges requires the generation of novel and creative ideas (Qureshi, Alshamat, & Sabir, 2014). Project teams must find innovative approaches to enable improvements in time, quality, and budget control. The success of agile organizations in changing and competitive environments illustrates the wide acceptance and significance of agility (Mao, Liu, & Zhang, 2014).

Teams in non-software development industries have the opportunity to make process improvements by integrating agile project management methods into their development processes. In doing so, they hope to achieve gains in efficiency and overall project success enjoyed by the software industry. However, as they begin their implementation journey, they may find that incorporating agile tools is not the same as what they have studied from the software industry. The information gathered in this study will make a contribution to research by helping to determine if agile project management methods are being used in non-software related industries. This research will also help indicate what variables are significant in achieving project success and will provide a framework for practical applications in the field.

Chapter 1 Closure

This chapter highlighted elements of product development success and the challenges in achieving it. The software development industry has demonstrated success by utilizing agile project management methods to deliver value to their customers in an efficient manner. Non-software development industries, using traditional project management techniques, have an opportunity to integrate these tools developed by the software industry.

Chapter 2 presents a literature review to establish how the software development industry is using agile project management methods to achieve project success. The discussion then shifts to the opportunities and challenges of non-software related industries as they attempt to integrate similar tools into traditional stage-gate processes.

CHAPTER 2

LITERATURE REVIEW

This literature review begins by providing an analysis of how the software industry has established agile project management methods as a course to improve their product development process. Common agile project management attributes are discussed as well as the importance of strong agile leadership and support. Applications of Scrum, a popular framework for administering agile methods, is presented followed by a discussion of how agile project management methods are being used in education and other non-software related industries. Finally, the literature review is closed with a discussion of how teams from non-software related industries are integrating agile project management methods into their stage-gate systems.

Agile in the Software Industry

In order to build a foundation in the study of methods leading to agile project management, I begin my analysis with an understanding of how the research of this concept has been presented for the software development industry in utilizing tools and techniques to become more agile. Agile project management methods are gaining in popularity in the software industry as software development teams are being asked to be adaptive to market needs, and to react to change and uncertainty (Mishra & Mishra, 2011). Market uncertainty, especially for start-up companies, make it risky to develop a full product without the opportunity to test a concept (Moogk, 2012). Changing market conditions can present a challenge to software development companies that aspire to provide a product that is timely and relevant to their customer's needs. Agile methodologies include early and continuous delivery of usable software releases as the agile teams react quickly to change. The benefits of agile methods include higher team satisfaction, a feeling of effectiveness, increased autonomy and happiness, and improved quality with earlier defect detection (Laanti et al., 2011). The resources of time and money are most often limited and companies must find ways to work within these constraints.

Misra et al. (2010) described how agile software development techniques were often used in an ad hoc manner by many practitioners, but when a group of advocates got together in 2001 to further develop the agile philosophy, the term agile gained in popularity. In an effort to find common ground in software development processes, 17 representatives from various software disciplines met and developed the following Manifesto for Agile Software Development ('Manifesto for agile software development,' 2001):

Manifesto for Agile Software Development

We are uncovering better ways of developing
software by doing it and helping others do it.
Through this work we have come to value:

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

The group, who named themselves the Agile Alliance, indicated that while there is value in the items on the right of each sentence, they found greater value in the items on the left (i.e., Individuals and interactions on the left, and processes and tools on the right). Characteristics of agile software development teams have followed the agile manifesto closely. Hislop et al. (2002) explained how software development requires rapid iteration cycles with effective feedback loops which allow for teams to minimize the up-front exhaustive collection of customer requirements. Frequent interaction with project sponsors, face-to-face communication, frequent delivery of useable portions of a product, acceptance to change, and the selection of high caliber teams were also mentioned as common agile techniques (Chow & Cao, 2008; Misra et al., 2009).

In a study to determine what factors and environments aid software development agility in successful projects, Sheffield and Lemétayer (2013) received 106 valid responses from an international survey sent to 452 members from agile communities of practice. Participants in the study were asked to rank survey questions as to their importance as an indicator of software development agility in successful projects. They found that organizational culture and the empowerment of the project teams were indicators of project development agility. To further define the concept of agile software development, Sheffield and Lemétayer offered that agile approaches are designed to embrace change within projects by using an iterative cycle of product development and are driven not by a master plan but by the value of the product. The team places emphasis in tacit knowledge over detailed documentation, and provides flexibility for the team to react efficiently to change requests.

Common Agile Project Management Attributes

There are a number of attributes that practitioners use to bring agility to their project development process. For example, project deliverables are most often broken into smaller tasks. Misra et al. (2009) pointed out the importance of breaking the larger project timeframe into short durations, and providing scaled-down delivery requirements. Martinez Leon, Farris, and Letens (2013) studied four process design examples for software simulation modeling to determine whether project success was related to the amount, scope, and timing of iterations. The authors suggested that iterations should be induced at productive points of the development process to allow for parallelism of activities, a shortening of task time, an avoidance of incorrect assumptions, and early detection of problems. Tasks are typically listed on cards that are prioritized and placed on a physical or electronic board. A technique called “Kanban” is utilized to limit the number of cards the team can work on at a given time, as well as to identify what tasks will be worked on following the completion of the current task. Lei et al. (2015) described Kanban as using the skillset of the employees to get “the right work done at the right time” (p. 4). Project tasks are often grouped as a set of items that need to be completed during a specified period of time. The time allotted to complete a set of tasks is called a “sprint.” According to Eloranta, Koskimies and Mikkonen, (2015), the most common sprint duration is two weeks, and every sprint should produce a potentially useable product, including feature testing. This information was gathered by conducting semi-structured interviews with 18 teams in 11 companies using Scrum in the software development industry. Eloranta et al. cited two common issues of sprint completions. The first was the lack of inclusion of product testing within the sprint which meant that the team did not develop a shippable product in that sprint. This also caused problems because new software code could be written over the top of old code that was still under test. The second issue was related to disruptions caused by the customer, especially when the customer was in a position of controlling team activity which affected the return on investment for the project. In some cases, the customer dictated how the team implemented features, and the customer gave new work tasks for the development team members directly which interrupted the workflow of the group.

As with any situation involving teams, communication is a key attribute in keeping everyone informed and aligned. Grapenthin, Poggel, Book and Gruhn (2015) studied the effect of providing an interaction room to two teams of software developers for a medium sized company. The room provided an area where the team had a central place to meet, share information, and encourage open communication. The effectiveness of the software development team was observed prior to providing the interaction room, and after. The study showed that the rooms allowed for increased communication among all stakeholders, provided a focused and logical way for the team to correspond, and it enabled improved identification and planning of tasks requiring completion.

Another potential requirement for successful agile project management is the willingness of team members to be flexible, responsive to the developing needs of the project and to take-on different roles to help the team succeed. Several authors, including Hoda et al. (2013), Gill (2014), and Stettina and Horz (2015) discussed the notion of self-organizing teams, agility of people, processes, tools, and consideration of a revised culture. Stettina and Horz interviewed 30 participants from 14 European software development organizations and found that agile methods empowered team members to take-on tasks that are traditionally performed by project managers, such as coordinating their own work. They noted that teams had increased interaction, were more stable, and they experienced increased collaboration, transparency, and trust.

In a study to determine whether agile methods achieved greater project success than traditional approaches, Serrador and Pinto (2015) collected survey information from 859 people, representing 1,002 projects across multiple industries. Interestingly, they found that one of the benefits of using agile methods is that it allows less experienced staff to achieve superior results. They also noted that project complexity was not a significant moderator of agile success. Laanti et al. (2011) administered a questionnaire to more than 1,000 respondents in seven different countries to study the agile transformation of a large scale project within Nokia. Their results listed the benefits of agile methods to include higher satisfaction, a feeling of effectiveness, increased quality and transparency, increased autonomy and happiness, and earlier detection of defects.

While Mishra and Mishra (2011) described that agile project management provides advantages such as lower costs, better productivity, better quality and better business satisfaction, several other authors, such as Drury et al. (2012), Leybourne (2009), and Serrador and Pinto (2015) discussed how agile techniques encourage tactical vs. strategic decisions, less structure and more improvisational focus, and a reduction in downstream product and planning changes. Chakravorty et al. (2014) summarized the benefits nicely when they stated that the attributes of agile project management include prioritization of features according to customer requirements, early customer involvement, incremental and iterative sprints, and flexible development environments with less documentation and complexity management.

Agile Leadership

As companies transition from traditional project management methods to agile project management methods, it is important for teams to know that their efforts are supported by their management teams. This support system is relevant for software and non-software related entities.

Agile development methods share the decision making authority in a company by keeping business-level decisions with executives, but allowing the software developers to manage items like development techniques and time estimates (Williams & Cockburn, 2003). Getting upper management onboard for trying agile methods may not be a difficult task when projects have a history of experiencing incorrect estimates of project delivery time; however, if project deliveries are typically on-time, it may take some convincing for managers to believe that agile project management methods could provide better results (Cohn & Ford, 2003). Having a conversation about software issues with upper management can be challenging due to the technical nature of the subject, but Boehm and Turner (2005) suggested keeping the terminology appropriate for the audience in order to help garner interest.

Surprisingly, the presence of strong executive support and/or sponsor commitment as well as an agile-style work environment were not significant factors for project success according to survey results from studies conducted by Chow and Cao (2008), and Stankovic et al. (2013). However, this contradicts what other researchers have reported about leadership. Several authors found management support to be important factors when implementing agile project management practices in organizations.

In a literature review of challenges and success factors for large scale agile transformations, Dikert, Paasivaara, and Lassenius (2016) highlighted management support to be one of the most noteworthy success factors, along with choosing and customizing the agile model, training and coaching, and mindset and alignment. Pikkarainen et al. (2012) performed an analysis of 57 developers, architects, project managers, customers, quality managers, and line and product managers to identify strengths and barriers of deploying agile within three different companies. They discussed the importance of management providing the necessary goals and support for agile development, while giving developers the freedom to continuously improve their own agile techniques during the execution of the project. This was echoed by Javdani Gandomani and Ziaei Nafchi (2015) in a study where they utilized a large grounded theory approach to learn from 49 agile experts from 13 different countries how to inductively develop an agile transition and adoption framework. This framework identified major project characteristics as being value based, interactive, continuous, and gradual. Their work highlighted the main benefits discussed among the participants as being the knowledge of business values and a focus on achieving more business values during the transition, the iterative process, and continuous transition framework. Serrador and Pinto (2015) also noted the importance of management sharing the vision by indicating that the quality of the vision/goals is a marginally significant moderator of success.

Certainly, a firm's leadership team will have an impact on the work atmosphere. Isaksen and Akkermans (2011) performed a survey of 140 participants who played various roles in managing innovation and creativity from 103 different organizations in 31 industries and 10 countries. The data indicated that organizational leaders influenced innovative productivity as well as the climate for creativity and innovation. They also found that a perceived increase in leadership support for innovation showed an increase in creative climate scores. Further, they found that when innovative new products are important to a firm's strategy, it is important for a leader to acknowledge the effect they can have on their employee's view of the organization's climate. By interviewing members of PRINCE2, PMI, and agile communities and administering an international survey, Sheffield and Lemétayer (2013) found that organizational culture was a factor in software development agility. Their factor analysis revealed that top management support for agility was one of three measures of organizational culture in the project environment, along with the level of entrepreneurship and risk tolerance.

Scrum

Agile development methodologies fall within a subcategory of iterative development practices that focus on shorter timetables for product delivery. There are a variety of agile processes available for practitioners to use. Qumer and Henderson-Sellers (2008) evaluated methods called XP, Scrum, Feature Driven Development, Adaptive Software Development, Dynamic Software Development, and Crystal as to the degree of agility each has when used during various phases of product and process development. They also compared these methods to traditional project management approaches such as waterfall, where projects are completed in a sequential manner and flow from one group to the next until a final product is ready to ship. They found the traditional waterfall method to have no agility value. Although this comparison took place with software development in mind, the information will be helpful as non-software development processes are explored. Scrum was found to be the most agile in the practices of a process, noting advantages such as frequent product deliveries and collaboration and cooperation among stakeholders.

In separate comparisons of agile methods, Scrum was reported as being the most used model (Cervone, 2011; Nathan-Regis & Balaji, 2012). And according to Sommer et al. (2015), Scrum is attracting a lot of interest in the industrial product development industry.

Scrum is defined by Schwaber and Sutherland (2016) as "A framework within which people can address complex adaptive problems, while productively and creatively delivering products of the highest possible value" (p. 3). They pointed-out that Scrum was not a technique used to develop products, but is a framework to work within. Schwaber and Sutherland further described Scrum theory as an empirical process control theory, suggesting that "knowledge comes from experience and making decisions based on what is known" (p. 3). Scrum optimizes predictability and controls risk through an iterative, incremental approach.

The Scrum teams are led through the product development process by a person titled as the Scrum master. In order to keep progress moving during the sprints, the Scrum master will meet with the team on a daily basis in what is called a daily stand-up meeting. Stray, Sjøberg and Dybå (2016) described the daily stand-up meeting as a brief communicative event between team members that occurs at a pre-arranged time and place. Participants stand during the meeting with the primary purpose to increase team awareness. Typically, each member of the team will discuss three items: what they completed yesterday, what they plan to complete today, and what barriers may be in their way. According to Stray et al., the sharing of information and the opportunity to discuss and solve problems are contributors to a positive attitude by the team. Also, the use of a board to visualize tasks as they were being reported had a positive effect. Factors contributing to a negative attitude were the time taken to provide status reports to the manager, meeting too frequently and long meeting duration. Other issues with the daily stand-up meeting included an over-reaction to problems by the Scrum master, resulting in team members withholding information about problems, and the reporting of a finished task prior to testing being complete (Moe et al., 2010). When this happens, the testing must be completed at the beginning of the next sprint which causes the team to begin with a backlog of work.

Agile in Non-Software Related Industries

Established originally for software development, an agile-focused process is still predominantly an IT phenomenon. But, due to its success, it has now spread to non-IT projects (Serrador & Pinto, 2015). Software development project teams have been experiencing success when evaluating outcomes such as scope, quality, cost, and timing. Chow and Cao (2008) surveyed agile software development professionals from 25 countries to gather data from 109 agile projects using multiple regression to analyze and determine what factors had a significant impact, suggesting that there is a relationship between these variables and project success. Out of a total of 48 hypotheses, only 10 were supported, identifying three critical success factors including a correct delivery strategy, a proper practice of agile techniques, and a high-caliber team. In a similar manner, Misra et al. (2009) performed a web-based survey analysis to gather information from 174 eligible responses from practitioners that had transferred from traditional software development practices to agile software development practices. Respondents came from multiple industries and included persons from CIO Magazine, Agile Alliance, and various networking connections. Linear multiple regression was conducted at a decision level of 0.05 to determine what factors were significant in determining project success. The survey data showed that customer satisfaction, customer collaboration, customer commitment, decision time, corporate culture, control, personal characteristics, societal culture, and training and learning were statistically significant factors, meaning that they were positively related with project success. Team distribution, team size, planning, technical competency, and communication and negotiation were not significantly related to project success.

While agile project management has been widely used for software development, the characteristics of agile and Scrum can be applied to projects outside of the software development market. As part of a study to determine if agile methods are being used in non-IT markets, Stare (2014) analyzed 21 product development projects in five Slovenian enterprises and found that agile methods were used in a portion of the product development projects, mostly within the execution phase. As part of their research, they also hoped to encourage the stimulation of professional discussion and research of agile management of other types of projects and encouraged the introduction of agile techniques wherever proven to contribute to the success of the projects. Utilizing a survey instrument, Serrador and Pinto (2015) studied 1,002 development projects utilizing agile methods across multiple industries and countries. They asked the project managers to consider two projects, one more successful and one less successful, while using agile methods to manage projects. The results of the survey found four industries that showed significant project success. These industries included high technology, health care, professional services and a category reported as other. Industries that did not show significant project success included construction, manufacturing, and retail. This data shows that agile is more prevalent in high tech and information technology fields, confirming earlier work by Dybå and Dingsøyr (2008) where they stated that agile was originally designed for this type of environment.

Agile in Education

Literature exists for groups beyond those involved in software development. Although not as prevalent, literature characterizing the use of agile methods in education does exist, and the inclusion of this research provides an example of how agile project management techniques can be used outside of the software development industry. With study plans and homework assignments often following a set time pattern with frequent communication from the instructor, the opportunity to apply agile project management methods seems appropriate.

The popularity of agile and Scrum methods has prompted educational institutions to evaluate the need to prepare students for agile working environments upon graduation. Devedžić and Milenković (2011) offered that the implementation of agile software development into computing classrooms has begun to take place, while Scott, Rodríguez, Soria, and Campo (2014) stated that the use of agile methodologies in industry positions the teaching of agile practices in software engineering education as cutting edge. Scott et al. collected data from 33 software engineering students and found a positive relationship of the learning style of students to their performance in a Scrum based capstone project.

Education can come in different forms, including the basic instruction of agile project management or the inclusion of agile methods in the completion of class projects. Devedžić and Milenković (2011) listed several computing curricula such as software engineering and computer science, where software development is being taught as a team-based development technique. The authors utilized their eight years of experience in teaching agile software methodologies to analyze three different courses on agile software development and to offer suggestions based on their learnings. They advised that having the students complete tasks in short iterations is best because this allows for more iterations to be experienced during the semester. Smaller, self-organized teams are more effective and pairing students that embrace agile techniques with those that are less engaged will help with learning pace. Lastly, they stated that teaching agile should be done in an agile way, meaning that they should value student participation and skills more than the books and processes.

As schools introduce agile methods to students, additional difficulties arise in the mentoring of students as they develop software solutions, including time schedule limitations, required computer software knowledge, student performance, and the evaluation of projects (Meerbaum-Salant & Hazzan, 2010). Through questionnaires, interviews, and observation, Meerbaum-Salant and Hazzan (2010) developed and utilized a mentor-framework called Agile Constructionist Mentoring Methodology (ACMM) to assist teachers in mentoring high school computer science students in their development of software projects. The framework provides a mechanism to address difficulties teachers encounter during the mentoring process of software development in high schools. In a similar manner, Mahnic (2012) studied how 49 undergraduate capstone projects utilized agile methodologies to develop software. The author described how the capstone course allowed students to be exposed to agile software development, and it allowed for the observance of developer’s behavior while using Scrum for the first time. As a result of this study, Mahnic noted that Scrum is a simple concept but difficult to implement, and that Scrum is best taught through projects and practical work, where the project becomes the vehicle for the learning experience as opposed to a lecture. Schneider (2011) cautioned that the assignment of tasks through the breakdown of projects into smaller units is easy but could be disruptive in a large group setting. A challenge, noted by Hislop et al. (2002) was that significant client interaction is needed for the agile methods to work and this may be difficult to obtain in the classroom setting.

The college senior capstone course has been one area where instructors have introduced agile project management methods. Hislop et al. (2002) studied different project management methodologies to determine when it was best to use agile techniques, while also considering the impact of instructional issues that agile practices can have on existing curricular conditions. They found that students should be given the opportunity to learn traditional methods prior to being taught agile methods. This would allow the students to become grounded in traditional project management theory, and then the instructors could introduce agile methods as an alternative approach. Grimheden (2013), Hislop et al., and Mahnic (2012) noted that capstone courses require increased organizational tasks, and with the short duration of the semester, students using agile methods were engaged more quickly, and they performed faster iteration cycles that produced an increased number of working solutions. Grimheden completed a case study on a mechatronics capstone course at KTH Royal Institute of Technology where Scrum was introduced to five student projects. In this study, the students showed an emphasis on rapid prototyping, fast feedback from stakeholders, and the utilization of incremental development.

These attributes are helpful in preparing the students for a future career. At first, the researchers noted that students felt that the agile process added another layer of work beyond the course itself; however, the reduction in problems with the group dynamic made the Scrum process worthwhile. Additionally, the majority of students felt that the experience was valuable for their future careers (Grimheden, 2013; Schneider, 2011).

In a separate research project, Su (2012) studied a team of five graduate students from Senegal, India, and the United States by observing how they used Scrum techniques to develop an educational mobile app that was utilized to help a group of five and six year old children learn math, geography, reading, and writing. Su found that the students struggled a bit with the first sprint of their project, but this was due to the learning curve of getting familiar with agile project management. However, as their sprints continued, they adapted well to the process and improved their performance.

Agile and Scrum concepts can also be taught in other areas in education. For example, Foss and Waters (2007) gave instructions for breaking a large dissertation project into twenty-nine smaller tasks which echoed the work breakdown structure suggested by agile techniques. Dividing the dissertation writing process into smaller tasks allows the author to focus on smaller, more manageable tasks as compared to trying to tackle the dissertation as a whole. This instruction was comforting to me and provided a constructive connection between theory and practice.

Agile Stage-Gate System

Projects involving the development of durable goods often follow a structured process involving a stage-gate approval protocol. The original stage-gate system was created based on an in-depth study of how successful new products were developed for the market. The early stage-gate model was derived based on their practices and lessons learned. However, as indicated by Cooper (2014), the world has changed into a faster-paced, more-competitive, and less-predictable environment on a global scale since the first stage-gate methods were introduced by Cooper himself in the 1980s. Although agile methods are growing in popularity within companies typically using traditional project management approaches, the majority of these organizations indicate a preference for maintaining both methodologies (Vinekar, Slinkman, & Nerur, 2006). An easy, one size fits all project management methodology does not exist for a specific project (Špundak, 2014). It may be possible to combine agile and traditional approaches within a project by applying each method where it is best suited.

Often, projects will contain a number of critical components requiring management acknowledgement and/or approval at predetermined phases. Typically, this stage-gate system will provide for management reviews at specific milestones of the project. This is one way of keeping upper management and other stakeholders up to date on project metrics. The structure of a typical stage-gate process is sometimes appropriate. Boehm (2002) offered that a structured process is suitable for project requirements that can be determined in advance with stable requirements and a low change rate. Mishra, Dangayach, and Mittal (2011) found that the most important factors for project success are clear objectives and scope, and a realistic time schedule. According to Augustine, Payne, Sencindiver, and Woodcock (2005), other factors project management factors to consider include the expense of frequent changes, the marketability of partial deliverables, and the participation of individuals in several projects simultaneously.

Karlström and Runeson (2005) performed case studies on three large software product companies to determine the advantages and disadvantages of combining agile methods with stage-gate management models. All three cases supported the integration of agile software development with stage-gate project management. Benefits included better cost control, increased product functionality, and the delivery of the project on time. The authors suggested keeping the phase gate structure, but integrating agile methods where it makes sense to help keep the communication flow intact. Conforto et al. (2014) performed an exploratory survey on the use of agile project management practices in 19 medium and large-sized firms from different industry sectors. They found that the presence of agile enablers, such as team experience, team size, and the level of new product development process formalization, provided a favorable environment for agile implementation. They also found evidence that some companies (deliberately or not) are moving toward the use of agile management combined with traditional management practices, even though these companies were not in the software industry.

The choice to use agile project management methods, allowing for reaction to uncertainties and unanticipated problems, is based on rules, structure, external factors influencing the project, and desired goals (Tatikonda & Rosenthal, 2000; Westerveld, 2003). Tatikonda and Rosenthal surveyed 120 completed new product development projects from a variety of industries and found that the success of project execution is positively related to project execution methods. Further, they found that product development methodology can be effective by using a balance of firmness and flexibility. This is the case when a portion of the project execution requires agility, while other portions benefit from the structure of a stage-gate process. Stage-gates and classical project management tools, such as work breakdown structures and Gantt charts, can be combined with iterative development processes to provide agility and discipline (Conforto & Amaral, 2016; Karlström & Runeson, 2006). Conforto and Amaral (2016) studied the effect of the iterative and visual project management method (IVPM2) they developed in 2010 to evaluate the overall performance of a project and product process. The model combines concepts from the product development stage-gate model with agile project management methods to allow for iterative work to be completed in the various phases of technology driven project. Combining the two approaches, by balancing stability with flexibility, resulted in a positive impact on project and product development performance, such as team commitment, leadership, and accuracy of information. The authors mentioned that the implementation of this hybrid model will require a thorough understanding of organizational and team characteristics in order to adapt these practices to particular projects.

Cooper (2014) explained that stage-gates will play a lesser role but will need to remain a part of the higher level portfolio management process. Stage-gates vary among companies and product development needs, but Stare (2014) offered that it is important to recognize that the agile approach focuses on the execution phase of a project in comparison to applying the tactic to all phases of the project.

The use of traditional project management tools, such as Gantt charts and waterfall timelines, may not allow the flexibility required to meet customer needs. Conforto et al. (2014) discussed how companies with new product development responsibilities often struggle with project planning and project management disciplines. Integrating the ability to iterate and react in this hybrid system requires the project team to adopt some basic agile concepts. Kumar and Krob (2007) utilized a framework of product and cycle time excellence called PACE®, developed by the consulting firm of Pittiglio, Rabin, Todd and McGrath (McGrath, 1996), to analyze how a company managed its product development pipeline. PACE® is a structured process that breaks a program into six phases, and includes the opportunity for stakeholders to review the project at the conclusion of each phase. This helps teams break the project management cycle into smaller sub-projects, and it provides clear direction to what tasks will be performed by whom and when.

As a function of improved communication, Karlström and Runeson (2006) recommended involving developers early in the process for clear direction, integrating agile micro planning to compliment the macro plan, identifying critical feedback loops, and striving to produce working solutions as quickly as possible. Conforto et al. (2014) also discussed how many product development companies use a predominance of phased planning instead of detailing the entire plan at once, then following with execution.

Chapter 2 Closure

Software development companies have been successful in using agile project management methods to improve their product development results. However, product development in non-software companies can be very different from that of the software industry. Product development companies often manage projects in stages, ranging from project initiation, design, and tooling to production. Agile methods may not be a good fit for the entire project but can be helpful in managing "sprints" or sections of the work.

Ultimately, the customer, or sponsor of the project, has a vested interest in the cost to develop a project, the delivery date of useful products, and to the ultimate satisfaction of the project sponsor and or customer. The successful traits of agile project management techniques can be applied to any project activity. Surely, there will be adjustments necessary to allow the agile tools to fit the needs of a specific project, but the main backbone of the system can stay intact. There is a gap in the literature with respect to how non-software development companies are integrating agile project management methods to improve project performance and success.

The information presented in this literature review has been referenced in the development of my theoretical framework and survey instrument. Chow and Cao (2008) presented a research model that illustrated how organizational, people, process, technical, and project factors were used as groups of independent variables to study their relationship with perceived success of the agile software development project as evaluated by quality, scope, time, and cost. I was able to utilize this model as a starting point to develop my conceptual frame. When completed, this research study will contribute to the body of knowledge in agile project management for industries beyond software development.

CHAPTER 3

METHODS

The literature review provided evidence that the software industry is successfully using agile project management methods (Scrum in particular) and offered information on what factors are critical for project success. The purpose of my research study was to understand whether agile project management methods are also being used by non-software development companies and whether they are integrating agile methods with their entire product development process or only in specific stages of the project. I also planned to learn what critical success factors of Scrum are connected to project success in non-software industries.

Research Design

I gathered information from participants as a result of their previous experience in non-software agile project management. The research design chosen for the study was a nonexperimental design grounded in quantitative analysis. For this type of design, Creswell (2013) suggests the use of correlational statistics to explain and measure the association between two or more variables. Although I identified a number of independent variables, I simply recorded their relationship to a dependent variable rather than manipulating the variables or participants as is done with an experimental design. Data gathered from all respondents was used for the analysis.

I used survey research as my methodology. According to Marshall and Rossman (2006), survey research is appropriate for using data collected from a relatively small number of individuals from a group to make inferences about a large group of people. I used an online survey instrument to collect data from agile practitioners and other personnel involved in the management of projects in non-software related industries. Laanti et al. (2011) indicated that, opposed to direct interviewing or mailed surveys, online instruments provide faster and easier data collection and analysis methods. I selected this approach in order to collect information on a larger scale, providing insight into what factors are successfully being utilized by agile practitioners as a group. Organizations and groups have moved online in order to promote their presence to consumers, providing an outreach opportunity for researchers to access a variety of populations who are involved with the interests of these groups (Wright, 2005). By studying a larger sample in a quantitative way, I was able to present information that represents a broad perspective of how agile practitioners are using methods to complete projects in a variety of industries.

My survey instrument was designed to collect data used to run both descriptive and inferential statistics. The descriptive information provided basic respondent information such as the industry of employment, their primary work area, and the number of years they have used agile project management methods. This information helped me better understand some basic demographic information about my sample. The inferential data provided information on the relationship between the independent predictor variables and the dependent variables of project success.

In regard to internal validity, I controlled several characteristics of the study, such as limiting the study to locations including people in non-software development industries, keeping the time to complete the survey under 10 minutes in an attempt to avoid participant fatigue, and using industry standard terminology on my data gathering instrument. The external validity of this study was limited to the group of agile project managers working in industries other than in software development.

Population, Sample and/or Site

It is important to have a well-thought-out strategy prior to administering any survey instrument. In an attempt to discover information about a given population, Gall, Gall, and Borg (2007) explained that quantitative researchers study a much smaller group called a sample. They described the population to be the larger group that the researcher wants to learn about, and the sample to be a smaller group selected with the intent that it accurately represents the defined population of interest. The selection of participants for the study, the specific type of sampling strategy, and the size of the sample to be studied are three considerations that go into the purposeful sampling approach in qualitative research, depending on the specific approach. Sample selection, questionnaire design, data collection and data analysis are all important factors in reducing the amount of survey error (Dillman, Smyth, & Christian, 2014). Although my study is quantitative rather than qualitative, I believe the same rigor in sample selection applies. My involvement in a number of professional project management, agile, and Scrum organizations provided access to organizations that assisted in reaching relevant participants in a variety of product development industries. My population included the global collection of agile project management professionals belonging to Scrum Alliance, Scrum Inc., a LinkedIn Agile group, and the West Michigan Project Management Institute developing products other than software.

I administered the survey to four groups. The first group was drawn from a population of members that belong to the Scrum Alliance organization. Members from this Scrum Alliance are of interest because of their desire to improve the effectiveness of individuals and organizations in product development and management through collaboration and other developmental activities specifically within agile project management methods. In this Scrum Alliance, there are more than 650,000 members from around the world who work in enterprises ranging from global corporations to new start-ups spanning across a large range of industries. Membership includes practitioners that hold a variety of positions within their companies. Although the majority of the membership is involved with software development, this survey option provided the opportunity for a large response and also to reach a number of members that are in non-software related industries. Although the Scrum Alliance staff initially offered to send the survey to all of their members who opted-in for email communication, a change in personnel resulted in the contact person sending the survey link via email only to a select group of members that she felt would be good candidates, resulting in 10 respondents to the survey.

A second group of potential respondents came from a local chapter of the Project Management Institute (PMI). I am involved with the West Michigan Project Management Institute (WMPMI) chapter through monthly networking opportunities. This group has over 750 members and represents a large variety of industries in the West Michigan area. The membership includes those interested in learning about project management tools and applying them within their trade. Conducting a survey within this group was within my reach, so the question of accessibility was not an issue. As with this Scrum Alliance organization, the membership includes practitioners who hold a variety of positions within their companies. One limitation to this group was that the majority of members using agile project management techniques also work in the software development industry. This group was very willing to help administer the survey. They sent an initial email link to the survey, as well as a follow-up email, resulting in 162 respondents.

A third group accessed was from a subset of Scrum Inc. members. The Scrum Inc. group provides knowledge and training based on the Scrum Framework for members in any industry or situation, not just for the software industry. Through many training sessions, a large database of nearly 9,000 email addresses of practitioners using agile project management methods in all domains was developed. This group had the greatest potential for targeting non-software users, thus I had the highest level of interest in utilizing this source for my sampling strategy. In this case, I sent the email communications directly from my Western Michigan University email account. After sending an initial email link to the survey, followed by a reminder email, 366 practitioners provided responses to the survey.

In a final attempt to increase the number of respondents, I shared the survey link online with a LinkedIn group called Agile. This group has over 67,000 members, but my efforts only resulted in adding two responses.

Human Subjects Institutional Review Board (HSIRB)

Prior to administering the survey instrument, I provided the survey document, and information about the study population to the Western Michigan University HSIRB to obtain approval to proceed. The HSIRB office determined that this research was not human subject research (see appendix D).

Instrumentation

I collected information from project managers by use of a researcher-developed survey instrument. Survey participants provided answers in a Likert Scale format, ranging from 1 (very little) to 6 (very much), when considering the independent variables presented in the survey. By using a 6 point Likert Scale, my intention was to collect interval and ratio data. Lomax and Hahs-Vaughn (2012) define interval data to be rank-ordered with equal differences between values, and ratio to also be rank-ordered with equal intervals, but with an absolute zero that allows ratios to be formed.

The survey questions were developed around the identification of variables that may have had an influence on project success, based on my review of the literature as well as personal knowledge acquired at local and national conferences on this topic. Previous study results from Chow and Cao (2008), Cooper (2014), Misra et al. (2009), and Stankovic et al. (2013) were utilized to help select success factors to be considered for my survey questions, including independent variables such as team capability, ability to react to change, and management commitment. The knowledge presented in these studies provided input for the organizational and human resource factor portions of my survey. The literature also provided content relative to the use of project timing, quality, and financial impacts as factors involved in defining project success as the dependent variable.

The survey instrument is grounded in the theory presented in the literature review as well as experienced in practice. I belong to a local project management community of practice. This group meets on a monthly basis with the purpose of sharing best practices and for dialogue about potential improvements. Because I belong to an organization that includes professional project managers, I had access to a number of individuals and companies that were either in the process of, or interested in, implementing agile project management processes within their companies. Informal conversations with these members regarding their use of agile techniques provided an opportunity for me to learn about and understand the struggles and the benefits these users were having in their use of the agile methodology. These conversations also helped shape the format of my survey instrument and provided insight as to what population to target for this study.

One particular source of practical knowledge came from a Scrum training conference I had recently attended. The information presented in the "Scrum in all domains" training by Justice (2017) provided valuable input for the sections of the survey that inquired about specific tools and processes that have been useful in the respondent's agile journey. Independent variables such as the use of daily Scrum meetings, holding retrospective reviews, and keeping a product backlog were added based on my participation in these agile and Scrum training courses. This information was particularly useful in the technical and process factors of the survey.

Additionally, under my leadership, my organization was in the process of blending agile project management techniques into our own project management processes. In the spirit of continuous improvement, we often look for gaps and potential improvements in our systems. Based on our experience, and in dialoging with others in our community, we are able to identify a number of factors that could influence project success. In our interactions with others, we have found that, as other companies attempt to introduce the agile project management process into their organization, the search for positive success factors is of great interest.

By utilizing the knowledge gained and documented from the literature review, and by taking advantage of my access to the practical applications, I was able to develop a survey instrument that was relevant to industries outside of software development. Building the survey in this manor provides the reliability necessary for others to carry-out similar data collection and analysis activities on similar samples in the field.

The survey was written and formatted using Survey Monkey, a web based survey software program. My intent was to keep the survey short (within 10 minutes) to encourage participants to follow-through with completion of all questions. Feedback from several respondents confirmed that the time to complete the survey was within the 10-minute goal.

The majority of the survey was designed to collect data associated with independent and dependent variables of interest; however, there were a few questions used for classification and demographic information. The survey collected basic information on whether or not the respondent belonged to the software industry and the area of the organization in which they primarily worked. Because participants came from a variety of industries and project segments, the survey included features that customized the particular questions a participant saw based on how they answered specific questions. The survey instrument probed deeper for rich information, or exited the participant from the survey all together by using skip features built into the web-based instrument. For example, participants were asked in which area of the organization they primarily worked, and if they selected software development or IT, they were exited from the survey. Another skip feature allowed users of the Scrum Framework to provide additional information by allowing them to continue with the survey, while skipping non-Scrum users to the end of the survey.

Questions were arranged to allow for several factors to be considered under a single statement. For example, participants were asked to rate the extent to which various agile characteristics were important for project success, with several characteristics presented in a column allowing respondents to select from the Likert scale by row. This allowed respondents to quickly provide feedback on several factors as they related to a common question. The survey included questions that probed how various predictor variables were related to the dependent variables of project success. Once this foundational agile project management information was obtained, respondents using the Scrum Framework for project management were presented with two more questions asking how particular Scrum tools and techniques contributed to project success.

Although the main purpose of the survey was to collect information on how agile project management methods are used, participants who were not using agile project management methods were presented with one question that provided an opportunity to declare why they were not using these tools. And finally, all respondents were given the opportunity to provide additional comments via an open text box in order to capture important thoughts that may have provided content for future studies.

Data Collection Procedures

Prior to sending the survey out for the mass collection of data, I pilot tested the instrument on a small number of colleagues from my network of agile professionals. This activity provided feedback on the survey format, helped establish content validity, and provided an estimate for the average survey completion time (Creswell, 2008). Such content validity refers to the appropriateness of the survey questions in measuring the data of interest (Muijs, 2004). Although this pilot testing did increase the overall time for the data collection phase, it provided valuable input to what was missing from questions, highlighted areas that were unclear, and helped determine whether there were any errors in the writing and functionality of the instrument.

I received confirmation from the administration within my targeted groups (Scrum Inc., Scrum Alliance, and WMPMI) that they would assist in reaching potential respondents. Surveying a targeted audience from professional organizations helped increase the trustworthiness of the data. Because surveys rely on self-reporting of knowledge, attitudes, and behaviors from individuals, Mertens (2005) explained that the validity of the results is contingent on the honest responses from the participants. In order to gain support from these groups, I offered to share the results of the survey with them. I also included specific content in the survey that will provide feedback and information relating to training materials from the Scrum Inc. group with the intention of increasing their desire to participate. Once the survey instrument was approved by my committee, I used the following process to administer the survey study.

Contact with potential participants was initiated through two separate methods. The first method required me to send emails from my university email account directly to a list of subscribers provided by the Scrum Inc. organization. In order to prevent my messages from being automatically reported as spam due to the large number of recipients on the email list, I broke the initial email group into small sub-groups of 25. Because I did not experience a high number of undeliverable email notifications, I increased the subgroup quantity to 100 respondents for the reminder email. The second method I used included help from the group of administration in forwarding my email through their email communication system. This was the method used with the Scrum Alliance and WMPMI groups. Dillman et al. (2014) recommend sending an email to ask for participation by providing a link to the survey followed by a second and third email to encourage participation. Although I expected to have difficulty providing multiple communication items through these organizations, I was able at least to send the initial survey request, followed-up by one reminder email for both the Scrum Inc. and WMPMI groups.

I used four separate survey collector links, one for each organization, to provide information on how many responses came from each group. Beyond this tracking method, the survey responses from individuals were anonymous. The emails to the memberships included a brief description of the survey study and the actual link to the survey document on Survey Monkey. My hope was that the utilization of an organization to communicate and send the survey would increase the participant's view that the study was valid and came from a trustworthy source. Because these organizations were member driven, contact information was easily available. My intention was to provide a survey instrument and data collection procedure that could be easily duplicated, thus providing a level of reliability that can be repeated by future studies. Copies of the initial and reminder emails are shown in Appendix A and B.

I used a variety of formats to store data collected from my research. I kept a copy of the data on my personal computer hard drive, posted a back-up file on the cloud, and kept a copy on a physical back-up drive. Creswell (2013) suggested that regardless of the style of data collection, it is important to develop a system for easy retrieval of information. Along with the safe keeping of information collected, equally important is the development of a system that will allow ease in locating data. This saved valuable time in the data analysis stage.

Data Analysis

I used statistical techniques to analyze and interpret the data. Gall et al. (2007) refer to statistics as mathematical techniques used for analyzing numerical data to accomplishing various purposes. Once the survey results were collected, the data was cleaned by searching for outliers and influential data points by analyzing descriptive statistics such as the range, and by viewing histograms, scatterplots, and other figures that provided a graphical representation of the data distribution. This collection of statistical techniques, tables, and charts was performed to increase the level of validity and reliability of the data used for the remaining analysis.

Two of my three research questions provided information that described attributes about the sample of survey respondents. The first research question queried the extent companies were using agile project management to develop products other than software, and in what specific stages of a given project. Answers to this question provided information on who, how, and when respondents were using agile project management within their organizations. The other descriptive research question probed why companies were not using agile project management. Answers to this question helped identify whether agile project management methods have no benefit in particular organizations, whether there is no support for using these methods, or whether there is a barrier that is preventing the adoption of agile project management methods in their work place.

Data from these quantitative Likert style questions was gathered and summarized in table format showing descriptive statistics for each characteristic. I used a computerized statistics program called SPSS v.24 to analyze the data from these two research questions using descriptive statistics functions. Descriptive statistics can provide a lot of useful information about the data. The computation of descriptive statistics as a means of conducting exploratory data analysis of each group in a study is the first step in the analysis of cause and effect data (Gall et al., 2006). Lomax and Hahs-Vaughn (2012) defined descriptive statistics as an abbreviated way of tabulating, summarizing, and representing a collection of data.

By calculating and analyzing descriptive statistics, it is possible to view basic information about the population sample, and to look for abnormalities in the data that has been collected. I presented data in three basic categories: (1) central tendency (mean), (2) degree of dispersion (standard deviation), and (3) frequency data expressed in the number and percentage of respondents.

After computing and analyzing the descriptive statistics, I utilized data from the remaining survey questions to run inferential statistics using regression analysis tests in SPSS to determine factors that were significant in predicting a perceived level of project success. I used the backwards-selection regression technique in order to build a regression model that included the most significant predictor variables. Inferential statistics techniques use data from a sample to infer properties on a population of an entire group through inductive reasoning (Lomax & Hahs-Vaughn, 2012). The remaining research question inquired about the extent that organizational, human resource, and technical factors predict the perceived level of success when using agile project management methods.

To determine whether success factors were significant for project success, researchers such as Chow and Cao (2008), Misra et al. (2009) and Stankovic et al. (2013) relied on data analysis tools and techniques in order to interpret results. Misra et al. utilized regression analysis techniques and graphing procedures to evaluate statistical significance and normality of the data when participants scored their survey questions on a Likert scale. Lomax and Hahs-Vaughn (2012) recommend using multiple regression when two or more predictor variables are used to explain the criterion variable. Because project success was defined in multiple dependent variables, multivariate regression analysis was used to identify the independent variables that were significant across all dependent variables.

Factor analysis was used to collapse independent variables into four factors that identified categories of variables. To test the reliability and consistency of these factors, I used Cronbach's alpha, stated by Field (2013) as the most common measure of scale reliability, to calculate the variance within an item, and the covariance between items on the scale.

I used the SPSS program to conduct studies to determine the usefulness of the data, and to test the assumptions of the linear regression. Lomax and Hahs-Vaughn (2012) list these assumptions as independence of the observations, achieved when the plotted residuals are random, homogeneity of variance, where all values of the independent variables x have a similar variance, normality of the distributions of y, linearity in the relationship between the observed scores on the dependent variables y and the values of the independent variables x, and multicollinearity, a violation where there is a strong correlation between independent variables. Results of the assumptions tests are presented in the results section of this study.

Once I was comfortable with the validity of the data, I reported the significance of the independent variables in predicting the dependent variable of project success. Mendenhall and Sincich (2012) explained that a level of significance, denoted by the alpha symbol (for which I will use a value of 0.05) is the probability of committing a type I error, or the probability of concluding that input variables are significant in predicting the outcome variable when in fact they are not. I compared this alpha level to the p-value, also called the observed significance level, in order to develop an interpretation of the results. For a p-value that was less than my alpha decision value of 0.05, I concluded that this predictor variable had a significant impact on project success and used this data to answer my research questions.

In order to differentiate between success factors and success criteria, Cooke-Davies (2002) offered that success criteria are used to evaluate whether the project was successful or not, while success factors are about the tools and techniques used to manage the project. My survey probed for information about independent variables related to several success factors such as organizational, human resource, technical, and project factors. Within the question matrix, on-time delivery, improved quality, customer satisfaction, being within budget, and other dependent variables are measures of success criteria. Project success was defined by multiple dependent variables. In order to measure the relationship of each predictor variable type, I first used SPSS to compute correlations between each independent variable with each dependent variable. Then, I used SPSS to analyze the data with multivariate regression techniques. R-squared, or the multiple coefficient of determination, measures how well a model fits a set of data (Mendenhall & Sincich, 2012). I ran an analysis that used all independent variables to find the best model, including main effects and interactions, to predict project success with the highest predictability by using r-squared as a measure.

The findings of this research is presented as a data driven method to identify the critical success factors that have accounted for project success within the sample surveyed. Although the data cannot be presented as a formula for success for all companies, the information could be used by the group membership to stimulate creative thinking on potential improvements to their project management process.

Cross Walk Table

Table 1 illustrates how each of my survey questions aligned with the research questions listed in chapter 1, and it lists the data analysis that was used to interpret the results. Variables were categorized as organizational, human resources, and technical factors.

Limitations and Delimitations

Because I was studying the result of the relationship between predictor variables and the dependent variable in a non-experimental setting, I was limited as to the control I had over these variables. Mendenhall and Sincich (2012) explained that establishing a cause and effect relationship between variables for observational data is much more difficult than experimental data. Therefore, the respondents came from a variety of situations with moderating factors that may have influenced correlation with one another. However, I narrowed these outside factors by targeting agile project management organizations.

The use of agile project management techniques is not yet a widely used concept for companies outside of the software development industry. For this reason, the number of respondents was limited, and the use of agile tools and processes may have been relatively new within their organization. My ability to work with global organizations such as Scrum Inc. and Scrum Alliance improved my potential to reach non-software industries with a targeted audience already knowledgeable with agile processes.

Table 1

Survey Results Analysis

Variables	**Items from the Survey (Collapsed Sub-Variables)**	**Data Analysis**
RQ1: To what extent, and how, are companies using agile project management methods to develop products other than software?		
Organizational	1 [industry] 2 [reported organizational area] 5 [organizational area agile usage] 6 [stage usage] 9 [agile adoption challenges] 16 [reason not using agile]	Descriptive Statistics
Human Resources	4 [years using agile] 7 [team dynamics]	Descriptive Statistics
Technical	3 [agile usage overall] 8 [agile methods] 11 [agile framework] 12 [Scrum tools] 13 [sprint duration] 14 [time reduction techniques] 15 [Scrum meeting frequency]	Descriptive Statistics
RQ2: To what extent do organizational, human resource, and technical critical success factors predict the perceived level of success when using agile project management methods?		
(IVs) Organizational Human Resource Technical	Items Noted Above	Multivariate Regression
(DV) Perceived Success	10 [perceived project success]	Multivariate Regression
RQ3: If companies are not using agile project management, why not?		
Non Usage	16 [non usage reasons]	Descriptive Statistics

However, in comparison to the organization options above, the WMPMI group is smaller in scale and has a smaller range of non-software industries available to analyze. On the other hand, this group was very relevant to project management techniques being studied and utilized in my local region.

The delimitations of the survey results relate to the usefulness and outreach of the data. Because I have targeted agile project managers in non-software related industries, the data will only be relevant to that group. Although it is interesting to see if the results are similar to survey results of the software industry, conclusions are only drawn only for non-software related industries. Overall, the information from this study will help fill the gap in the literature, and will contribute to the body of knowledge in agile project management.

Chapter 3 Closure

By administering my survey instrument through targeted organizations with members who use agile project management methods in non-software industries, I was able to increase the number of relevant responses. This quantitative research design, with the use of Likert scaled questions, allowed the collection of numerical data to be used to learn how agile project management methods are used in the non-software industry, and provided insight to what critical success factors are significant for project success. Statistical analysis of this data is interpreted and discussed in Chapter 4.

CHAPTER 4

RESULTS

This research study was designed to collect data on how agile project management is utilized on projects outside of software development industries. Agile practitioners took part in a web-based survey instrument to provide information about how and where agile project management was used in their workplace.

Demographic information describing the types of industries, work areas, and experience level is presented to provide information on the respondent's work environment. This chapter also provides descriptive statistics data derived from the survey questions, as well as results of the relationships between the independent variables and the dependent variables of project success, presented and interpreted using inferential statistics methods.

The purpose of this research study was to understand whether agile project management methods (Scrum in particular) used successfully in the software industry are also being used in full, or in part, in non-software development industries when managing product development projects. The research questions of interest are:

RQ1: To what extent, and how, are companies using agile project management methods to develop products other than software?

RQ2: To what extent do organizational, human resource, and technical factors predict the perceived level of success when using agile project management methods?

RQ3: If companies are not using agile project management, why not?

Reporting of Data

The data for this study was collected electronically through the Survey Monkey website during an eight-week period from May to July of 2017. The number of participants that completed any section of the survey is listed in Table 2. A total of 540 participants started the survey, of which 211 noted they worked in the software/IT industries and thus were skipped out of the survey, leaving 329 in other industries of interest. Of those, 238 noted they used agile to some degree and of those, 150 noted the use of Scrum in their agile efforts.

Table 2

Number of Respondents Completing the Survey

	All Respondents	Only Agile & Scrum Respondents
Number in software/IT industry (skipped from survey)	211	
Number in other industries	329	
- Number using Agile		238
- Number using agile with Scrum		150
	540	

Descriptive Results

Data has been analyzed and reported in two formats. First, descriptive statistics are presented to define specific demographic information about the respondent's work environment, as well as what aspects of their jobs they are using agile project management methods. Second, inferential statistics are shown to explain the relationship of a number of independent variables with the dependent variables of project success, and to identify the independent variables that have a significant impact on project success.

Research Question 1. My first research question asked to what extent, and how, are companies using agile project management methods to develop products other than software? Although the organizations I selected as my target population have an excess of 650,000 members, the industries in which they belong span a variety of industries, including software and IT (information technology). Of the 540 participants who participated in the survey, the largest group came from Scrum Inc. with 366 respondents. The WMPMI (West Michigan Project

Management Institute) organization had 162 respondents, followed by the Scrum Alliance with 10, and finishing with two respondents from the LinkedIn Agile group.

Because this study had a specific interest in non-software related groups, the first two questions on my survey were used to quickly collect demographic information about what industry in which the respondents worked, and in what area of the organization they primarily worked. Table 3 displays the diversity of industries represented by the respondents. While the software industry had the largest response rate (21%), manufacturing (19%) was also well represented.

Table 3

Industry in Which All Respondents Were Employed (N = 538)

Descriptors	Frequency	%
Software	114	21.2
Manufacturing	104	19.3
Training & Consulting	51	9.5
Research & Development	47	8.7
Education	42	7.8
Healthcare	31	5.8
Government	21	3.9
Finance	15	2.8
Insurance	15	2.8
Retail	10	1.9
Other	88	16.4

Note: Not all participants responded to this question.

Although software was identified as an industry of employment, respondents were not skipped from participating in the rest of survey simply by their association with the software industry. There are a number of job functions required to support a software development company, such as finance, human resources, sales, and training; therefore, a second question was used to identify those with software and information technology development as their primary role.

In order to filter the survey results to only those working in teams outside of the software and IT groups, participants were asked to identify the area of the organization in which they primarily worked. If software development or IT was chosen, they were exited from the survey via a skip function within the Survey Monkey survey instrument. Table 4 shows the results, with IT (20.7%) and software development (18.3%) making-up a large portion of the sample (39%). The remaining categories, shown below the dotted line, continued to the next section in the survey.

Table 4

Area of the Organization in Which All Respondents Primarily Worked (N = 540)

Descriptors	Frequency	%
IT (Information Technology)	112	20.7
Software Development	99	18.3
Product Design & Development (non-software)	115	21.3
Sales & Marketing	26	4.8
Training & Consulting	26	4.8
Production	22	4.1
Project Management	15	2.8
Finance, Purchasing, or Other Support Department	13	2.4
Other	113	20.9

The elimination of these two groups resulted in a reduction of 211 respondents from the initial 540 who began the survey, leaving 329 to continue with the survey. Data presented from this point on pertains only to those respondents who did not select software development or IT as their area of primary work.

The 329 respondents of primary research interest varied in their level of interest and usage of agile project management methods. This variation is graphically presented in Figure 2, showing a majority of respondents (*n* = 238, 76%) using agile to some degree. It should be noted that the 75 (24%) who indicated they did not use agile use agile project management methods were skipped to a question asking for information on why not. That information is presented later in this chapter.

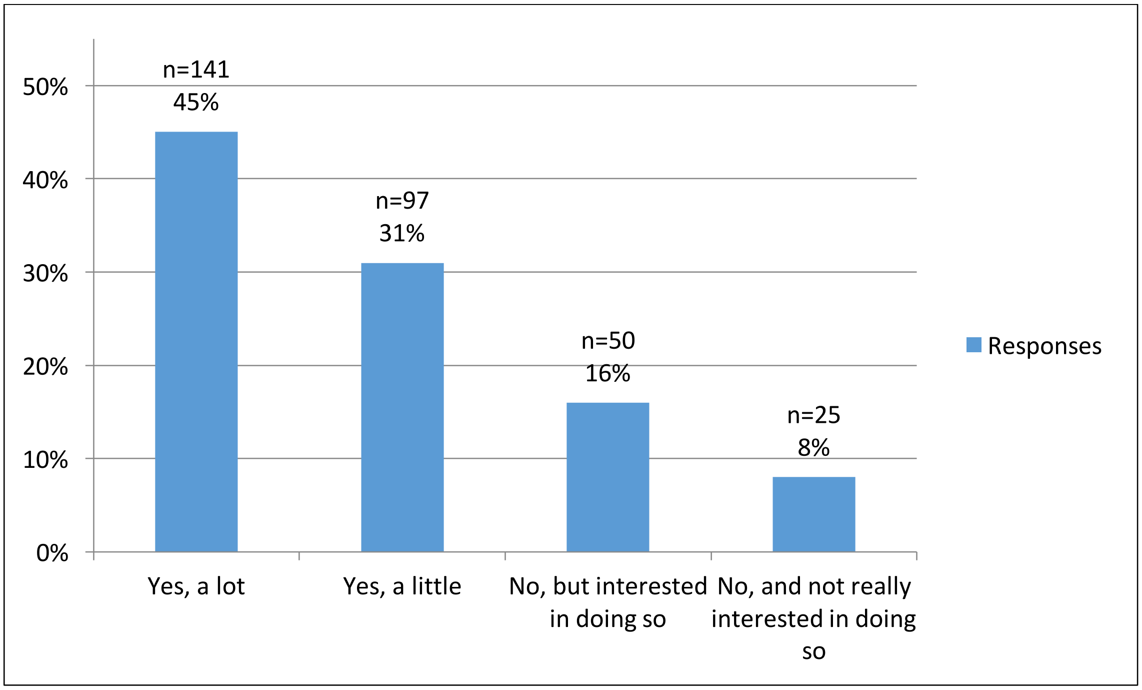

Figure 2. Respondents using agile project management methods in their area of work (*n* = 313).

After removing the respondents that were not using agile, data from the remaining 238 (non-software development or IT) agile users was analyzed to show the industries in which they were employed. Table 5 lists the industries in the same order as from highest to lowest agile reported usage from Table 3. Of these users, manufacturing had the highest usage rate (*n* = 49, 20.6%), with the lowest being retail (0.8%). An analysis of the respondent's organizational work area was also completed after the non-agile users were removed. The elimination of IT respondents and the reduction of software development respondents (*n* =1) is reflected in Table 6. The list of organizational areas has been reordered from highest to lowest frequency. Product design & development (*n* = 93, 39.1%) showed the highest frequency of the agile users.

Table 5

Industry in Which Respondents Using Agile Methods Were Employed (n = 238)

Descriptors	Frequency	%
Software	19	8.0
Manufacturing	49	20.6
Training & Consulting	40	16.8
Research & Development	33	13.9
Education	21	8.8
Healthcare	9	3.8
Government	11	4.6
Finance	5	2.1
Insurance	5	2.1
Retail	2	0.8
Other	44	18.5

Note: Not all participants responded to this question.

Table 6

Area of the Organization in Which Respondents Using Agile Primarily Worked (n = 238)

Descriptors	Frequency	%
Product Design & Development (non-software)	93	39.1
Training & Consulting	21	8.8
Sales & Marketing	20	8.4
Production	11	4.6
Finance, Purchasing, or Other Support Department	8	3.4
Project Management	5	2.1
Software Development	1	0.4
Other	79	33.2

It should be noted that following the survey question asking whether the respondents used agile project management methods, there was a decrease of about 70 agile using respondents for unknown reasons beyond the skip features in the survey instrument (perhaps due to the survey length). This reduced the agile using participants to about 168 that continued with the survey.

The average timespan the 165 respondents had been using agile project management methods had a mean of 6.3 years, with a median value of 5 years. While the majority of respondents (*n* = 98, 59%) had been using agile methods between zero and five years, Figure 3 displays how the range of experience spans to 20 years and beyond. It should be noted that the survey question did not limit the respondent's agile project management usage to non-software related industries only, therefore, there may be a mix of usage history in software and non-software industries amongst the respondent's answers.

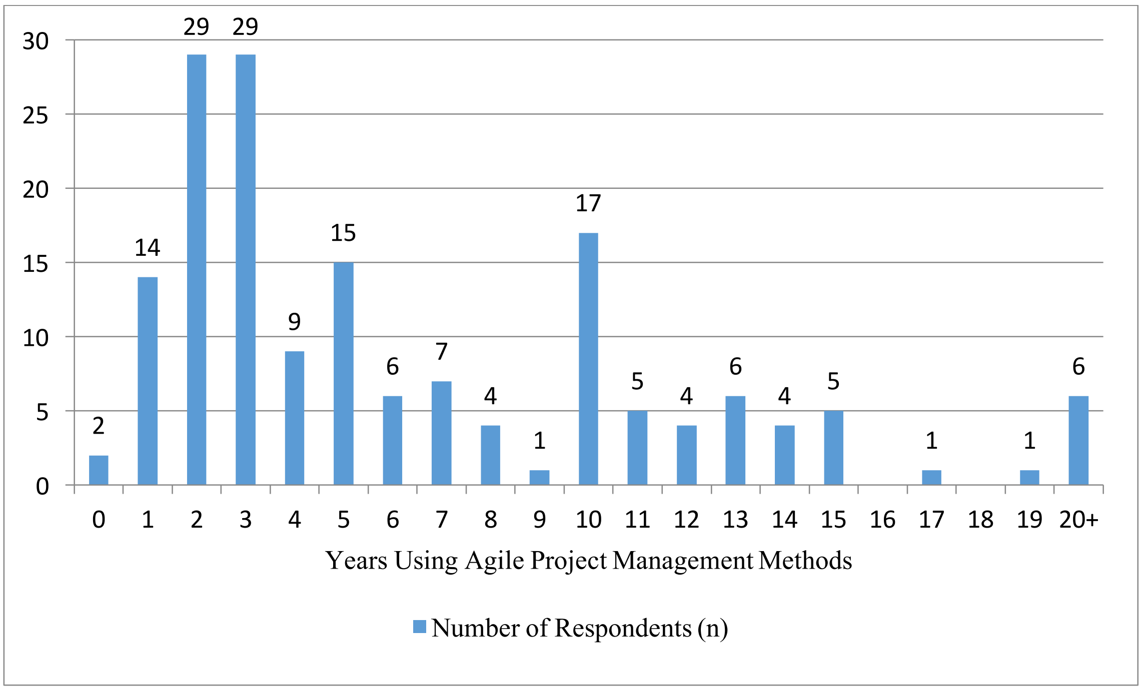

Figure 3. Number of years respondents had been using agile project management methods (*n* = 165).

Once this basic demographic information was summarized, the survey instrument was utilized to determine how and where agile project management was used in the respondents' work areas. In order to determine if companies were using agile project management methods in selective stages of a development effort, participants were asked to what extent they used agile project management methods in select stages of the development.

Table 7 shows results for all work areas presented in the survey, as listed from highest to lowest mean. Using a Likert scale from 1 (not applicable) to 6 (always used), respondents indicated that they used agile project management methods in all work functions listed in the survey.

Table 7

Frequency of Agile Project Management Methods by Work Area (n = 168)

Q5: In your area, how frequent are agile project management methods routinely used for:	Not applicable n (%)	Not used at all (1) n (%)	Rarely used (2) n (%)	Occasionally used (3) n (%)	Frequently used (4) n (%)	Almost always used (5) n (%)	Always used (6) n (%)	Mean	Std. Dev.
Functional Product Development	15 (9.1)	5 (3.0)	13 (7.9)	39 (23.6)	37 (22.4)	25 (15.2)	31 (18.8)	4.68	1.76
Research & Development	14 (8.4)	11 (6.6)	18 (10.8)	43 (25.8)	34 (20.4)	21 (12.6)	26 (15.6)	4.43	1.75
Sales & Marketing	33 (19.8)	43 (25.8)	18 (10.8)	33 (19.8)	18 (10.8)	11 (6.6)	11 (6.6)	3.32	1.82
Production & Operations (Mfg)	46 (27.4)	23 (13.7)	28 (16.7)	28 (16.7)	19 (11.3)	11 (6.6)	13 (7.7)	3.21	1.91
Hardware Development	63 (37.7)	7 (4.2)	25 (15.0)	28 (16.8)	17 (10.2)	14 (8.4)	13 (7.8)	3.14	2.03

Note: Not all participants responded to all items.

The top two areas consisted of "functional product development" (*M* = 4.68) and "research and development" (*M* = 4.43). "Hardware development (*M* = 3.14) resulted in the lowest score.

Using a Likert scale from 1 (not used at all) to 6 (always used), respondents were then asked to rate the extent to which they used agile project management methods in various project stages. The results are listed from highest to lowest mean in Table 8. The stages listed in the survey question were (a) initiation, (b) design and prototyping, (c) tooling, (d) validation, and (e) mass production.

Table 8

Frequency of Agile Project Management Methods Used in Project Stages (n = 166)

Q6: Within a project, how often are agile project management methods used during the following project stages?	Not Applicable n (%)	Not used at all (1) n (%)	Rarely used (2) n (%)	Occasionally used (3) n (%)	Frequently used (4) n (%)	Almost always used (5) n (%)	Always used (6) n (%)	Mean	Std. Dev.
Design & Prototyping	10 (6.1)	2 (1.2)	20 (12.1)	39 (23.6)	41 (24.9)	23 (13.9)	30 (18.2)	4.75	1.62
Initiation	7 (4.2)	9 (5.4)	34 (20.5)	31 (18.7)	33 (19.9)	22 (13.3)	30 (18.1)	4.57	1.69
Validation	12 (7.4)	16 (9.8)	21 (12.9)	36 (22.1)	33 (20.3)	24 (14.7)	21 (12.9)	4.34	1.74
Tooling	39 (23.9)	19 (11.7)	24 (14.7)	30 (18.4)	22 (13.5)	11 (6.8)	18 (11.0)	3.50	1.99
Mass Production	53 (32.5)	32 (19.6)	23 (14.1)	25 (15.3)	16 (9.8)	4 (2.5)	10 (6.1)	2.82	1.80
Other	54 (56.8)	3 (3.2)	5 (9.5)	9 (9.5)	3 (3.2)	5 (5.3)	16 (16.8)	1.82	2.39

Note: Not all participants responded to all items.

With a mean score of 4.75, the stage that showed the most usage was “design and prototyping,” while “mass production” showed the least amount of usage with a mean score of 2.82. “Initiation” ($M = 4.57$), “validation” ($M = 4.34$), and “tooling” ($M = 3.5$) also showed usage in various levels.

Respondents were then asked to consider whether characteristics within the organization were in place as they used agile project management methods. Organizational factors that were in place while using agile project management methods are listed in Table 9 from highest to lowest mean. Using a Likert scale from 1 (not at all in place) to 6 (always in place), respondents indicated the extent to which organizational factors were in place while using agile project management methods.

Table 9

Organizational Factors in Place While Using Agile Project Management Methods (N = 167)

Q7: To what extent are the following organizational factors in place as you use agile project management methods?	Not at all in place (1) n (%)	Rarely in place (2) n (%)	Occasionally in place (3) n (%)	Frequently in place (4) n (%)	Almost always in place (5) n (%)	Always in place (6) n (%)	Mean	Std. Dev.
Highly capable team	2 (1.2)	12 (7.2)	36 (21.6)	56 (33.5)	37 (22.2)	24 (14.4)	4.11	1.18
Dedicated team members	2 (1.2)	22 (13.3)	32 (19.3)	52 (31.3)	31 (18.7)	27 (16.3)	4.02	1.30
Commitment by mgt, clear vision	9 (5.4)	20 (12.0)	50 (30.0)	35 (21.0)	27 (16.2)	26 (15.6)	3.77	1.42
Co-located team	12 (7.3)	23 (13.9)	42 (25.5)	48 (29.1)	27 (16.4)	13 (7.9)	3.57	1.33
Highly involved customer	8 (4.8)	36 (21.6)	56 (33.5)	30 (18.0)	21 (12.6)	16 (9.6)	3.41	1.34

Note: Not all participants responded to all items.

The results showed relatively close scores, ranging from “highly capable team” (*M* = 4.11) to “highly involved customer” (*M* = 3.41). “Dedicated team members” (*M* = 4.02) also received a high score, indicating that team characteristics were important organizational factors.

Table 10 lists several methods that were in place while using an agile project management framework as listed from highest to lowest mean. Using a Likert scale from 1 (not at all in place) to 6 (always in place), respondents rated several techniques utilized while using agile project management methods.

Table 10

Techniques in Place While Using Agile Project Management Methods (n = 169)

Q8: To what extent are the following methods in place as you use agile project management methods?	Not at all in place (1) n (%)	Rarely in place (2) n (%)	Occasionally in place (3) n (%)	Frequently in place (4) n (%)	Almost always in place (5) n (%)	Always in place (6) n (%)	Mean	Std. Dev.
Prioritizing back logs	4 (2.4)	10 (5.9)	21 (12.4)	47 (27.8)	38 (22.5)	49 (29.0)	4.49	1.31
Keeping iterations short	3 (1.8)	15 (8.9)	20 (11.8)	46 (27.2)	34 (20.1)	51 (30.2)	4.46	1.36
Using visual management	7 (4.1)	12 (7.1)	22 (13.0)	39 (23.1)	34 (20.1)	55 (32.5)	4.46	1.45
Holding daily stand-up meeting	9 (5.3)	8 (4.7)	25 (14.8)	40 (23.7)	35 (20.7)	52 (30.8)	4.42	1.45
Keeping task sizes small	2 (1.2)	10 (5.9)	28 (16.6)	51 (30.2)	40 (23.7)	38 (22.5)	4.37	1.23
Holding retrospective meetings	6 (3.6)	17 (5.9)	28 (16.6)	44 (30.2)	37 (23.7)	37 (22.5)	4.18	1.40
Using team-based estimation	9 (5.3)	26 (15.4)	27 (16.0)	38 (22.5)	36 (21.3)	33 (19.5)	3.98	1.50
Using Kanban	23 (13.6)	19 (11.2)	39 (23.1)	36 (21.3)	27 (16.0)	25 (14.8)	3.59	1.58
Using burn down charts	26 (15.5)	30 (17.9)	36 (21.4)	30 (17.9)	25 (14.9)	21 (12.5)	3.36	1.61

Note: Not all participants responded to all items.

Respondents scored "prioritizing back logs" (M = 4.49) the highest, with several other variables achieving similar scores. These scores indicate that most respondents were using these tools in their workplace. The variable labeled as "using burn down charts" (M = 3.36) received the lowest score, indicating that fewer teams are using this tool in the work place as compared to the other tools and methods listed.

In order to gage the level of success experienced when using agile project management methods, respondents rated the items listed from highest to lowest mean in Table 11 using a Likert scale from 1 (not at all) to 6 (always).

Table 11

Project Success as a Result of Using Agile Project Management Methods (n = 168)

Q10: To what extent have these objectives been accomplished as a result of using agile project management methods?	Not at all (1) n (%)	Rarely (2) n (%)	Occasionally (3) n (%)	Frequently (4) n (%)	Almost always (5) n (%)	Always (6) n (%)	Mean	Std. Dev.
Ability to react to change	2 (1.2)	6 (3.6)	15 (8.9)	56 (33.3)	49 (29.2)	40 (23.8)	4.57	1.12
Improved project visibility	3 (1.8)	8 (4.8)	19 (11.5)	50 (30.1)	46 (27.7)	40 (24.1)	4.49	1.22
Improved employee engagement	4 (2.4)	5 (3.0)	23 (13.9)	50 (30.1)	55 (33.1)	29 (17.5)	4.41	1.16
Improved team dynamics/morale	5 (3.0)	7 (4.2)	22 (13.1)	51 (30.4)	47 (28.0)	36 (21.4)	4.40	1.24
Improved product quality	3 (1.2)	8 (4.2)	19 (17.9)	50 (33.3)	46 (30.4)	40 (13.1)	4.27	1.10
Customer satisfaction	1 (0.6)	6 (3.6)	32 (19.2)	60 (35.9)	47 (28.1)	21 (12.6)	4.25	1.06
Reduced project risk	3 (1.8)	9 (5.4)	35 (21.1)	57 (34.3)	40 (24.1)	22 (13.3)	4.13	1.16
On-time delivery	4 (2.4)	9 (5.4)	38 (22.9)	67 (40.4)	36 (21.7)	12 (7.2)	3.95	1.58
Improved managerial effectiveness	8 (4.8)	15 (9.0)	31 (18.7)	68 (41.0)	23 (13.9)	21 (12.7)	3.88	1.61
Within project budget	4 (2.4)	17 (10.2)	43 (25.9)	54 (32.5)	34 (20.5)	14 (8.4)	3.84	1.19
Increased business revenue	13 (8.0)	17 (10.5)	49 (30.3)	48 (29.6)	19 (11.7)	16 (9.9)	3.56	1.33

Note: Not all participants responded to all items.

These 11 items in Table 11 were the dependent variables that defined project success for this study. Although none of the variables received very low marks, the highest scores came from "ability to react to change" (*M* = 4.57), "improved project visibility" (*M* = 4.49), and "improved employee engagement" (*M* = 4.41). "Increased business revenue" (*M* = 3.56) resulted in the lowest score for defining project success.

In summary, the results from research question 1 showed that respondents were using agile project management methods in industries other than software development and IT. The results also indicated that usage varied depending on the respondent's work area and the stage in which their project was in. The next section shows the results of agile adoption challenges, as well as usage specific to the Scrum Framework.

Challenges When Attempting Agile Project Management. In order to gain an understanding of the challenges experienced when attempting to use agile project management methods, participants used a Likert scale from 1 (not at all challenging) to 6 (extremely challenging) to evaluate the factors listed in Table 12.

It is important to note that this survey question differed slightly in that a high score represented a larger barrier to success. This means that a high scoring variable produced a negative effect on using agile project management methods as opposed to supporting its usage. The factor showing the largest challenge was "team members on multiple projects" (*M* = 4.25), followed by "project interruptions" (*M* = 4.07). Both of these factors represent the inability of team members to stay focused on completing project tasks. The challenge receiving the lowest score was "lack of project management tools" (*M* = 2.48).

Table 12

Factors That are Challenging When Adopting Agile Project Management Methods (n = 170)

Q9: To what extent are these factors challenges to successfully adopting agile methods?	Not at all challenging (1) n (%)	Slightly challenging (2) n (%)	Moderately challenging (3) n (%)	Challenging (4) n (%)	Very challenging (5) n (%)	Extremely challenging (6) n (%)	Mean	Std. Dev.
Team members on multiple projects	9 (5.3)	11 (6.5)	26 (15.3)	40 (23.5)	50 (29.4)	34 (20.0)	4.25	1.39
Project interruptions	8 (4.8)	18 (10.8)	26 (15.7)	47 (28.3)	36 (21.7)	31 (18.7)	4.07	1.41
Lack of clear company vision	20 (11.8)	17 (10.0)	31 (18.2)	40 (23.5)	30 (17.7)	32 (18.8)	3.82	1.60
Unclear project scope	14 (8.2)	36 (21.2)	27 (15.9)	43 (25.3)	29 (17.1)	21 (12.4)	3.82	1.50
Product owner on multiple projects	17 (10.0)	19 (11.2)	22 (12.9)	55 (32.4)	39 (22.9)	18 (10.6)	3.79	1.45
Lack of upper management support	25 (14.9)	21 (12.5)	25 (14.9)	27 (16.1)	40 (23.8)	30 (17.9)	3.75	1.70
Lack of product owner involvement	21 (12.7)	23 (13.9)	29 (17.5)	33 (19.9)	38 (22.9)	22 (13.3)	3.66	1.59
Team distributed in diff. locations	18 (10.6)	32 (18.8)	37 (21.8)	49 (28.8)	26 (15.3)	8 (4.7)	3.34	1.35
Lack of project management tools	47 (28.0)	47 (28.0)	37 (22.0)	24 (14.3)	10 (6.0)	3 (1.8)	2.48	1.30

Note: Not all participants responded to all items.

Descriptive Results Specific to Scrum. As respondents continued with the survey, they were asked to identify whether they used the Scrum Framework as one of the methods of agile project management. Those that did not select Scrum as a framework were exited from the survey. Those that chose the Scrum Framework (*n* = 150) continued to answer questions specific to Scrum tools in practice.

Respondents were also asked to identify what agile project management frameworks were used routinely with their projects. Figure 4 clearly shows that the Scrum Framework is used most (*n* = 150), followed by Kanban (*n* = 108). Because respondents were asked to choose all frameworks that applied, the total number of entries was 349. With 174 participants answering this question, it is clear that the majority of them are using more than one framework. Among the responses in the "other" category was Extreme Manufacturing, SAFe, and Scrumban to name a few.

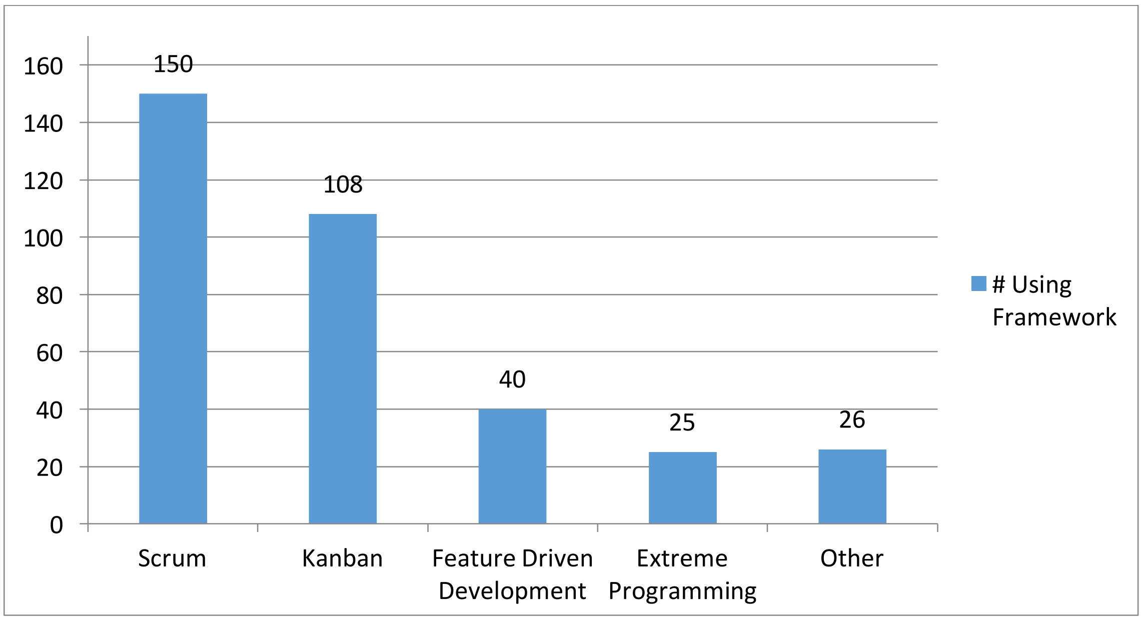

Figure 4. Agile project management frameworks used routinely in projects (*n* = 174).

The 150 respondents who selected Scrum as one of their frameworks were allowed to continue on with the survey instrument to collect information specific to the Scrum Framework. All others were sent to the end of the survey via a skip function in Survey Monkey.

For the 150 using Scrum, when asked how long the respondent's sprints typically ran in their Scrum Framework, the average time period was 2.6 weeks. Figure 5 shows that the distribution of answers ranged from one week to more than 10 weeks, but two weeks was clearly the most frequent answer capturing 59% (*n* = 85) of the responses.

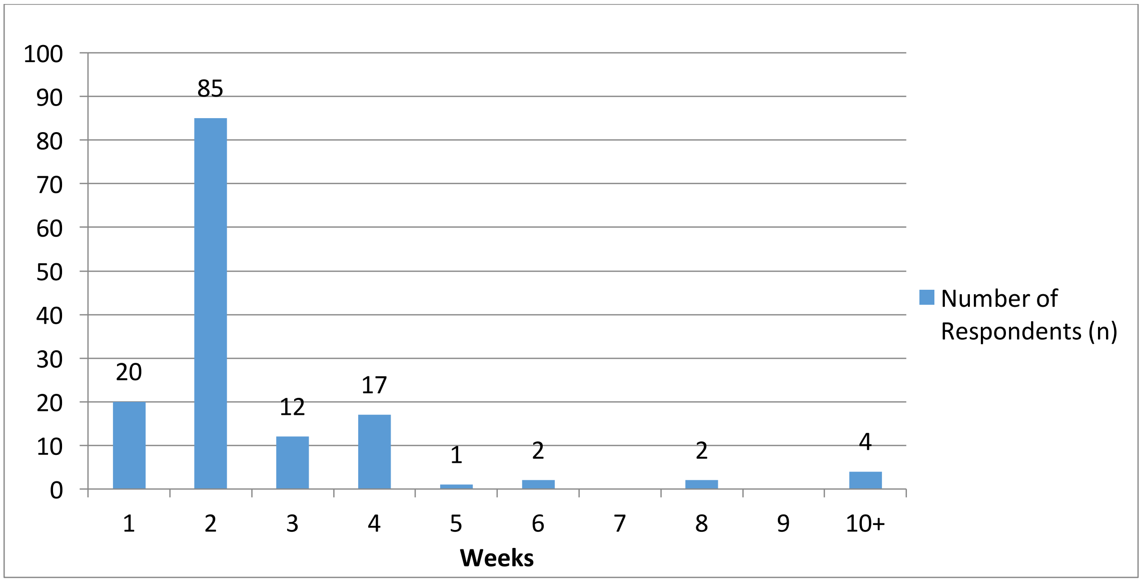

Figure 5. Number of weeks the respondent's Scrum sprints typically ran (n = 143).

In order to learn more about how teams communicated within the sprints, participants were asked about the frequency of holding any type of Scrum meeting. Figure 6 shows that most respondents tended to hold meetings on a more frequent basis, with the daily meeting being the most frequent (62%; n = 88), followed by meetings that were held multiple times in a week (21%; n = 30).

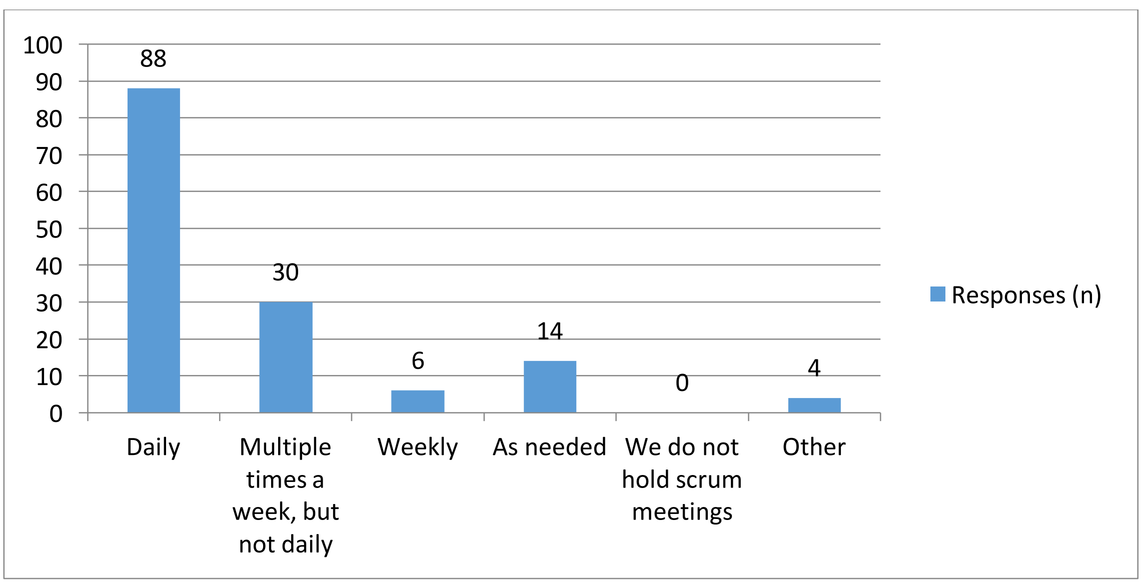

Figure 6. Frequency in which any Scrum meetings are held (n = 142).

Table 13 shows 11 tools representing Scrum roles, meetings, and outputs and the reported levels of usage, as listed from highest to lowest mean. Respondents used a Likert scale from 1 (not used at all) to 6 (always used) to answer the question.

Table 13

Scrum Tools Usage While Using Agile Project Management Methods (n = 142)

Q12: To what extent are the following Scrum tools in place as you use agile project management methods?	Not used at all (1) n (%)	Rarely used (2) n (%)	Occasionally used (3) n (%)	Frequently used (4) n (%)	Almost always used (5) n (%)	Always used (6) n (%)	Mean	Std. Dev.
Scrum team	1 (0.7)	4 (2.8)	11 (7.8)	30 (21.1)	37 (26.1)	59 (41.6)	4.94	1.14
Sprint planning	3 (2.1)	3 (2.1)	9 (6.3)	37 (26.1)	34 (23.9)	56 (39.4)	4.86	1.20
Make work visible	5 (3.6)	2 (1.4)	11 (7.9)	31 (22.1)	32 (22.9)	59 (42.1)	4.86	1.28
Product backlog	1 (0.7)	5 (3.5)	21 (14.8)	28 (19.7)	34 (23.9)	53 (37.3)	4.75	1.24
Scrum master	2 (1.4)	6 (4.3)	11 (7.8)	36 (25.5)	38 (27.0)	48 (34.0)	4.74	1.21
Sprint backlog	5 (3.6)	8 (5.7)	12 (8.5)	28 (19.9)	33 (23.4)	55 (39.0)	4.71	1.39
Daily Scrum	3 (2.1)	6 (4.2)	17 (12.0)	33 (23.2)	29 (20.4)	54 (38.0)	4.70	1.32
Product owner	3 (2.1)	5 (3.6)	16 (11.4)	31 (22.0)	42 (30.0)	44 (31.2)	4.67	1.25
Product backlog refinement	2 (1.4)	7 (4.9)	14 (9.9)	47 (33.1)	29 (20.4)	43 (30.3)	4.57	1.23
Retrospective	3 (2.1)	9 (6.3)	21 (14.8)	31 (21.8)	35 (24.7)	43 (30.0)	4.51	1.34
Sprint review	5 (3.5)	12 (8.5)	14 (9.9)	37 (26.1)	24 (16.9)	50 (35.2)	4.50	1.45

Note: Not all participants responded to all items.

All scores for these Scrum tools resulted in values equal to or above 4.5, with “scrum team” (M = 4.94) being the highest score, and “sprint review (M = 4.5) resulting in the lowest score. The high mean scores throughout this selection indicate that most respondents are frequently using these Scrum tools as they practice agile project management.

Another question relating directly to those respondents using the Scrum Framework inquired about the importance of using the 11 tools geared towards reducing project completion time. Table 14 shows the scores for this question, as listed from highest to lowest mean, with “stable teams” (M = 5.07), “dedicated teams” (M = 4.99), “daily Scrum meetings” (M = 4.65), and “ready backlog” (M = 4.55) showing the highest scores. “Having an interrupt buffer” (M = 3.76) was scored the lowest of the variables.

To summarize this section, respondents are experiencing barriers to using agile project management methods, particularly from issues coming from team members being on multiple teams, and from the occurrence of project interruptions. Users of the Scrum Framework reported that Scrum tools were in place as they practiced agile project management. The results presented in this section provided descriptive information on the use of agile project management methods. The next section provides a discussion on the inferential results of my study.

Table 14

Scrum Techniques Important to Reducing Project Time (n = 142)

Q14: To what extent are the following Scrum techniques important to reducing project time?	Not at all important (1) n (%)	Not very important (2) n (%)	Somewhat important (3) n (%)	Important (4) n (%)	Very important (5) n (%)	Extremely important (6) n (%)	Mean	Std. Dev.
Stable teams	0 (0.0)	0 (0.0)	5 (3.5)	29 (20.4)	59 (41.6)	49 (34.5)	5.07	0.83
Dedicated teams	0 (0.0)	2 (1.4)	8 (5.7)	31 (22.0)	48 (34.0)	52 (36.9)	4.99	0.98
Daily Scrum meetings	1 (0.7)	4 (2.8)	20 (14.2)	37 (26.2)	36 (25.5)	43 (30.1)	4.65	1.18
Ready backlog	2 (1.4)	4 (2.9)	22 (15.8)	32 (23.0)	46 (33.1)	33 (23.7)	4.55	1.18
Small teams	1 (0.7)	4 (2.8)	25 (17.7)	55 (39.0)	35 (24.8)	21 (14.9)	4.29	1.06
All testing completed within sprint	6 (4.3)	12 (8.6)	20 (14.3)	36 (25.7)	33 (23.6)	33 (23.6)	4.26	1.41
T-shaped people	6 (4.3)	8 (5.7)	19 (13.6)	45 (32.1)	43 (30.7)	19 (13.6)	4.20	1.25
Collocation of team	6 (4.3)	16 (11.4)	15 (10.6)	42 (29.8)	35 (24.8)	27 (19.2)	4.17	1.39
Finishing early (yesterday's weather)	4 (2.9)	14 (10.3)	28 (20.6)	50 (36.8)	25 (18.4)	15 (11.0)	3.90	1.23
Having an interrupt buffer	6 (4.4)	22 (15.9)	25 (18.1)	47 (34.1)	22 (15.9)	16 (11.6)	3.76	1.34
Fix issues within a day	8 (5.7)	19 (13.6)	31 (22.1)	42 (30.0)	23 (16.4)	17 (12.1)	3.74	1.37

Note: Not all participants responded to all items.

Inferential Results

The second research question in this study inquired about the relationship between a number of independent variables with the dependent variables that define project success. To analyze this relationship, regression techniques were used to produce the inferential results interpreted in this section.

Assumptions of the Multivariate Analysis. In order to determine the usefulness of the data, the assumptions of multivariate regression were tested. These tests were performed using the SPSS statistical analysis software.

The distributions of the residuals were plotted using histograms and q-q (quantile-quantile) plots. The histograms showed to be normal in shape, therefore normality of the distributions was verified. The histogram shown in Figure 7 is for "on-time delivery."

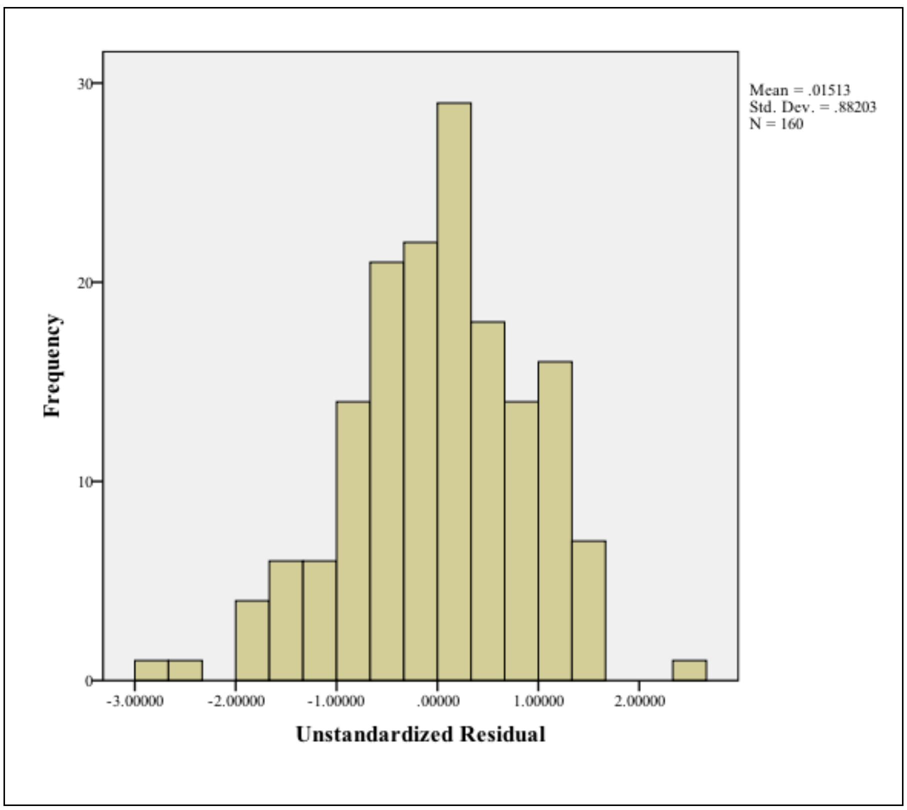

Figure 7. Histogram for Unstandardized Residual for on-time delivery (n = 160).

Linearity in the relationships between the observed dependent variable values and the independent variables showed that the data points in the q-q plots followed an approximate straight line. An example of a q-q plot is shown in Figure 8 for "on-time delivery." No issues with the data were identified.

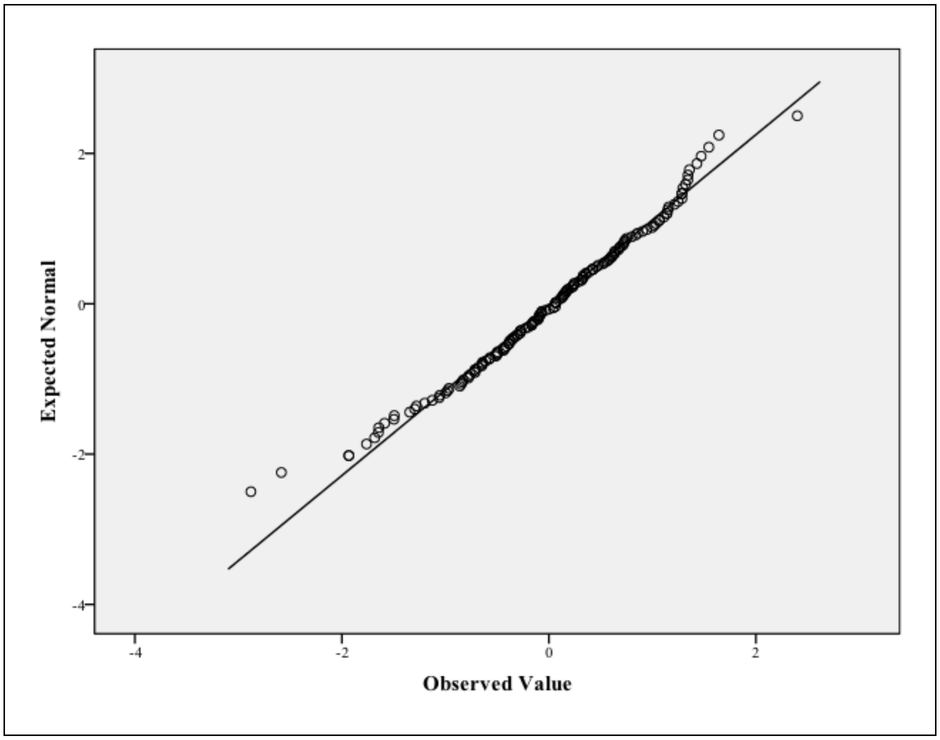

Figure 8. Normal Q-Q Plot of Unstandardized Residual for on-time delivery (n = 160).

Tests for multicollinearity were conducted to look for strong correlations between independent variables by evaluating the variable tolerance (percent of variance in the predictor that cannot be accounted for by the other predictors) and VIF (Variance Inflation Factor) values. There was no tolerance less than 0.10, and no VIF values greater than 10. These results suggest that no strong correlations exist that will affect the results of the regression models.

All residual plots were evaluated by plotting the predicted versus standard residuals for each of the dependent variables. No patterns were found in the plots, indicating that the test for homogeneity of variance was satisfied. The Durbin-Watson values were calculated with all results being close to 2.0, indicating that there was no worrisome levels of correlation between the residuals, therefore, the independence of the observations was satisfied.

Figure 9 shows the scatterplot for the regression predicted value against the regression standardized residual for "on-time delivery." The points are displayed in diagonal lines due to use of the Likert scale to limit results to categorical values between zero and six. Beyond these lines, the shape of the plot is random.

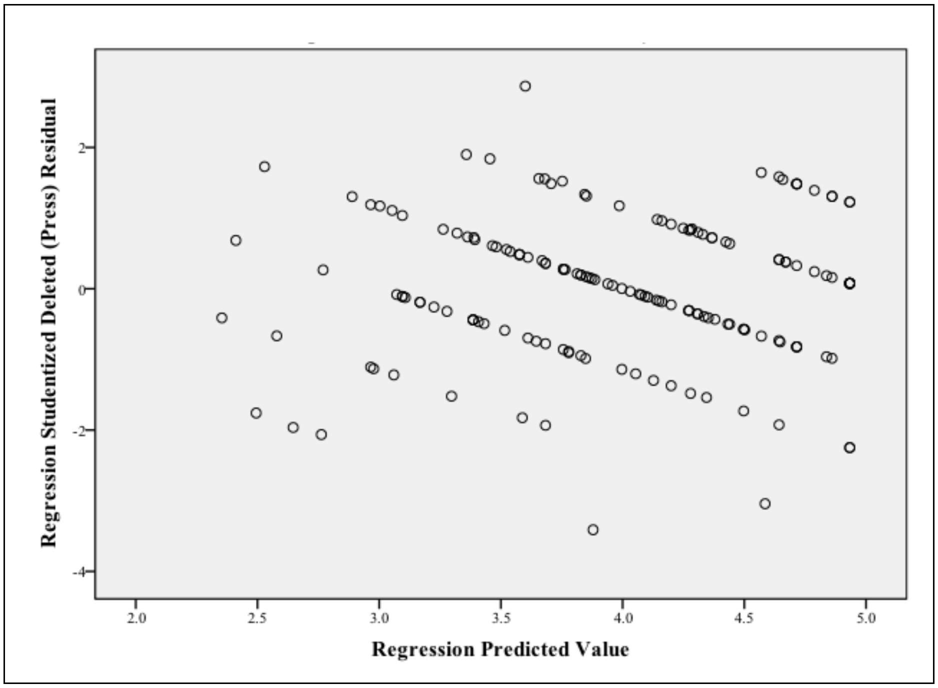

Figure 9. Scatterplot of regression predicted value against regression standardized residual for on-time delivery (n = 160).

The assumptions of the multivariate multiple regression seemed reasonable and, therefore, the analysis was continued with no concerns.

Research Question 2. Research question 2 asked to what extent organizational, human resource, and technical factors predict the perceived level of success when using agile project management methods? A multivariate multiple regression analysis was completed using independent variables from the general agile project management and Scrum tool portions of the survey to test their significance in predicting each of the 11 project success dependent variables: (1) on-time delivery, (2) improved product quality, (3) customer satisfaction, (4) within project budget, (5) increased business revenue, (6) improved managerial effectiveness, (7) improved employee engagement, (8) ability to react to change, (9) reduced project risk, (10) improved project visibility, and (11) improved team dynamics/moral.

In these regression analyses, the independent variables were tested against all 11 dependent variables, and an independent variable was required to have significance across the entire set of project success variables in order to be included in the final model. The backward regression technique was used to eliminate the non-significant independent variables from the model.

Only four independent variables showed significance below the p-value of 0.05: the "commitment by management with a clear vision," "holding daily stand-up meetings," "keeping task sizes small," and "using visual management." Although these four variables were useful to predict all of the dependent variables in conjunction with other variables, some were not significant for certain dependent variables on their own. Each dependent variable for project success is shown with the four significant independent variables in Tables 13 - 23. The independent variables in the tables are labeled using their survey question number (e.g., "Q8_5 Keeping task sizes small" came from line 5 of question 8). The survey question numbers (Q8_5) will be used in the model formulas in order to abbreviate the formula length, but the actual variable name (keeping task sizes small) will be used in the interpretation of the models.

Table 15 shows the results for the regression analysis of "on-time delivery" as the first dependent variable. An interpretation of the results follows below the table, paying specific attention to the significance of the four independent variables and their ability to predict "on-time delivery."

In Table 15, "on-time delivery" shows a significant relationship with "keeping task sizes small" (sig. = .003) and "using visual management" (sig. = .001). Because "keeping task sizes small" had the highest value (B = .243) of the five coefficients, it is predicted to have the most impact on "on-time delivery."

Table 15

Parameter Estimates for On-Time Delivery by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
On-time delivery	Intercept	1.274	.307	4.153	.000*
	Q7_1 Commitment by management with a clear vision	.095	.059	1.611	.109
	Q8_1 Holding daily stand-up meeting	.069	.064	1.086	.279
	Q8_5 Keeping task sizes small	.243	.081	2.988	.003*
	Q8_7 Using visual management	.220	.065	3.415	.001*

Note: *Model df = 4, F Value = 21.729, *Sig. ≤ 0.05, adjusted R square = 0.356*

This means that a one-unit increase in "keeping task sizes small", holding all other variables constant, is predicted to result in a .243 increase in "on-time delivery." A one unit change in any of the other four variables is predicted to result in a smaller change in "on-time delivery" based on their own coefficient (B) value (e.g., for every one-unit value of change for "using visual management," "on time delivery" is predicted to change by a value of .220, holding all other variables constant). This overall model has an adjusted R-squared value of 0.356, meaning that the four variables in the model are useful in explaining 36% of the variance in the output of the model (on-time delivery). This means that 36% of the variability, or difference in "on-time delivery" can be explained by the four variables in the model. Therefore, there are other factors that can affect the variability in the value for "on-time delivery."

Based on these data, if multiple independent variables are changed at the same time, the products of all changes need to be added together in order to find the total predicted impact on "on-time delivery." The following model can therefore be used to evaluate the total predicted impact on "on-time delivery" when one or more independent variables are changed:

$$\text{On-time delivery} = 1.274 + .095(Q7\_1) + .069(Q8\_1) + .243(Q8\_5) + .220(Q8\_7)$$

To calculate the total change in "on-time delivery," each independent variable (in parenthesis in the model) would be replaced with its change in value and multiplied by its coefficient "B." Then, all products would be added together to represent the total change in "on-time delivery." The absence of change in any of the independent variable values would result in an on-time delivery score equaling the intercept value listed in the model (e.g., 1.274). This means that the score for "on-time delivery" would start at 1.274 when all predictor variables are scored at zero, and would remain at 1.274 if there were no change in value for the predictor variables.

The second dependent variable examined was "improved product quality" with the regression results for this variable shown in Table 16. Three of the four independent variables were significant as predictors of improved product quality.

Table 16

Parameter Estimates for Improved Product Quality by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
Improved product quality	Intercept	1.268	.307	4.153	.000*
	Q7_1 Commitment by management with a clear vision	.149	.057	2.614	.010*
	Q8_1 Holding daily stand-up meeting	.041	.062	.670	.504
	Q8_5 Keeping task sizes small	.344	.079	4.369	.000*
	Q8_7 Using visual management	.169	.063	2.703	.008*

Note: *Model df = 4, F Value = 28.324, *Sig. ≤ 0.05, adjusted R square = 0.422*

The only variable that was not significant was "holding daily stand-up meeting." "Keeping task sizes small" had the highest impact (B = .344, sig. = .000) on the model. A one-unit increase in "keeping task sizes small," holding all other variables constant, is predicted to result in a .344 increase in "improved product delivery." There were two additional significant variables in this model. A one-unit increase in value for "commitment by management with a clear vision" (B = .149, sig. = .010), keeping all other variables constant, is predicted to result in a .149 increase in “improved product quality.” And, a one-unit increase in value for “using visual management” (B = .169, sig. = .008) is predicted to result in a .169 increase in value for “improved product quality.” With an adjusted R-squared value of 0.422, these variables are useful in explaining 42% of the variance in the model. The final model used to evaluate the total predicted impact on “improved product quality” is:

$$\text{Improved product quality} = 1.268 + .149(Q7\_1) + .041(Q8\_1) + .344(Q8\_5) + .169(Q8\_7)$$

The third dependent variable examined was “customer satisfaction” with the regression results for this variable shown in Table 17. Two of the four independent variables were significant factors in predicting “customer satisfaction”.

Table 17

Parameter Estimates for Customer Satisfaction by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
Customer satisfaction	Intercept	1.887	.311	6.070	.000*
	Q7_1 Commitment by management with a clear vision	.099	.060	2.657	.100
	Q8_1 Holding daily stand-up meeting	.076	.065	1.175	.242
	Q8_5 Keeping task sizes small	.222	.082	2.698	.008*
	Q8_7 Using visual management	.161	.065	2.467	.015*

Note: *Model df = 4, F Value = 16.207, *Sig. ≤ 0.05, adjusted R square = 0.289*

In reference to “customer satisfaction” as the dependent variable, the variables “keeping task sizes small” and “using visual management” had significant relationships with that dependent variable. Table 17 shows both variables with a p-value under 0.05 indicating significance of the variables in predicting the outcome of “customer satisfaction.” “Keeping task sizes small” again, had the highest impact (B = .222) on the model. A one-unit increase in “keeping task sizes small,” holding all other variables constant, is predicted to result in a .222 increase in “customer satisfaction,” while a one-unit increase in “using visual management,” holding all other variables constant, is predicted to result in a .161 increase in "customer satisfaction." With an adjusted R-squared value of 0.289, these variables are useful in explaining 29% of the variance in the model. The final model used to evaluate the total predicted impact on "customer satisfaction" is:

$$\text{Customer satisfaction} = 1.887 + .099(Q7\_1) + .076(Q8\_1) + .222(Q8\_5) + .161(Q8\_7)$$

The fourth dependent variable examined was "within project budget" with the regression results for this variable shown in Table 18. The project budget is the third leg of the golden triangle (quality, cost, and timing) mentioned in Chapter 1.

Table 18

Parameter Estimates for Within Project Budget by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
Within project budget	Intercept	2.148	.375	5.724	.000*
	Q7_1 Commitment by management with a clear vision	.035	.072	.493	.622
	Q8_1 Holding daily stand-up meeting	-.080	.078	-1.032	.304
	Q8_5 Keeping task sizes small	.180	.099	1.806	.073
	Q8_7 Using visual management	.264	.079	3.342	.001*

Note: *Model df = 4, F Value = 8.238, *Sig. ≤ 0.05, adjusted R square = 0.162*

When the same four predictor variables were analyzed against the dependent variable of "being within the project budget," Table 18 summarizes that only one variable, "using visual management" (sig. = .000) was significant. "Using visual management" had the highest predicted impact (B = .264) on being within project budget, meaning that a one-unit increase in "using visual management," holding all other variables constant, is predicted to result in a .264 increase in being "within project budget." Notice that in this equation, "holding daily stand-up meeting" has a negative coefficient (B = -.080). This means that a one-unit increase in this variable will result in a reduction of .080 in the value of "within project budget." With an adjusted R-squared value of 0.162, these variables are useful in explaining 16% of the variance in the model. The final model used to evaluate the total predicted impact on "within project budget" is:

$$\text{Within project budget} = 2.148 + .035(Q7\_1) - .080(Q8\_1) + .180(Q8\_5) + .264(Q8\_7)$$

The fifth dependent variable examined was "increased business revenue" with the regression results for this variable shown in Table 19. "Increased business revenue" was reported in Table 11 with the lowest mean score (*M* = 3.56) of the project success dependent variables.

Table 19

Parameter Estimates for Increased Business Revenue by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
Increased business revenue	Intercept	.778	.407	1.912	.058
	Q7_1 Commitment by management with a clear vision	.229	.078	2.937	.004*
	Q8_1 Holding daily stand-up meeting	.132	.084	1.569	.119
	Q8_5 Keeping task sizes small	.189	.108	1.757	.081
	Q8_7 Using visual management	.112	.086	1.310	.192

Note: *Model df = 4, F Value = 12.895, *Sig. ≤ 0.05, adjusted R square = 0.241*

Only one of the four predictor variables had a significant relationship with "increased business revenue." Table 19 shows that "commitment by management with a clear vision" (sig. = .004) had p-value below .05. In this case, "commitment by management with a clear vision" had the highest impact (B = .229) on the model, meaning that a one-unit increase in "commitment by management with a clear vision," holding all other variables constant, is predicted to result in a .229 increase in "increased business revenue." With an adjusted R-squared value of 0.241, these variables are useful in explaining 24% of the variance in the model. The final model used to evaluate the total predicted impact on "increased business revenue" is:

Increased business revenue = .778 + .229(Q7_1) + .132(Q8_1) + .189Q8_5) + .112(Q8_7)

The sixth dependent variable examined was "improved managerial effectiveness" with the regression results for this variable shown in Table 20. Serrador and Pinto (2015) noted the importance of management sharing the vision as a factor of project success.

Table 20

Parameter Estimates for Improved Managerial Effectiveness by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
Improved managerial effectiveness	Intercept	.423	.343	1.232	.220
	Q7_1 Commitment by management with a clear vision	.175	.066	2.661	.009*
	Q8_1 Holding daily stand-up meeting	.104	.071	1.461	.146
	Q8_5 Keeping task sizes small	.197	.091	2.161	.032*
	Q8_7 Using visual management	.337	.072	4.666	.000*

Note: *Model df = 4, F Value = 29.387, *Sig. ≤ 0.05, adjusted R square = 0.431*

The variables significant in predicting "improved managerial effectiveness" were "commitment by management with a clear vision" (sig. = .009), "keeping task sizes small" (sig. = .032), and "using visual management" (sig. = .000). "Using visual management" is shown in Table 20 as having the highest impact (B = .337) on "improved managerial effectiveness," meaning that a one-unit increase in "using visual management." holding all other variables constant, is predicted to result in a .337 increase in "improved managerial effectiveness." With an adjusted R-squared value of 0.431, these variables are useful in explaining 43% of the variance in the model. The final model used to evaluate the total predicted impact on improved managerial effectiveness is:

Improved managerial effectiveness = .423 + .175(Q7_1) + .104(Q8_1) + .197(Q8_5) + .337(Q8_7)

The seventh dependent variable examined was "improved employee engagement" with the regression results for this variable shown in Table 21. Stray et al. (2016) described the daily stand-up meeting as a brief communicative event between team members. The results show that the independent variable "holding daily stand-up meeting" was in fact significant in predicting the dependent variable "improved employee engagement."

Table 21

Parameter Estimates for Improved Employee Engagement by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
Improved employee engagement	Intercept	1.233	.307	4.021	.000*
	Q7_1 Commitment by management with a clear vision	.170	.059	2.900	.004*
	Q8_1 Holding daily stand-up meeting	.280	.064	4.396	.000*
	Q8_5 Keeping task sizes small	.138	.081	1.699	.091
	Q8_7 Using visual management	.157	.065	2.427	.016*

Note: *Model df = 4, F Value = 29.808, *Sig. ≤ 0.05, adjusted R square = 0.434*

"Holding daily stand-up meeting" is listed in Table 21 as the variable with the highest impact (B = .280) on "improved employee engagement," meaning that a one-unit increase in "holding daily stand-up meeting," holding all other variables constant, is predicted to result in a .280 increase in "improved employee engagement." Along with this variable with a p-value of (sig. = .000), "commitment by management with a clear vision" (sig. = .004) and "using visual management" (sig. = .016) were also significant. With an adjusted R-squared value of 0.434, these variables are useful in explaining 43% of the variance in the model. The final model used to evaluate the total predicted impact on "improved employee engagement" is:

Improved employee engagement = 1.233 + .170(Q7_1) + .280(Q8_1) + .138(Q8_5) + .157(Q8_7)

The eighth dependent variable examined was "ability to react to change" with the regression results for this variable shown in Table 22. The dependent variable "ability to react to change" was shown in Table 11 as the highest mean value (*M* = 4.57) of all dependent variables defining project success.

Table 22

Parameter Estimates for Ability to React to Change by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
Ability to react to change	Intercept	1.793	.320	5.608	.000*
	Q7_1 Commitment by management with a clear vision	.142	.061	2.320	.022*
	Q8_1 Holding daily stand-up meeting	.117	.066	1.765	.080
	Q8_5 Keeping task sizes small	.260	.085	3.071	.003*
	Q8_7 Using visual management	.138	.067	2.058	.041*

Note: *Model df = 4, F Value = 20.646, *Sig. ≤ 0.05, adjusted R square = 0.344*

The "ability to react to change" also had three significant predictor variables: "commitment by management with a clear vision" (sig. = .022), "keeping task sizes small" (sig. = .010), and "using visual management" (sig. = .041). Table 22 lists these results, as well as showing the highest impact on "ability to react to change" coming from "keeping task sizes small" (B = .260). With an adjusted R-squared value of 0.344, these variables are useful in explaining 34% of the variance in the model. The final model used to evaluate the total predicted impact on "ability to react to change" is:

Ability to react to change = 1.793 + .142(Q7_1) + .117(Q8_1) + .260(Q8_5) + .138(Q8_7)

The ninth dependent variable examined was "reduced project risk" with the regression results for this variable shown in Table 23. There was only one of the four independent variables that was significant in this model.

When "reduced project risk" was concerned, "keeping task sizes small" (B = .286) had the highest impact, meaning that a one-unit increase in "keeping task sizes small," holding all other variables constant, is predicted to result in a .286 increase in "ability to react to change." Table 23 shows that "keeping task sizes small" (sig. = .002) was also the only significant variable in the model.

Table 23

Parameter Estimates for Reduced Project Risk by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
Reduced project risk	Intercept	1.561	.340	4.591	.000*
	Q7_1 Commitment by management with a clear vision	.094	.065	1.447	.150
	Q8_1 Holding daily stand-up meeting	.085	.071	1.200	.232
	Q8_5 Keeping task sizes small	.286	.090	3.173	.002*
	Q8_7 Using visual management	.139	.072	1.942	.054

Note: *Model df = 4, F Value = 15.840, *Sig. ≤ 0.05, adjusted R square = 0.284*

With an adjusted R-squared value of 0.284, these variables are useful in explaining 28% of the variance in the model. The final model used to evaluate the total predicted impact on "reduced project risk" is:

$$\text{Reduced project risk} = 1.561 + .094(Q7\_1) + .085(Q8\_1) + .286(Q8\_5) + .139(Q8\_7)$$

The tenth dependent variable examined was "improved project visibility" with the regression results for this variable shown in Table 24. The only independent variable of the four that was a significant predictor for this model was "using visual management."

Table 24

Parameter Estimates for Improved Project Visibility by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
Improved project visibility	Intercept	1.635	.340	4.803	.000*
	Q7_1 Commitment by management with a clear vision	.093	.065	1.430	.155
	Q8_1 Holding daily stand-up meeting	.075	.071	1.062	.290
	Q8_5 Keeping task sizes small	.136	.090	1.507	.134
	Q8_7 Using visual management	.362	.072	5.051	.000*

Note: *Model df = 4, F Value = 22.168, *Sig. ≤ 0.05, adjusted R square = 0.361*

"Using visual management" resulted in the highest impact (B = .362) when predicting "improved project visibility." Table 24 lists the only significant variable as being "using visual management" (sig. = .000). Therefore, a one-unit increase in "using visual management" holding all other variables constant, is predicted to result in a .362 increase in "improved project visibility." With an adjusted R-squared value of 0.361, these variables are useful in explaining 36% of the variance in the model. The final model used to evaluate the total predicted impact on "improved project visibility" is:

Improved project visibility = 1.635 + .093(Q7_1) + .075(Q8_1) + .136(Q8_7) + .362(Q8_7)

The last dependent variable examined was "improved team dynamics/morale" with the regression results for this variable shown in Table 25. It should be noted that the 11 dependent variables shown in Tables 15 through 25 were not listed in any order of importance. The results for each variable were simply reported in the order listed on the survey instrument.

Table 25

Parameter Estimates for Improved Team Dynamics/Morale by Agile Project Management Predictor Variables

Dependent Variable	Parameter	B	Std. Err	t	Sig.
Improved team dynamics/morale	Intercept	1.796	.363	4.940	.000*
	Q7_1 Commitment by management with a clear vision	.037	.070	.525	.600
	Q8_1 Holding daily stand-up meeting	.165	.075	2.193	.030*
	Q8_5 Keeping task sizes small	.192	.096	1.999	.047*
	Q8_7 Using visual management	.212	.076	2.773	.006*

Note: *Model df = 4, F Value = 14.920, *Sig. ≤ 0.05, adjusted R square = 0.271*

The last dependent variable evaluated, "improved team dynamics/morale," is listed in Table 25. "Using visual management," once again, had the highest impact (B = .212). Three variables, "holding daily stand-up meeting" (sig. = .004), "keeping task sizes small" (sig. = .047), and "using visual management" (sig. = .006), were significant in this analysis. With an adjusted R-squared value of 0.271, these variables are useful in explaining 27% of the variance in the model. The final model used to evaluate the total predicted impact on "improved team dynamics/morale" is:

Improved team dynamics/morale = 1.796 + .037(Q7_1) + .165(Q8_1) + .192(Q8_7) + .212(Q8_7)

Factor Analysis. A factor analysis was completed to identify if the independent variables could be clustered together and identified into common themes. The purpose of performing a factor analysis is to reduce a cluster of highly correlated variables into fewer components called factors (Field, 2013).

Eigenvalues were used as an estimate of how much variance in the data each factor could explain. Starting with 45 factors, only 11 had an initial Eigenvalue greater than 1.0, explaining 69% of the variance. An Eigenvalue greater than 1.0 represents a substantial amount of variation (Field, 2013), therefore, concentrating on the factors with Eigenvalues greater than 1.0 focuses on the factors with the most explanatory power. The scree plot in Figure 10 displays the factors with the cumulative Eigenvalues from highest to lowest, and shows a point of inflexion at 5, where the curve tapers-off to a horizontal line. Based on this point of inflexion, I ran the analysis to create four factor clusters which represent 47% of the variance: organizational (including 13 of the 45 independent variables), organizational challenges (including eight of the 45 independent variables), human resources (including 12 of the 45 independent variables), and technical (including 16 of the 45 independent variables). All variables with coefficients below .400 were suppressed, so the values below .400 are not shown in the variable factor tables which follow.

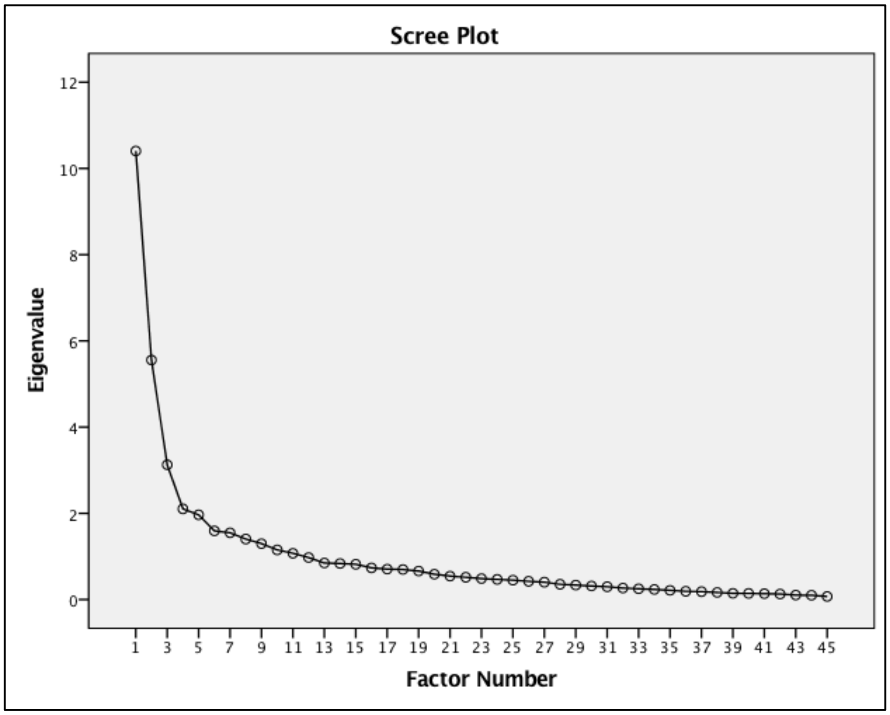

Figure 10. Factor Analysis Scree plot of Eigenvalues by factor.

The first factor included 13 variables related to the area of the organization that agile project management was prevalent, fitting the *organizational factor* theme. Table 26 displays a complete list of variables that had a value of .400 or greater for this cluster.

Table 26

Pattern Matrix for Factor Analysis – Factor 1 (Organizational Factors)

Independent Variable	Factor Loading
Design & prototyping	.841
Validation	.814
Tooling	.760
Initiation	.718
Functional product development	.672
Research & development	.594
Production & operations (manufacturing)	.566
Highly capable team	.435
Commitment by management with a clear vision	.428
Hardware development	.427
Mass production	.411

Note: *Extraction Method: Principal Axis Factoring.*
Rotation Method: Oblimin with Kaiser Normalization.
Cronbach's Alpha = .890.

This factor revealed high reliability via a strong Cronbach's Alpha (0.890). The factor loading values explain the impact each variable has on the factor. For the *organizational factor*, "Design & prototyping" (factor load = .841), "validation" (factor load = .814), "tooling" (factor load = .760), and "initiation" (factor load = .718) were among the variables with the highest loadings. The common theme of these variables relates to the project stages and areas in an organization. Although "dedicated team members (factor load = .347) was included in the results for the *organizational* factor, its low value indicates that it had less of an impact on this factor.

The second factor included eight variables related to barriers to using agile project management. This factor had high reliability with a strong Cronbach's Alpha (0.867). Table 27 shows a list of the variables that had a value of .300 or greater which fit within an *organizational challenge* theme.

Table 27

Pattern Matrix for Factor Analysis – Factor 2 (Organizational Challenge Factors)

Independent Variable	Factor Loading
Unclear project scope	.840
Lack of clear company vision	.822
Lack of product owner involvement	.812
Lack of upper management support	.782
Lack of project management tools	.538
Project interruptions	.537
Product owner on more than one project	.452

Note: *Extraction Method: Principal Axis Factoring.*
Rotation Method: Oblimin with Kaiser Normalization.
Cronbach's Alpha = .867.

The variables with the highest factor loading values for the *organizational challenge* factor were "unclear project scope" (factor load = .840), "lack of clear company vision" (factor load = .822), "lack of product owner involvement" (factor load = .812), and "lack of upper management support" (factor load = .782) indicating that these four variables had the largest impact on the factor. All of the variables in this factor identified with challenges in using agile project management methods in the organization.

The third factor included 12 variables relating to human resource characteristics. This factor had high reliability with a strong Cronbach's Alpha (0.841). Table 28 provides a list of *human resource* factors with a value of -.300 or greater which are clustered together.

Table 28

Pattern Matrix for Factor Analysis – Factor 3 (Human Resource Factors)

Independent Variable	Factor Loading
Collocation of team	-.625
Finishing early (using yesterday's weather/results)	-.587
Having an interrupt buffer	-.587
Daily Scrum meetings	-.560
Small teams	-.549
Dedicated teams	-.470
T-shaped people (can help in 2 or more areas)	-.454
Stable teams	-.444
Ready backlog	-.435

Note: *Extraction Method: Principal Axis Factoring.*
Rotation Method: Oblimin with Kaiser Normalization.
Cronbach's Alpha = .841.

The fourth and last factor is made-up of 16 variables relating to Scrum Framework tools and techniques used. This factor had high reliability with a Cronbach's Alpha (0.897). Table 29 lists the variables relating to technical factors that have a value of -.400 or greater. These variables fit within a *technical* factor.

Table 29

Pattern Matrix for Factor Analysis – Factor 4 (Technical Factors)

Independent Variable	Factor Loading
Prioritizing back logs	-.845
Keeping task sizes small	-.778
Keeping iterations short	-.672
Using visual management	-.634
Holding retrospective meetings	-.616
Using team-based estimation	-.608
Using burn down charts	-.501
All testing completed within a sprint	-.423

Note: *Extraction Method: Principal Axis Factoring.*
Rotation Method: Oblimin with Kaiser Normalization.
Cronbach's Alpha = .897.

All four factor clusters identified had high reliability numbers as shown by the Cronbach's Alpha value (.897). In order to determine if these factors, made from several combined independent variables, were significant in predicting project success, a regression analysis was completed. Prior to running the regression analysis, a new combined dependent variable was computed in SPSS by taking the product of each of the individual dependent variables. The results are shown in Table 30.

Table 30

Regression Coefficients for Factors with Combined Dependent Variable

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	45.258	.739		61.280	.000
	Factor 1 Organizational	1.730	.985	.152	1.756	.082
	Factor 2 Organizational Challenges	-2.281	.936	-.186	-2.438	.017*
	Factor 3 Human Resources	-2.564	1.001	-.214	-2.561	.012*
	Factor 4 Technical	-5.992	1.147	-.509	-5.222	.000*

Notes: *Dependent Variable: ComboDV. Adjusted R Square = .531, *Sig. ≤ 0.05.*

The *organizational* factor (where agile project management is being used) was not significant (Factor 1, sig. = .082). This means that the independent variables that made up this factor cluster, such as “design & prototyping,” “validation,” and “tooling,” are not significant in predicting the combined dependent variable of project success. However, organizational challenges (Factor 2, sig. = .017), human resource (Factor 3, sig. = .012), and technical (Factor 4, sig. = .000) factors were all significant in predicting project success.

The *technical* factor cluster had the highest impact (B = -5.992) on the combined dependent variable for project success. With an adjusted R-squared value of 0.531, these four factor clusters are useful in explaining 53% of the variance in the model. The four factor clusters presented in Tables 26 through 29 align with the organizational, human resource, and technical factors presented in the conceptual frame in Chapter 1.

To summarize research question two, the four significant independent variables useful for predicting project success were “commitment by management with a clear vision,” “holding daily stand-up meetings,” “keeping task sizes small,” and “using visual management The variables were significant for predicting the collective group of 11 dependent variables that defined project success. The factor analysis showed that the independent variables could be clustered into the three main factors of organizational, human resource, and technical. The next section will provide data for the reasons companies were not using agile project management methods.

Research Question 3. Research question 3 asked those companies not using agile project management, why not? Respondents indicating that their company did not use, or had no interest in using agile project management methods were skipped to a final question asked only of this group. This group was asked to indicate why they were not using agile project management methods. Table 31 shows varied responses to this question, with answers ranging from “completely disagree” to “completely agree.”

Scores for this question are listed from highest to lowest mean, with "insufficient time to change from current methods" (*M* = 3.96), "lack of management support" (*M* = 3.91), and "a more structured system is required in our industry" (*M* = 3.86) showing the highest scores skewed towards agreement, indicating a possible issue with those areas. "No benefits are expected" (*M* = 2.88) was scored the lowest of the variables indicating that most respondents thought that agile had some benefit.

Table 31

Reasons for not Using Agile Project Management Methods (n=60)

Q16: Why are you not using agile project management methods?	Completely disagree (1) n (%)	Mostly disagree (2) n (%)	Slightly disagree (3) n (%)	Slightly agree (4) n (%)	Mostly agree (5) n (%)	Completely agree (6) n (%)	Mean	Std. Dev.
Insufficient time to change from current methods	5 (8.9)	5 (8.9)	11 (19.6)	10 (17.9)	16 (28.6)	9 (16.1)	3.96	1.53
Lack of management support	9 (15.8)	5 (8.8)	6 (10.5)	11 (19.3)	14 (24.6)	12 (21.1)	3.91	1.74
A more structured system is required in our industry	9 (15.8)	5 (8.8)	4 (7.0)	15 (26.3)	15 26.3)	9 (15.8)	3.86	1.66
Our customer requires a specific approach	12 (21.4)	4 (7.1)	4 (7.1)	15 (26.8)	11 (19.6)	10 (17.9)	3.70	1.78
Lack of training available	8 (14.0)	4 (7.0)	13 (22.8)	15 (26.3)	12 (21.1)	5 (8.8)	3.6	1.49
No benefits are expected	12 (21.1)	12 (21.1)	14 (24.6)	12 (21.1)	4 (7.0)	3 (5.3)	2.88	1.43

Note: Not all participants responded to all items.

There were 18 open-ended comments left by respondents such as not having any control over what products their company uses, resistance to change, and the notion that agile is too expensive to implement. Additional comments suggested that customers or industries were too structured, or had critical characteristics about their projects that did not allow the introduction of agile project management to take place.

In summary of research question three, not all industries or work areas were appropriate for using an agile approach to project management. Where the industries were appropriate, a lack of management support was among the top responses of why agile project management methods were not used.

Chapter 4 Closure

Chapter 4 presented the descriptive statistics and inferential data calculated from the results of the electronic survey created to explore agile project management in non-software industries. Information from the survey was used to answer three research questions. Two research questions were answered using frequency, mean, and standard deviation values. The remaining research question was answered by showing relationships between variables using correlation, regression, multivariate regression, and factor analysis techniques. A discussion of major results and concluding thoughts will follow in Chapter 5.

CHAPTER 5

DISCUSSION

This chapter summarizes the major results from the online survey instrument titled, *Agile in Non-Software Related Industries,* which was completed by 540 practitioners belonging to the Scrum Alliance, Scrum Inc., West Michigan Project Management Institute, and/or the LinkedIn Agile group. The purpose of this research study was to understand whether agile project management methods used successfully in the software industry are also being used in full, or in part, in non-software development industries when managing product development projects.

This chapter presents the major research study results to explain how this information helps answer the research questions presented in Chapter 1, to discuss the importance of the findings, and to compare how these findings relate to previous research studies of agile project management. Limitations of this research study, and implications for future research will also be presented.

Analysis/Discussion of Major Results

Although the intended population of interest for this research study was limited to users of agile project management methods in industries other than software development, the membership of the organizations chosen to participate in the survey included respondents from all industries. For this reason, a large portion (n = 211) of respondents that started the survey were skipped out of the survey as a result of their affiliation with their IT or software development roles, resulting in 329 (72.3%) participants in non-software development industries. Additionally, 91 respondents who were not using agile project management methods were skipped out of the survey, leaving only those respondents using agile methods in non-software related industries (n = 238) to answer my three research questions.

Findings Related to Research Question 1

The first research question asked to what extent, and how, companies are using agile project management methods to develop products other than software?

After filtering-out the respondents working in IT or software development, as well as those that reported no interest or use of agile project management methods, the top three industries of reported usage of the 238 respondents were manufacturing (n = 49, 20.6%), training and consulting (n = 40, 16.8%), and research and development (n = 33, 13.9%). These results suggest the iterative development sequence of most research and development efforts can be a logical place for agile project management methods to be used. Manufacturing is often considered a very structured environment, but the product development stage and continuous improvement loops are two areas that may be suitable for agile project management methods. Training and consulting functions can be agile in their approach through their methods used to train, but also in leading clients towards using agile project management methods in their roles.

The respondents' work area in their organization showing the largest frequency of use was in product design and development (n = 93, 39.1%), followed by training and consulting (n = 21, 8.8%) as the next most frequent area. Using the Likert scale from 1 (not used at all) to 6 (always used), the mean score values for functional product development (M = 4.68) and research and development (M = 4.43) had the highest frequency results for the use of agile project management methods by work area. Product design and development, functional product development, and research and development are all logical selections for agile project management, as these work areas are all early development functions which typically proceed in iterative improvement cycles.

The average time that participants had been using agile project management methods was 6.3 years. However, it is not clear whether the respondents may have gained experience in the software industry prior to their current role, or if all of their experience came from their current role. The 238 respondents represented 44% of the original 540 respondents, indicating that agile project management is indeed used in industries beyond software development and IT.

When asked to report on what stage of a project the respondents used agile project management methods, design and prototype ($M = 4.75$), initiation ($M = 4.57$), and validation ($M = 4.34$) were the highest reported stages using a Likert scale from 1 (not used at all) to 6 (always used). Tooling ($M = 3.5$) and mass production ($M = 2.82$) were reported with the lowest usage. Tooling often requires long lead times and high investment costs, and must be completed to a level where it can produce a part of the product. For tooling, the benefits of building a minimal viable product to collect feedback and accelerate revenue generation may be difficult to achieve. Tooling most often needs to be completed to a nearly full level in order to product a part. However, the use of prototype tooling, or fast, low cost temporary tooling, could be a step towards an agile approach. Although agile project management methods are used less in the tooling phase, this may be an area that warrants further study. Finding methods to produce shorter lead times and lower cost tooling could allow practitioners to learn and react to necessary changes faster. This improvement in tooling speed and price may be a way to increase the usage of agile project management methods in the tooling phase, potentially allowing practitioners to integrate the tooling development phase as an iterative cycle of product development.

It is important to note that some respondents did not like how the question broke the project into stages, like a waterfall system. Respondents provided comments arguing that Scrum and agile do not have project stages, but instead move through each phase with every iteration of a potentially shippable product. However, the intent of this question was to see if people were using agile methods only in portions of a development project. The data shows that the mean values for each of the stages listed are different, indicating that respondents are using agile project management methods at a different level depending on the stage of the project. This thought pattern supports the suggestion by Cooper (2014) that a blend can be achieved by embedding agile development methodology inside a stage-gate model.

Results of the survey showed the factor that prevented respondents from using agile project management methods was having team members on multiple projects ($M = 4.25$) as rated on a Likert scale from 1 (not at all challenging) to 6 (extremely challenging). When team members are asked to participate in multiple projects, their performance may be less efficient as opposed to when they were allowed to focus their efforts on a specific task.

Findings Related to Research Question 2

The second research question asked to what extent the organizational, human resource, and technical factors predict the perceived level of success when using agile project management methods? This research study sought to understand which of the independent variables were significant in predicting project success when using agile project management methods in industries outside of software development. Project success was defined by 11 dependent variables: (1) on-time delivery, (2) improved product quality, (3) customer satisfaction, (4) within project budget, (5) increased business revenue, (6) improved managerial effectiveness, (7) improved employee engagement, (8) ability to react to change, (9) reduced project risk, (10) improved project visibility, and (11) improved team dynamics/moral.

Individual dependent variables. It is important to note that a number of independent variables may be significant in predicting any of the individual dependent variables of project success (e.g., on-time delivery) when analyzed in isolation. For the purpose of this study, in order for an independent variable to be significant in predicting project success as a whole, it was required to have a p-value equal to or less than 0.05.

Only four independent variables showed significance below the p-value of 0.05 when analyzed against all 11 dependent variables: "Commitment by management with a clear vision," "holding daily stand-up meetings," "keeping task sizes small," and "using visual management." Moreover, after using SPSS to compute the parameter estimates for each of the individual dependent variables, not all of the four variables showed significance for each model. Table 32 summarizes the significance for each of the four independent variables as tested against the individual dependent variables.

The independent variable that was a significant predictor for the most dependent variables was "using visual management" (9 of 11 dependent variables). "Keeping task sizes small" was next (7 of 11 dependent variables), followed by "commitment by management with a clear vision" (5 of 11 dependent variables), and "holding daily stand-up meeting" (2 of 11 dependent variables). This data suggests that "using visual management" and "keeping task sizes small" can have the greatest impact on project success when considering the dependent variables as a group. The use of visual management is an important finding considering the availability of the internet and other electronic solutions available for tracking information. Although information can be collected manually or electronically, displaying the information visually provides a constant reference for team members. Keeping task sizes small was presented by Karlström and Runeson (2005) as a way to allow teams to focus, reduce confusion, and provide a sense of giving practitioners control of their work.

Table 32

Significant Independent Variables Predicting Dependent Variables

	Independent Variables			
Dependent Variable (Predicts)	Commitment by Management With a Clear Vision	Holding Daily Stand-up Meeting	Keeping Task Sizes Small	Using Visual Management
On-time delivery			X	X
Improved product quality	X		X	X
Customer satisfaction			X	X
Within project budget				X
Increased business revenue	X			
Improved managerial effectiveness	X		X	X
Improved employee engagement	X	X		X
Ability to react to change	X		X	X
Reduced project risk			X	
Improved project visibility				X
Improved team dynamics/morale		X	X	X

X = Significant $p \leq 0.05$.

Although "holding daily stand-up meeting" only showed a significant impact for "improved employee engagement" and "improved team dynamics/morale," it was still a significant independent variable when analyzed against all 11 dependent variables of project success, and therefore, should not be underestimated. When asked about the frequency of holding any of the scrum meetings, respondents tended to hold meetings on a more frequent basis, with the daily meeting being the most frequent (62%; *n* = 88).

The percentage of variance in the dependent variables is explained by the significant independent variables. Table 33 shows the percentage of explained variance for each dependent variable, along with its related significant independent variables.

Table 33

Percentage of Variance in Dependent Variables Predicted by Independent Variables

Dependent Variables	% of Variance Accounted For	Significant Independent Variables
On-time delivery	35.6%	• Keeping task sizes small • Using visual management
Improved product quality	42.2%	• Commitment by management with a clear vision • Keeping task sizes small • Using visual management
Customer satisfaction	28.9%	• Keeping task sizes small • Using visual management
Within project budget	16.2%	• Using visual management
Increased business revenue	24.1%	• Commitment by management with a clear vision
Improved managerial effectiveness	43.1%	• Commitment by management with a clear vision • Keeping task sizes small • Using visual management
Improved employee engagement	43.4%	• Commitment by management with a clear vision • Holding daily stand-up meeting • Using visual management
Ability to react to change	34.4%	• Commitment by management with a clear vision • Keeping task sizes small • Using visual management
Reduced project risk	28.4%	• Keeping task sizes small
Improved project visibility	36.1%	• Using visual management
Improved team dynamics/morale	27.1%	• Holding daily stand-up meeting • Keeping task sizes small • Using visual management

For example, 35.6% of the variance in "on-time delivery" is explained by the two independent variables "keeping task sizes small" and "using visual management." The value for the percentage of variance explained is provided by the R-squared result in the SPSS multivariate regression analysis. Lomax and Hahs-Vaughn (2012) suggested that the coefficient of determination, which conveys the proportion of total variation in the dependent variable, can be used as a measure of effect size, with an R-squared value of 0.10 being a small effect size, an R-squared value of 0.3 a medium effect size, and an R-squared value of 0.5 a large effect size. The effect size is a standardized way of measuring the magnitude of the effect, or the strength of the relationship between variables (Field, 2013).

The largest R-squared value belonged to "improved employee engagement" (43.4%), explained by "commitment by management with a clear vision," "keeping task sizes small," and "using visual management." When these three independent variables were in place, they accounted for nearly half of the variance associated with employee engagement, which is a strong effect. Having a high level of employee engagement can be beneficial for team performance, and was rated by the respondents as one of the top three accomplishments as a result of using agile project management methods. The smallest R-squared value (16.2%) was connected with the dependent variable "within project budget," and "using visual management" as the only significant independent variable.

Although there were only four significant independent variables, they were able to result in a number of medium and high effect sizes. One noticeable trend in the data is that the larger effect sizes belonged to dependent variables predicted by most of the four independent variables, while the small effect sizes tended to include fewer of the independent variables.

The four independent variables that showed significance in predicting perceived project success seem to align with the thoughts by Takeuchi and Nonaka (1986) regarding self-managed teams. That is, if the management team provides the commitment with a clear vision, teams could self-manage their progress on small tasks by using visual management methods during their daily stand-up meetings.

Factor analysis of independent variables. A factor analysis was utilized to place independent variables into factor clusters. The resulting factor clusters were comprised of independent variables with common themes which supported the conceptual frame presented in Chapter 1. These clusters represented organizational, human resource, and technical factors as illustrated in Figure 11.

Only the independent variables with factor loadings equal to or greater than 0.400 are shown in the figure. "Holding daily stand-up meeting" was a significant variable, but had a factor loading less than 0.400, therefore is not shown in the table. This variable was listed in three of the factor clusters (organizational, human resources, technical) with values less than 0.400. This independent variable is very similar with the variable "daily scrum meetings" listed in the "human resources" factor cluster with a factor loading of -0.560. These two variables have the same intent, but were listed in the survey instrument with slightly different titles. Therefore, I am showing a relationship between the "human resource" factor with the two dependent variables of "improved employee engagement" and "improved team dynamics/morale." This relationship is shown as a dotted green line in Figure 11.

The independent variable "commitment by management with a clear vision" was the only variable listed within the "organizational" factor cluster. This variable had a significant relationship with five of the 10 dependent variables of project success.

The independent variables "keeping task sizes small" and "using visual management" both fell within the "technical" factor cluster. These variables had significant relationships with 10 of the 11 dependent variables of project success, leaving "business revenue" as the only non-significant relationship. Based on the number of significant relationships these independent variables had with the 10 dependent variables, practitioners in non-software related fields may want to consider placing them at the top of their implementation list.

The technical factor cluster contained the most independent variables that were significant in predicting the most (10 of 11) dependent variables of project success. These independent variables were "keeping task sizes small" and "using visual management." This is illustrated in Figure 8 by the connecting lines between the factor clusters and dependent variables.

The organizational factor contained two separate factor clusters. Factor 1 contained the independent variables that defined what agile project management methods were used for and where, and factor 2 was made up of independent variables that defined organizational challenges. When the factor clusters were analyzed for their significance in predicting project success, the only factor cluster that was not significant in predicting project success was factor 1 of the organizational independent variables. The factor analysis showed that this organizational factor was not significant in predicting project success. In this case, project success was not dependent on where agile project management was being performed. The remaining three factor clusters were significant in predicting project success.

The division of independent variables into organizational, human resource, and technical factors supported the idea from Conforto et al. (2014) that agile project management methods include enablers and tools. The organizational and human resource factors are internal and external factors that may enable agile project management, while the technical factors are the tools, actions, and techniques that may guide the implementation of agile project management.

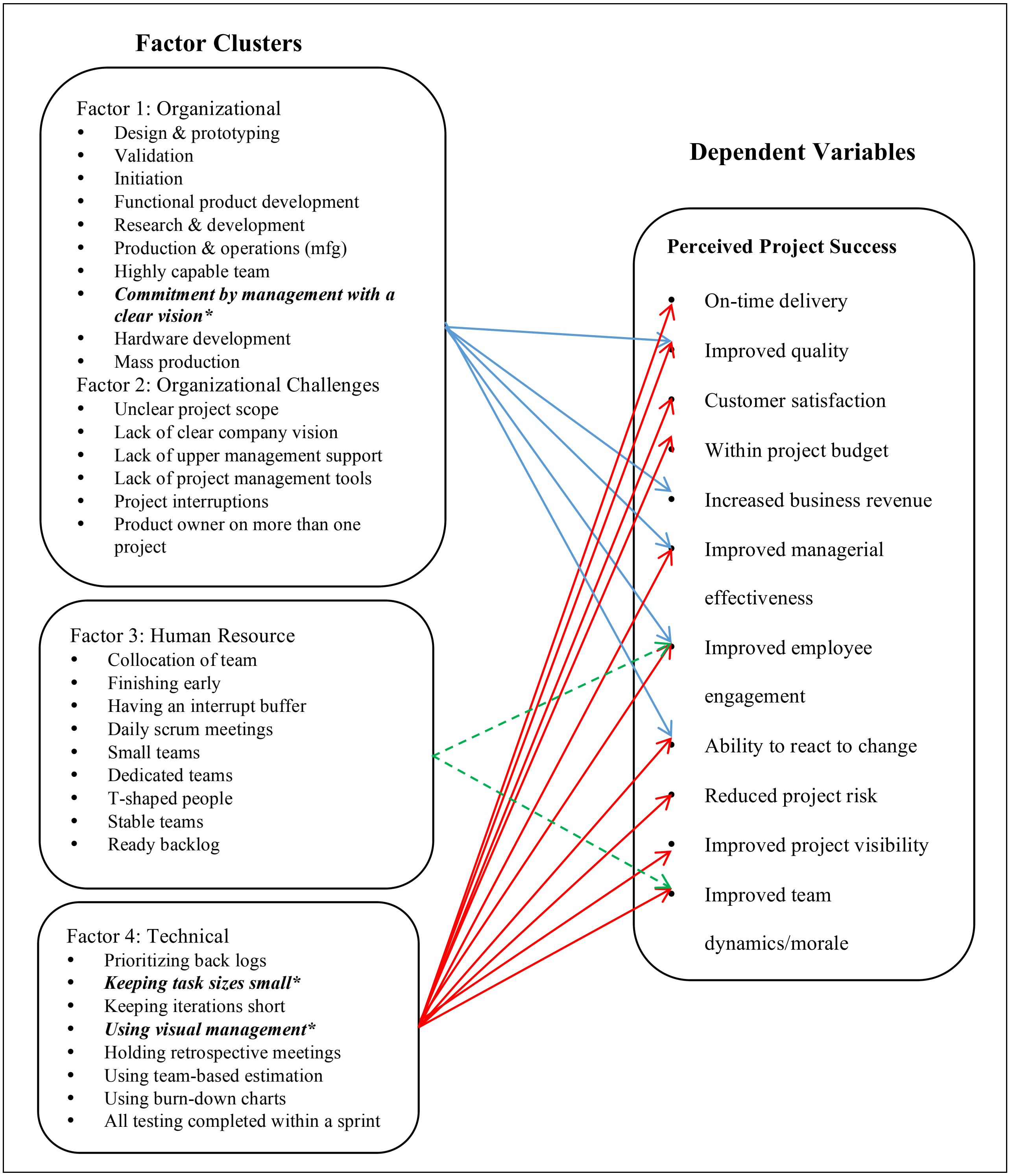

Figure 11. Factor clusters influencing project success, showing independent variables with factor loading greater than 0.400. * Significant ($p \leq 0.05$). The independent variable "holding daily stand-up meeting" was a significant independent variable, but is not shown due to its factor loading being less than 0.400.

Findings Related to Research Question 3

The third research question asked if companies are not using agile project management, why not? The independent variables that resulted in the highest scores for why respondents were not using agile project management methods were "insufficient time to change from current methods" (*M* = 3.96), and "lack of management support" (*M* = 3.91). The fact that the "lack of management support" was listed as a barrier for using agile project management supports the result of "commitment by management with a clear vision" being a significant independent variable for predicting project success.

In an open-ended comment section, respondents also indicated that their particular customer or industry required them to use specific processes in order to meet stringent safety requirements. These comments supported Serrador and Pinto (2015) where they indicated that certain project circumstances, such as large projects with known futures or projects with specific safety factors may be better suited for traditional waterfall project management techniques. Respondents also indicated that there was a resistance to change, their teams were not set-up in a way that agile methods could be used, and that their company thought that agile methods would cause issues by miss-prioritizing their work or resulting in additional expense.

The variable that received the lowest mean score was "no benefits are expected" (*M* =2.88). This score indicates that most respondents, even though agile project management methods were not being used, believed that agile methods would provide benefits to their project development efforts.

Given the findings from the three research questions, it can be concluded that agile project management methods are being used in industries beyond the software development and IT categories. Due to safety and regulatory requirements, some industries or product segments are not suitable for using agile project management methods. The average length of time that respondents have used agile project management methods in non-software/IT development industries was 6.3 years.

There are a number of independent variables that can be applied when adopting an agile project management approach, but not all variables resulted in being significant for predicting all 11 dependent variables of project success. Using visual management, keeping task sizes small, having a commitment by management with a clear vision, and holding daily stand-up meetings were the only significant independent variables for predicting the combined dependent variables of project success.

Relationship of Results to Previous Research

Previous research on agile methods from Chow and Cao (2008), Dikert et al. (2016), Misra et al. (2009), Serrador and Pinto (2015), and Stankovic et al. (2013), identified independent variables that were significant in predicting the dependent variable of project success. Chow and Cao (2008) presented a research model that illustrated how organizational, people, process, technical, and project factors were used as groups of independent variables to study their relationship with perceived success of the agile software development project as evaluated by quality, scope, time, and cost. The conceptual model chosen for my research study, and supported by the factor analysis, used a similar clustering of the independent variables, of using organizational, human resources, and technical as the factors. Although most of these studies targeted a population within the software development industry, there was interest in learning whether the same predictor variables would carry-over to non-software industries. Table 34 shows the connections of key findings from my study with previous research and literature, indicating how the descriptive and inferential results from my study supported existing research.

The results of my survey instrument indicate that respondents are indeed using agile project management in industries beyond software development and IT. The largest non-software response rate belonged to manufacturing. Using data from 1002 projects across multiple industries, Serrador and Pinto (2015) also reported that manufacturing was among the top response rate in their population.

The commitment by management with a clear vision confirmed the research from Dikert et al. (2006) and Misra et al. (2015) who also reported on the importance of management support and corporate culture. When respondents were asked in my survey instrument about the reasons they were not using agile project management methods, the lack of management support was the second highest reported answer. This data also supports the desire for the commitment by management with a clear vision.

In my findings, the independent variable that resulted as being the biggest reason for not using agile project management methods was “insufficient time to change from current methods.” Perhaps to counter this barrier, teams could transition into agile at the start of a new project. A “lack of management support” was the second highest reported reason for not using agile project management methods. This result is consistent with “commitment by management with a clear vision” surfacing as a significant variable for predicting project success. The variable that recived the lowest score in relation to why respondents were not using agile was “No benefits are expected.” This result indicates that respondents did not look at agile project management methods in a negative way, and that they would expect to see benefits if these methods were introduced in their work area.

"Keeping task sizes small" resulted in being a signicant independent variable for predicting project success. This variables was not found in the literature review as significant factor useful in predicting project success by other authors.

The Scrum Framework includes the independent variables of making work visible and holding daily scrum meetings as part of their suggested tools for success. The results of my survey insrument showed that "Holding daily stand-up meeting" and "using visual management" were significant factors for predicting project success. No previous research was found to support the significance of these variables.

Another suggested Scrum Framework variable was having a stable team. This was the highest scoring independent variable reported when asked about reducing project time. In a training event, Justice (2017) suggested that a stable team consisted of having four members, out of a team of five, being consistent. This variable was not reported as being significant in the research found for my literature review.

One other data point that was not presented in previous research was the number of years the respondents had been using agile project management methods. The average time the respondents in my research study used agile project management methods was 6.3 years. However, the survey instrument did not stipulate whether this experience was entirely in non-software development industries, or if this experienced was gained in the software industry and transferred with the respondent into a new work area. In either case, the experience of agile methods could be available to apply to non-software industries.

Table 34

Connections with Previous Research and Literature

Totten Findings (2017)	Previous Research
Agile project management methods are used in multiple industries other than software development and IT	Confirms Serrador and Pinto's (2015) findings regarding the use of agile in mulitple industries
The commitment by management with a clear vision is an important factor for creating successful team performance	Confirms Dikert et al. (2006) and Misra et al. (2009) findings regarding the importance of management support and corporate culture
Insufficient time to change from current methods was the highest reported reason for not using agile project management methods	No previous research found
A lack of expected benefits was not a reason for the absence of using agile project management methods	No previous research found
Holding daily stand-up meetings improves employee engagement and team dynamics	No previous research found
Keeping task sizes small enables teams to improve project success	No previous research found
Using visual management was significant in predicting the most variables of project success	No previous research found
Having stable teams was the highest reported Scrum techniques important to reducing project time	No previous research found
The average number of years respondents in non-software industries have been using agile project management methods is 6.3 years	No previous research found

Limitations

The data collection phase of this research study was limited by the terminology used to describe agile in conjunction with project management. Some respondents objected to the terminology of "agile project management." The feedback received in email responses as well as survey comments stated that agile is not a process, a methodology, or project management approach, but instead it is a mindset. Some respondents could not get past the terminology issue and refused to participate in the survey. In the literature review, the words "agile project management" were included in the title of the work of several authors (Augustine et al., 2013; Cervone, 2011; Conforto et al. 2014; Leybourne, 2009; Stare, 2014). This research study used similar terminology in order to build on previous research and to add to the body of knowledge.

Another limitation of the research study was the concentration of tools in the Scrum Framework. Respondents commented that the survey instrument was too heavy on Scrum and did not include other agile frameworks. Independent variables from the Scrum Framework were purposely chosen to be included in this research due to their popularity in a variety of industries. The popularity of Scrum was validated in this research when respondents chose Scrum (n = 150, 40%) as the framework most routinely used in their workplace.

The timing of the data collection phase may have also limited the number of respondents that participated in the study. The data collection was carried-out in May, June, and July which seemed to coincide with many respondent's vacation schedules, as a I received a number of out-of-office responses to both the initial and follow-up emails.

Implications for Future Research

Although the agile mindset is to complete all stages of a project within each iteration until a minimal viable product is achieved, the results of this research indicated that respondents vary in their usage of agile project management methods depending on the stage of the project. There may be reasons that a non-software development project needs to be managed in stages. Perhaps, each stage is a project in itself with several iterations taking place within the stage. It is also possible that practitioners in industries outside of software have simply not mastered the use of agile methods to eliminate the need for stages at all. There is an opportunity for future research to be conducted in order to provide insight into the use and need for project stages in non-software industries. Identifying and discussing industries, beyond software development, where stage gates have been reduced or eliminated through the optimization of factors such as cost and timing would provide valuable knowledge to project management professionals wishing to integrate agile methods. Further, the identification of industry segments where stage gate processes cannot be modified would also make a positive contribution of knowledge to research on agile project management.

The golden triangle of quality, cost, and timing is a common way to define project success (Drury-Grogan, 2014; Westerveld, 2003). However, there are several other attributes of project success, that do not fit neatly into these three categories, that may be valuable to the overall success of a team, company, or industry. The 11 dependent variables of project success introduced in this study were developed to provide a more detailed analysis of the independent variables that would result in a significant relationship with the collective project success variables. Future research studies could limit the number of dependent variables to a critical few in order to determine if a different set of independent variables surface as the significant factors in the study.

Implications for Practice

When the decision has been made to adopt agile project management methods in an industry outside of software development, project management practitioners have a large number of tools and techniques to select from to aid in their implementation efforts. The results of my study suggest that not all variables will have a significant impact on achieving project success.

Focusing implementation efforts on a subset of variables may offer teams a more efficient way of realizing project success. Having the support and commitment of the management team is an important first step. Exhibiting information visually and holding daily stand-up meetings will help keep team members engaged in the process, and keeping task sizes small will help promote the focus that is necessary for task completion.

The product development activity in some industries may currently take place in stages, such as when expensive tooling with long lead times is required. Implementation teams have the option to start their agile journey within a specific project stage they see as being more suitable for agile methods, and then expand beyond this stage as they gain experience. Ultimately, the team will be challenged to combine all stages within a single agile iteration to offer a minimal viable product to their customer. This may drive the team to innovate different methods of designing, tooling, and validating their products.

The variable clusters identified in the factor analysis (organizational, organizational challenges, human resource, and technical) provide the beginnings of a diagnostic tool for measuring the dimensions worth paying attention to when implementing agile project management methods. The impact that each factor has on project success can be monitored and used as feedback to create continuous improvement opportunities for firms as they implement agile project management methods. These factor analysis results can also be leveraged in future research to continue building this diagnostic instrument.

Concluding Thoughts

The results of this study reveal that agile project management methods are indeed being used in industries beyond software development. As this trend increases, implementation teams need to know what independent variables can have the greatest impact on achieving project success. These results suggest that the implementation of agile project management methods should include organizational and human resource factors as well as the tools of technical factors in order to be successful.

Project success was defined by 11 dependent variables and scored by respondents as to the extent each objective had been accomplished as a result of using agile project management methods. The variables scoring highest were those that affected the team members and the dynamics of the process itself, such as the ability to react to change, improved project visibility, improved employee engagement, and improved team dynamics/morale. The objectives that scored the lowest can be considered as those providing business performance benefits, such as on-time delivery, improved managerial effectiveness, staying within project budget, and increasing business revenue. It should be noted that although these scores were lower, all project success variables were rated relatively close, received scores within a range of 1.01 on the Likert scale. From the respondents' view, success came in the form of improved team dynamics. Although the business performance benefits lagged, the primary success from the team dynamics likely made a positive contribution towards the secondary performance benefits realized by the business.

The four significant independent variables shown to predict project success in this research study were (1) commitment by management with a clear vision, (2) holding daily stand-up meetings, (3) keeping task sizes small, and (4) using visual management. This would indicate that a newly formed agile project management team would see the most impact on project success if they started their implementation with these variables in place. Keeping task sizes small, visually displaying information, and holding daily update meetings are all techniques that will keep employees engaged.

The importance of management commitment was highlighted both as a significant predictor of project success, and when absent, was a barrier to implementing agile project management methods. This factor was also reported as a significant variable in previous research in the software industry, indicating that the tools within the agile framework, when significant in the software industry, may also be significant in non-software related industries.

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Appendix A

Survey Email

Subject line: Your Opinion on Agile in Non-Software Industries

Dear Agile Professional,

In support of my doctoral dissertation, I am conducting a survey to gather information about the use of agile project management methods in non-software industries.

The survey is expected to take less than ten minutes to complete. I ask that you complete this survey by June 20, 2017. Thank you in advance for supporting me by completing this survey.

Please access the survey by clicking the following link, or copying and pasting the URL into your web browser:

https://www.surveymonkey.com/r/Agile_in_Non-Software_Industries_SI

If you have any questions or concerns, please feel free to contact me by email at jeffrey.e.totten@wmich.edu.

Sincerely,

Jeff Totten
Ph.D. Candidate
Western Michigan University

Appendix B

Survey Follow-up Email

Subject line: Reminder for Agile in Non-Software Industries Survey Request

Dear Agile Professional,

Thank you VERY MUCH to those that completed the survey. If you did not have a chance to complete it, and are willing to help with my doctoral dissertation, please proceed by clicking the link below, or copying and pasting the URL into your browser.

Note: The target group is users of agile practices (Scrum Framework in particular) for projects in non-software applications.

https://www.surveymonkey.com/r/Agile_in_Non-Software_Industries_SI

The survey is expected to take less than ten minutes to complete. I ask that you complete this survey by July 15, 2017.

This will be the final request for participation. Thank you for your time.

If you have any questions or concerns, please feel free to contact me by email at jeffrey.e.totten@wmich.edu.

Sincerely,

Jeff Totten
Ph.D. Candidate
Western Michigan University

Appendix C

HSIRB Approval Letter

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: May 3, 2017

To: Louann Bierlein Palmer, Principal Investigator
Jeff Totten, Student Investigator for dissertation

From: Amy Naugle, Ph.D., Chair

Re: Approval not needed for HSIRB Project Number 17-05-05

This letter will serve as confirmation that your project titled "Critical Success Factors for Agile Project Management in Non-Software Related Product Development Teams" has been reviewed by the Human Subjects Institutional Review Board (HSIRB). Based on that review, the HSIRB has determined that approval is not required for you to conduct this project because you are not collecting personal identifiable (private) information about individual and your scope of work does not meet the Federal definition of human subject.

> **45 CFR 46.102 (f) Human Subject**
>
> (f) *Human subject* means a living individual **about whom** an investigator (whether professional or student) conducting research obtains
>
> (1) Data through intervention or interaction with the individual, or
> (2) Identifiable private information.
>
> *Intervention* includes both physical procedures by which data are gathered (for example, venipuncture) and manipulations of the subject or the subject's environment that are performed for research purposes. Interaction includes communication or interpersonal contact between investigator and subject. *Private information* includes information about behavior that occurs in a context in which an individual can reasonably expect that no observation or recording is taking place, and information which has been provided for specific purposes by an individual and which the individual can reasonably expect will not be made public (for example, a medical record). Private information must be individually identifiable (i.e., the identity of the subject is or may readily be ascertained by the investigator or associated with the information) in order for obtaining the information to constitute research involving human subjects.

"**About whom**" – a human subject research project requires the data received from the living individual to be about the person.

Thank you for your concerns about protecting the rights and welfare of human subjects.

A copy of your protocol and a copy of this letter will be maintained in the HSIRB files.

1903 W. Michigan Ave., Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276
CAMPUS SITE: 251 W. Walwood Hall

Appendix D

Survey Instrument

Agile in Non-Software Industries

1. In what industry are you employed?

- ◯ Software
- ◯ Government
- ◯ Education
- ◯ Manufacturing
- ◯ Retail
- ◯ Research & Development
- ◯ Other (please specify)

* 2. In which area of your organization do you primarily work?

- ◯ Product Design & Development (non-software)
- ◯ Production
- ◯ Sales & Marketing
- ◯ Finance, Purchasing, or other Support Department
- ◯ Software Development
- ◯ IT (Information Technology)
- ◯ Other (please specify area)

Agile in Non-Software Industries

* 3. Are you using agile project management methods in your area of work?

- ◯ Yes, a lot
- ◯ Yes, a little
- ◯ No, but interested in doing so
- ◯ No, and not really interested in doing so

Agile in Non-Software Industries

4. How many years have you been using agile project management methods (please round to the nearest year)?

0 — 20 [ ]

5. In your area, how frequent are agile project management methods routinely used for:

	N/A	Not used at all	Rarely used	Occasionally used	Frequently used	Almost always used	Always used
Sales & Marketing	○	○	○	○	○	○	○
Research & Development	○	○	○	○	○	○	○
Functional Product Development	○	○	○	○	○	○	○
Hardware Development	○	○	○	○	○	○	○
Production & Operations (Manufacturing)	○	○	○	○	○	○	○

6. Within a project, how often are agile project management methods used during the following project stages:

	N/A	Not used at all	Rarely used	Occasionally used	Frequently used	Almost always used	Always used
Initiation	○	○	○	○	○	○	○
Design & Prototyping	○	○	○	○	○	○	○
Tooling	○	○	○	○	○	○	○
Validation	○	○	○	○	○	○	○
Mass Production	○	○	○	○	○	○	○
Other	○	○	○	○	○	○	○

Other (please specify)

[ ]

7. To what extent are the following organizational factors in place as you use agile project management methods?

	Not at all in place	Rarely in place	Occasionally in place	Frequently in place	Almost always in place	Always in place
Commitment by management with a clear vision	○	○	○	○	○	○
Highly capable team	○	○	○	○	○	○
Co-located team	○	○	○	○	○	○
Dedicated team members	○	○	○	○	○	○
Highly involved customer	○	○	○	○	○	○

8. To what extent are the following methods in place as you use agile project management methods?

	Not at all in place	Rarely in place	Occasionally in place	Frequently in place	Almost always in place	Always in place
Holding daily stand-up meeting	○	○	○	○	○	○
Prioritizing back logs	○	○	○	○	○	○
Keeping iterations short	○	○	○	○	○	○
Holding retrospective meetings	○	○	○	○	○	○
Keeping task sizes small	○	○	○	○	○	○
Using burn down charts	○	○	○	○	○	○
Using visual management	○	○	○	○	○	○
Using team-based estimation	○	○	○	○	○	○
Using kanban	○	○	○	○	○	○

9. To what extent are these factors challenges to successfully adopting agile methods:

	Not at all challenging	Slightly challenging	Moderately challenging	Challenging	Very challenging	Extremely challenging
Team distributed in different locations	○	○	○	○	○	○
Team members on multiple projects	○	○	○	○	○	○
Product owner on more than one project	○	○	○	○	○	○
Lack of clear company vision	○	○	○	○	○	○
Unclear project scope	○	○	○	○	○	○
Lack of product owner involvement	○	○	○	○	○	○
Lack of project management tools	○	○	○	○	○	○
Lack of upper management support	○	○	○	○	○	○
Project interruptions	○	○	○	○	○	○

10. To what extent have these objectives been accomplished as a result of using agile project management methods?

	Not at all	Rarely	Occasionally	Frequently	Almost always	Always
On-time delivery	○	○	○	○	○	○
Improved product quality	○	○	○	○	○	○
Customer satisfaction	○	○	○	○	○	○
Within project budget	○	○	○	○	○	○
Increased business revenue	○	○	○	○	○	○
Improved managerial effectiveness	○	○	○	○	○	○
Improved employee engagement	○	○	○	○	○	○
Ability to react to change	○	○	○	○	○	○
Reduced project risk	○	○	○	○	○	○
Improved project visibility	○	○	○	○	○	○
Improved team dynamics/moral	○	○	○	○	○	○

* 11. The following agile project management frameworks are used routinely with my projects (select all that apply):

- [ ] Scrum
- [ ] Extreme Programming
- [ ] Feature Driven Development
- [ ] Kanban

Other (please specify)

Agile in Non-Software Industries

12. To what extent are the following scrum tools in place as you use agile project management methods?

	Not at all used	Rarely used	Occasionally used	Frequently used	Almost always used	Always used
Product owner	○	○	○	○	○	○
Scrum master	○	○	○	○	○	○
Scrum team	○	○	○	○	○	○
Product backlog refinement	○	○	○	○	○	○
Sprint planning	○	○	○	○	○	○
Daily scrum	○	○	○	○	○	○
Sprint review	○	○	○	○	○	○
Retrospective	○	○	○	○	○	○
Product backlog	○	○	○	○	○	○
Sprint backlog	○	○	○	○	○	○
Make work visable	○	○	○	○	○	○

13. How many weeks do your scrum sprints typically run?

0 10

14. To what extent are the following scrum techniques important to reducing project time?

	Not at all important	Not very important	Somewhat important	Important	Very important	Extremely important
Stable teams	◯	◯	◯	◯	◯	◯
Finishing early (using yesterday's weather/results)	◯	◯	◯	◯	◯	◯
Dedicated teams	◯	◯	◯	◯	◯	◯
Daily scrum meetings	◯	◯	◯	◯	◯	◯
Having an interrupt buffer	◯	◯	◯	◯	◯	◯
Small teams	◯	◯	◯	◯	◯	◯
Ready backlog	◯	◯	◯	◯	◯	◯
Fix issues within a day	◯	◯	◯	◯	◯	◯
T-shaped people (can help in 2 or more areas)	◯	◯	◯	◯	◯	◯
All testing completed within sprint	◯	◯	◯	◯	◯	◯
Collocation of team	◯	◯	◯	◯	◯	◯

15. How often does your team generally hold any of the scrum meetings?

◯ Daily

◯ Multiple times a week, but not daily

◯ Weekly

◯ As needed

◯ We do not hold scrum meetings

◯ Other (please specify)

Agile in Non-Software Industries

16. Why are you not using agile project management methods?

	Completely disagree	Mostly disagree	Slightly disagree	Slightly agree	Mostly agree	Completely agree
A more structured system is required in our industry	○	○	○	○	○	○
Our customer requires a specific approach	○	○	○	○	○	○
No benefits are expected	○	○	○	○	○	○
Lack of management support	○	○	○	○	○	○
Lack of training available	○	○	○	○	○	○
Insufficient time to change from current methods	○	○	○	○	○	○

Other (please specify)

Agile in Non-Software Industries

17. Thank you for participating in this survey. If you have any additional comments about agile project management enablers or barriers, please share them in the field below:

Agile in Non-Software Industries

18. Thank you for your interest in this survey. The intent of the survey is to collect information from practitioners working in non-software applications. Therefore, if you selected software or IT as the area you primarily work in, no further information is necessary. If you selected software or IT in error, please re-start the survey by following the original survey link in the email.