DOES DEVIATING FROM AGILE PRINCIPLES HAVE AN IMPACT ON PROJECT SUCCESS IN NORTH CAROLINA HIGHER EDUCATION INSTITUTIONS?

by

Douglas A. Stanley

Dissertation

Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Agile software development projects are over three times more likely to succeed than waterfall projects, but 58% of agile-led projects are unable to satisfy the timeline, budget, and customer (Standish Group, 2020). This quantitative correlational study examines if a relationship exists between deviating from the 12 agile principles outlined in the *Manifesto for Agile Software Development* (Beck et al., 2001) and the perceived level of success for agile software development projects within North Carolina higher education institutions. The general problem addressed by this study is the failure of organizations adhering to agile principles resulting in unsuccessful software development projects. Using a derivative of the Chow and Cao (2008) survey instrument, ordinal data was collected using a secure online survey platform from 351 Information Technology professionals and project managers employed at North Carolina degree-granting, not-for-profit higher education institutions. The 12 agile principles outlined in the *Manifesto for Agile Software Development* served as the independent variables, and project success was the dependent variable. Three primary research questions and 12 sub-questions guided the study. SPSS was used to perform correlation analysis to test for an association between the variables and regression analysis was used to determine the strength of the relationships. The results of the statistical tests revealed that only four of the 12 agile principles had a statistically significant correlation with project success. They are management commitment, face-to-face collaboration, simplicity, and team environment, and they explain approximately 7.9% of the variance in project success for agile software development projects. This study is significant to organizations who manage software development projects using agile methods so IT leaders can avoid deviating from principles that impact project success.

Keywords: agile software development, agile principles, project success, higher education

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Approvals

____ ____________________

Douglas A. Stanley, Doctoral Candidate Date

____ ____________________

Dr. Mike Kipreos, Dissertation Chair Date

____ ____________________

Dr. Yongli Luo, Committee Member Date

____ ____________________

Alexander Averin, PhD, MBA Chair, Doctoral Programs Date

Dedication

This work is dedicated to my wife and children, who made many sacrifices to help me get to this point. Amber, this journey has taken many turns, but you have always been supportive and a voice of encouragement. I love and appreciate you more than you will ever know! Holden and Jake, I appreciate your patience when I had to do homework at night and on weekends. I pray you never see this as lost time, but instead that anything is achievable with God and family. You both defined my purpose in this world, and I hope that I get the opportunity to help you achieve your dreams in return. You are both a gift from God and I will love you forever. I long for the moment that I can finally say to you, "Daddy's done."

Acknowledgments

First, I must acknowledge that I owe thanks to God for this opportunity and for His help throughout the process. Whenever my progress became stagnant, I sought His help and He always answered by getting me back on task. “Ask the lord to bless your plans, and you will be successful in carrying them out” (*Good News Bible*, 2001, Proverbs 16:3). Anything is possible through Him, and I recognize that I would not be where I am today without His good graces.

Next, I would like to acknowledge my family and friends for their support throughout this journey. You all made varying sacrifices the past several years, but you helped motivate and support me in different ways when I needed it most. I hope to spend more time catching up with you all soon.

Last, but certainly not least, I would like to thank my dissertation chair, Dr. Mike Kipreos. You were incredibly helpful, responsive, and supportive throughout this process. The dissertation journey can be overwhelming at times, but your feedback and guidance were always helpful and professional. Thank you for all your help throughout the journey.

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List of Abbreviations

Critical Success Factor = CSF (plural, CSFs)

eXtreme Programming = XP

Information Technology = IT

Minimal Viably Product = MVP

Section 1: Foundation of the Study

Software development projects have experienced low success rates for many years. In 1994, the Standish Group concluded that only 16% of Information Technology (IT) projects were successful. To help address the issue of low IT project success rates, a group of software development practitioners collaborated in 2001 and created a common framework that contributes to successful project outcomes (Beck et al., 2001). Their *Manifesto for Agile Software Development* (hereinafter “Agile Manifesto”) established a set of four core values and 12 principles that software development teams should adhere to in order to improve their chance at success. Their work sparked a movement and many organizations adopted agile practices to manage their software development projects. By 2020, software development project success rates had risen to 31% and agile-led software development projects were over three-times more likely to be successful than traditional-led projects, but 69% of all software development projects and 58% of agile-led software development projects were still unable to satisfy the timeline, budget, and customer (Standish Group, 2020). Although researchers agree that adhering to agile principles can improve project success rates, a significant percent of IT projects continue to fail or are challenged (Cram, 2019; Serrador & Pinto, 2015). This study tests if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions so IT leaders can improve project success rates.

The first chapter covers the foundation of the study by introducing the background of the problem, the problem statement, and the purpose statement. The problem guides the foundation, which the remainder of the study was built upon. Next, the research questions, the hypothesis, and the nature of the study are presented. The nature of the study includes the design and method that were employed to investigate the problem, as well as my worldview as the researcher of this project. Following the nature of the study, Rockart's (1977) critical success factor theory and Chow and Cao's (2008) framework are introduced. These are significant because the current study was built on a derivative of the Chow and Cao framework. Afterward, the assumptions, limitations, and delimitations of the study are documented. The next sections—implications for biblical integration and benefit to business practice—convey how the research aligns with God's will for people to utilize the skills He provides to serve others (Keller & Alsdorf, 2012). Finally, a literature review is presented.

The second chapter provides an outline of the study. That section reiterates the purpose of the study and discusses the design and method that was used. It frames the blueprint of the research by incorporating information on the research participants, a description of the eligible population, and a discussion on the sampling method and sample size. The section also communicates the data collection process and data analysis plan. After that, the third and final section of this paper brings closure to the study by presenting the findings and practical use of the information learned by conducting the research. The section begins with an overview of the study followed by the presentation of the findings. It includes a description of the survey participants and the data collected. Finally, Section 3 includes the results for each of the study's hypotheses and discusses how the findings connect with existing research on the topic. The research ends with recommendations for further study and reflections from the author.

Background of the Problem

For nearly four decades, software development projects have been plagued with low success rates (Hughes et al., 2017). The Standish Group (1994) first recognized the low success rate of IT projects in 1994 with their publication of the first *Comprehensive Human Appraisal* *for Originating Software (CHAOS) Report*—an annual report that investigates the success rate of IT projects based on a project meeting the original timeline, budget, and scope. The report concluded that nearly five out of six IT projects were challenged or outright failed (Standish Group, 1994). Some literature supports that poor project management, requirements management, and change management contribute to the low success rate (Hughes et al., 2017). Other research suggests that IT projects managed by plan-driven, waterfall approaches that do not account for evolving requirements or facilitate regular customer feedback may contribute to the high failure rates (Petersen & Wohlin, 2010).

In response to the need for an adaptive, lightweight approach to manage software development projects, a group of practitioners met in 2001 and a new philosophy for managing software development projects spawned: the Agile Manifesto. The philosophy consisted of a set of four core values and 12 principles which centered around team interactions, creating working software, collaborating with customers, and responding to change (Cram, 2019). Over the next two decades, many studies conveyed that practicing agile principles significantly improves project success rates; however, the majority of IT projects are still considered unsuccessful (Cram, 2019; Serrador & Pinto, 2015; Standish Group, 2020). This is significant because high failure rates can have significant financial repercussions for businesses, including lost opportunity cost. Some literature (Boehm, 2002) suggests that a sweet-spot exists between plan-based and agile-based projects, but other research (Eloranta et al., 2016) advocates for additional studies investigating the consequences of deviating from agile principles. Siddique and Hussein (2016) explored the process of conflicts in agile software projects and concluded that agile principles and values must be adhered to in order to avoid conflicts that negatively affect project success. Similarly, other literature suggests that organizations should be cautious before deviating from agile techniques and including traditional techniques like immense documentation and formal signoffs at various stages in the project because such deviations could dilute agile benefits (Cram, 2019). Several studies investigating CSFs for software development projects exist, but researchers often come to different conclusions about which factors help projects succeed (Chow & Cao, 2008; Garousi et al., 2019). Given agile software development projects have a higher success rate than waterfall projects, there is a need to explore if a relationship exists between deviating from agile methods and project success.

Problem Statement

The general problem to be addressed is the failure of organizations adhering to agile principles resulting in unsuccessful software development projects. Defining project success as being on time, on budget, and with satisfactory results, the Standish Group (2015) determined that only 39% of agile projects are successful, 52% are challenged, and 9% fail. Similarly, Suetin et al. (2016) found that organizations implementing agile principles for software development projects improved their quality of work but worsened their cost and time performance. This could be due to the high number of companies that claim to be agile in software development but merely utilize some agile practices (Eloranta et al., 2016). Of these companies, the ones that are most likely to deviate from agile principles and jeopardize the benefits seen from agile software development are larger companies or companies with extensive experience using Scrum, a form of agile software development. Cram (2019 highlighted that organizations that intend to tailor agile principles should be wary about the impact changes can have to the overall value of the approach, while Siddique and Hussein (2016) took it a step further and concluded that agile principles must be followed to avoid conflicts that result in decreased productivity. The specific problem to be addressed is the failure of organizations within the publicly and privately funded

North Carolina higher education sector adhering to agile principles resulting in unsuccessful software development projects.

Purpose Statement

The purpose of this quantitative correlational study was to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto (Beck et al., 2001) and the perceived level of success for agile software development projects within North Carolina higher education institutions. This study focused on higher education institutions because many colleges and universities are challenged to increase their value to students while maintaining or reducing their cost of attendance (Pathak & Pathak, 2010). A growing interest in online education, combined with budgetary constraints, probed executive leadership to look at using technology and other new methods to respond to evolving demands (Peppard, 2010), but the demand to create a competitive advantage for the organization and provide an environment that prepares graduates for the workforce of today and tomorrow has university IT departments facing increased costs (Sliep & Marnewick, 2020). As a result, many IT leaders have seen their daily duties shift from being more operationally natured to being more strategic (Pinho & Franco, 2017), which led some software development managers to implement agile practices to obtain a competitive advantage (Cram, 2019; Denning, 2016). This may be due to agile projects being over three times more successful than waterfall projects; however, 69% of IT projects were still considered unsuccessful (Standish Group, 2020). Eloranta et al. (2016) highlighted that deviating from agile principles is common but should be avoided because it can be destructive over time. Similarly, Cram (2019) warns that as hybrid approaches (those containing a blend of both agile and traditional methods) gain popularity, IT project managers need to select the appropriate mix of agile principles with other approaches to be successful. This research adds to the body of knowledge and offers insight into which agile principles outlined in Beck et al.'s Agile Manifesto influence the success of software development projects so future IT leaders can proactively avoid deviating from principles that have a significant impact on project success.

Research Questions

Many researchers agree that adhering to agile principles can improve project success; however, a large percentage of projects are still considered unsuccessful (Cram, 2019; Serrador & Pinto, 2015; Standish Group, 2020). Eloranta et al. (2016) called for further studies investigating the consequences of adopting anti-patterns, which are deviations from agile principles. Similarly, Serrador and Pinto (2015) call for additional research on hybrid agile methods.

This research was conducted in response to the calls for additional studies on deviating from agile methods and their relationship to project success. The three primary research questions and 12 sub-questions that guided this study are:

RQ1: How do organizations improve software development project success rates by adhering to agile principles?

RQ2: To what extent does adhering to the 12 agile principles help organizations improve software development project success rates?

RQ3: What is the relationship between deviating from the use of the 12 agile principles and the success of a software development project?

RQ3a: What is the relationship between deviating from early and continuous delivery of software and the success of a software development project?

RQ3b: What is the relationship between deviating from welcoming requirement changes at any point in the development process and the success of a software development project?

RQ3c: What is the relationship between deviating from delivering working software frequently and the success of a software development project?

RQ3d: What is the relationship between deviating from daily collaboration between the requestor and software developers and the success of a software development project?

RQ3e: What is the relationship between deviating from supporting and entrusting the project team to get the job done and the success of a software development project?

RQ3f: What is the relationship between deviating from face-to-face collaboration and the success of a software development project?

RQ3g: What is the relationship between deviating from measuring progress through the delivery of working software and the success of a software development project?

RQ3h: What is the relationship between deviating from maintaining a constant pace and the success of a software development project?

RQ3i: What is the relationship between deviating from continuous attention to technical excellence and good design and the success of a software development project?

RQ3j: What is the relationship between deviating from simplicity and the success of a software development project?

RQ3k: What is the relationship between deviating from self-organizing teams and the success of a software development project?

RQ3L: What is the relationship between deviating from regular reflection adjusting behavior accordingly and the success of a software development project?

Hypotheses

This research investigated the relationship between the 12 agile principles outlined in the Agile Manifesto, and the success of agile software development projects. The principles served as the independent variables and project success served as the dependent variable. This study was guided by 15 hypotheses. The first three hypotheses correspond with the primary research questions, RQ1, RQ2, and RQ3, and the remaining 12 hypotheses correspond with the 12 sub-questions, RQ3a – RQ3L. The null and alternative hypotheses for the current study are:

H1o: Organizations cannot improve software development project success rates by adhering to agile principles.

H1a: Organizations can improve software development project success rates by adhering to agile principles.

H2o: There is no relationship between adhering to the 12 agile principles and the success of agile software development projects.

H2a: There is a relationship between adhering to the 12 agile principles and the success of agile software development projects.

H3o: There is no relationship between deviating from the 12 agile principles and the success of an agile software development project.

H3a: There is a relationship between deviating from the 12 agile principles and the success of an agile software development project.

H4o: There is no relationship between deviating from the agile principle early and continuous delivery of software and the success of an agile software development project.

H4a: There is a relationship between deviating from the agile principle early and continuous delivery of software and the success of an agile software development project.

H5o: There is no relationship between deviating from the agile principle welcoming requirement changes at any point in the development process and the success of an agile software development project.

H5a: There is a relationship between deviating from the agile principle welcoming requirement changes at any point in the development process and the success of an agile software development project.

H6o: There is no relationship between deviating from the agile principle delivering working software frequently and the success of an agile software development project.

H6a: There is a relationship between deviating from the agile principle delivering working software frequently and the success of an agile software development project.

H7o: There is no relationship between deviating from the agile principle daily collaboration between the requestor and software developers and the success of an agile software development project.

H7a: There is a relationship between deviating from the agile principle daily collaboration between the requestor and software developers and the success of an agile software development project.

H8o: There is no relationship between deviating from the agile principle supporting and entrusting the project team to get the job done and the success of an agile software development project.

H8a: There is a relationship between deviating from the agile principle supporting and entrusting the project team to get the job done and the success of an agile software development project.

H9o: There is no relationship between deviating from the agile principle face-to-face collaboration and the success of an agile software development project.

H9a: There is a relationship between deviating from the agile principle face-to-face collaboration and the success of an agile software development project.

H10o: There is no relationship between deviating from the agile principle measuring progress through the delivery of working software and the success of an agile software development project.

H10a: There is a relationship between deviating from the agile principle measuring progress through the delivery of working software and the success of an agile software development project.

H11o: There is no relationship between deviating from the agile principle maintaining a constant pace and the success of an agile software development project.

H11a: There is a relationship between deviating from the agile principle maintaining a constant pace and the success of an agile software development project.

H12o: There is no relationship between deviating from the agile principle continuous attention to technical excellence and good design and the success of an agile software development project.

H12a: There is a relationship between deviating from the agile principle continuous attention to technical excellence and good design and the success of an agile software development project.

H13o: There is no relationship between deviating from the agile principle simplicity and the success of an agile software development project.

H13a: There is a relationship between deviating from the agile principle simplicity and the success of an agile software development project.

H14o: There is no relationship between deviating from the agile principle self-organizing teams and the success of an agile software development project.

H14a: There is a relationship between deviating from the agile principle self-organizing teams and the success of an agile software development project.

H15o: There is no relationship between deviating from the agile principle regular reflection adjusting behavior accordingly and the success of an agile software development project.

H15a: There is a relationship between deviating from the agile principle regular reflection adjusting behavior accordingly and the success of an agile software development project.

Nature of the Study

The nature of the study presents the selected research method and design used in this research as well as the research paradigm employed by me as the researcher. The research paradigm is the worldview I brought to the study. This section contains a description of the various methods and designs that were considered for the study. A justification is included noting why the selected method and design were chosen and why the other methods and designs were not appropriate for the study. The research paradigm embraced by me as the author is also described.

Discussion of Research Paradigms

The research paradigm is the worldview I bring to the study. Quantitative research is typically based on a positivist or post-positivist research paradigm (Teherani et al., 2015). Positivists accept that a singular reality exists and believe that it can be discovered using experimental methods (Teherani et al., 2015). Post-positivists also believe that a single reality exists, but accept that researchers will never know exactly what that reality is (Creswell, 2014; Jelena & Jelena, 2023). This single reality cannot be known because it can only be experienced through a lens which is subject to researcher bias (Gamlen & McIntyre, 2018). As the author of this study, I bring a post-positivist perspective to this research because I believe in a cause-and-effect worldview and that while a single reality exists, I will never know exactly what it is. Petty et al. (2012) noted that post-positivist researchers must work to minimize bias in their research. As such, I objectively analyzed the data and worked with my dissertation chair to help ensure that I did not introduce any bias that compromised the results.

Discussion of Design

Research designs are the strategies of inquiry that are available for each research method (Creswell, 2014). They help guide the research question and method of inquiry. When choosing a design, researchers should consider the problem being examined and their approach to investigating it (Creswell, 2014). This section introduces some of the prevalent research designs for quantitative, qualitative, and mixed methods research and outlines reasons researchers might utilize each in a study. A description of each design and a discussion supporting why each design was or was not the preferred design for this study is included in the subsequent sections.

Quantitative Designs. The two design approaches relevant to quantitative research are experimental and non-experimental. First, experimental designs include experimental and quasi-experimental research. With both, an experiment is conducted on study participants, but with experimental research, the subjects are randomly assigned to the control and treatment groups (Keppel, 1991, as cited in Creswell, 2014). Conversely, the participants are not randomly assigned with quasi-experimental research because it is either not feasible or impractical (Kornuta & Germaine, 2019). Non-experimental designs, include casual-comparative research and correlational research. Creswell (2014) defines casual-comparative research as a study comparing independent variables between two or more groups. With casual-comparative designs, a researcher analyzes characteristics of a problem and attempts to discover the critical relationships between the characteristics and the result (Simon & Goes, 2017). On the contrary, researchers use numeric data to investigate the relationship between independent and dependent variables for non-experimental correlational research designs (Creswell, 2014). Correlational designs are also known as ex post facto studies, meaning from after the fact (Simon & Goes, 2017).

Qualitative Designs. Five common qualitative designs are narrative research, phenomenological research, grounded theory research, ethnographic research, and case study research (Creswell & Poth, 2018). Each design approaches the research question differently, so researchers should gain a foundational understanding of each prior to determining which design to use (Creswell & Poth, 2018). Additionally, qualitative researchers should select a design based on the nature of the problem, the question(s) being researched, and knowledge they seek to understand (Korstjens & Moser, 2017). When a researcher chooses to document an individual’s story about an encounter or an experience, that researcher may choose to use a narrative design, but if the researcher chooses to focus on many individuals’ lived experiences about a particular encounter in order to culminate the essence of the experiences, the researcher may choose to utilize a phenomenological design (Creswell, 2014). Grounded theory should be used when researchers want to study topics from a different perspective, to gain new insight into and build on the body of knowledge for an existing problem, or to examine and develop theory on an emerging topic (Corbin & Strauss, 2015). Next, ethnographic—arguably the most challenging and time-consuming design—places the researcher in the study by immersing himself or herself within the research group to learn the cultural interactions, language, rituals, and behaviors in order to gain the trust and identify the cultural norms, believes, and social structures of the participants (Simon & Goes, 2017). Finally, case study designs can consist of a single case or multiple cases. With case study research, researchers seek to gain a more in-depth understanding of a social phenomenon by focusing on a specific case or multiple cases (Yin, 2014). This list is not an exhaustive list of qualitative designs, but one overlapping limitation with each of these designs and many other qualitative designs is the researcher becomes a tool. This introduces personal biases when deducing from verbose notes derived from interviews, observations, documents, and audio-video materials. The researcher should make an effort to identify and document these biases in their work.

Mixed Designs. A mixed design exhibits characteristics of both qualitative and quantitative designs. By incorporating facets of both qualitative and quantitative research, the mixed design enables researchers to collect a greater and more diverse collection of evidence to answer the same research question (Yin, 2014). The three most common mixed method designs are convergent parallel, explanatory sequential, and exploratory sequential. Each design is distinguished by the order in which the type of data is collected and analyzed. With convergent parallel designs, the qualitative and quantitative data are collected and analyzed at the same time; with explanatory sequential designs, quantitative research precedes the qualitative research; and with exploratory designs, qualitative data collection comes first (Creswell, 2014). One limitation unique to mixed-method research is the researcher assumes that combining qualitative and quantitative methods compliments each other and contributes to the effectiveness of the study (Simon & Goes, 2017).

Design of Choice. The preferred design to use for this study was a non-experimental, fixed, correlational design. This was the most appropriate design to use because this study collected data on independent and dependent variables to examine the relationship between them. Specifically, this study collected data on the use of the 12 agile principles and the perceived levels of success for agile software development projects. Unlike experimental designs, non-experimental designs use instruments to collect data on events that have already transpired. Similarly, the survey tool being used in this study requested research participants base their responses on projects that had already transpired. Experimental designs, however, utilize control and treatment groups to manipulate variables in order to determine their impact on an outcome that has not occurred. Since this study captured participants' feedback on past agile software development projects and did not manipulate variables to test the outcome of an experiment, an experimental design was not appropriate. Furthermore, a correlational design was more appropriate than a casual-comparative design for this study because as the researcher conducting the study, I did not compare independent variables between groups.

Discussion of Method

The three research methods predominantly used in studies today are quantitative, qualitative, and mixed methods. Newman and Benz (1998, as cited in Creswell, 2014) highlighted that these methods should not be considered dichotomies, but instead symbolize different points of the research scale. Although quantitative and qualitative methods have distinct characteristics, mixed methods blend the two to gain a more comprehensive understanding of the issue. The three subsequent sections include a description of each of the aforementioned research methods. Following the description of each method is a discussion justifying why each method was or was not selected for this research.

Quantitative Methods. Quantitative methods are an approach for testing objective theories using data to examine relationships between variables (Creswell, 2014). With quantitative methods, data collection is often done impersonally using instruments such as surveys (Stake, 2010). The data is typically collected on each variable in a measurable, numeric form and then it is analyzed using statistical techniques (Neuman, 2012). These statistical techniques are used to impartially test the validity of hypotheses in order to gain a more in-depth understanding about any relationships amongst the variables. Quantitative research is usually based on a positivist or post-positivist research paradigm (Teherani et al., 2015). With a positivist research paradigm, the researcher believes that a singular reality exists, and it can be discovered using appropriate experimental methods (Teherani et al., 2015). Similarly, post-positivism maintains a cause-and-effect worldview and supports the notion that a single reality exists, but the researcher will never know exactly what that reality is (Creswell, 2014).

Qualitative Methods. Qualitative methods provide an approach for gaining an understanding of the meaning behind an individual's or group's experience as it relates to a social or human problem (Creswell, 2014). This method is a naturalistic approach to investigate emerging themes and casual explanations from participant's lived experiences (Kornuta & Germaine, 2019). Stake (2010) highlighted that a significant difference between quantitative and qualitative methods is the former is a study of objective measure whereas the latter is a study of personal knowledge. Qualitative methods take a subjective approach to understand the meaning of a specific scenario. With qualitative studies, data is often collected in a manner that is sensitive to the individual or group participating in the study, such as interviews or observations (Creswell & Poth, 2018), and unlike quantitative research, the researcher is frequently an instrument, injecting his or her personal experience when making interpretations and deductions (Stake, 2010). Qualitative data is often verbose and does not cater to statistical analysis like quantitative data. Qualitative research is usually based on a constructivist or post-positivist research paradigm (Teherani et al., 2015). With a constructivist worldview, the researcher believes that no single reality exists, and the researcher thus draws on survey participants' views of reality (Teherani et al., 2015).

Mixed Methods. Mixed methods are a form of research where elements from both quantitative and qualitative methods are blended with the purpose of gaining a broad and precise understanding of a topic (Johnson et al., 2007). Both open-ended qualitative and predetermined quantitative instruments are used to collect data, and corresponding methods are used to analyze the data. Creswell (2014) conveyed that mixed methods emerged because of the concept that all methods have bias; therefore, collecting data through both methods offset the limitations of each. This is done through triangulation—a significant contribution transpired from mixed method research (Stake, 2010). Triangulation across sources and methods helps establish credibility (Creswell & Poth, 2018).

Method of Choice. The current study examined if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto and the success of software development projects; therefore, the preferred method to use was quantitative. The 12 agile principles served as the independent variables and the perceived level of project success was the dependent variable. Ordinal data was collected utilizing a modified version of the Chow and Cao (2008) survey and was analyzed using quantitative techniques. As the researcher conducting the study, I planned to use Pearson's correlation coefficient and multiple linear regression to analyze the data, but there was no linear relationship between the dependent variable and some independent variables. A prerequisite to using Pearson's analysis is a linear relationship, so Spearman's rank-order correlation analysis and multiple linear regression analysis were used instead. These techniques helped identify the direction and strength of relationships between variables (Pace, 2017; Syeda, 2018). A qualitative method was not appropriate for this research because I did not seek an understanding of personal experiences, nor was data collected in a personal manner. Similarly, a mixed methods approach was not appropriate because the embedded qualitative component was not suitable.

Summary of the Nature of the Study

I evaluated prevalent research methods and designs and concluded that this study would be conducted with a fixed design using a quantitative method. More specifically, a correlational design was used. The quantitative method was the most appropriate approach to use to test theories by examining the relationship between variables (Creswell, 2014). A correlational study was selected to identify the existence and significance of relationships between the variables (Pace, 2017). The independent variables were the 12 agile principles identified in the Agile Manifesto, and the dependent variable was project success. Starting with the specific problem, the failure of organizations within the publicly and privately funded North Carolina higher education sector adhering to agile principles resulting in unsuccessful software development projects, I collected data from North Carolina higher education institutions pertaining to their use of the 12 agile principles and project success. After the data was collected, it was analyzed using Spearman’s rank-order correlation and multiple linear regression analysis and the hypotheses were tested. Spearman’s rank-order correlation was used to examine the strength and direction between the independent and dependent variables, and multiple linear regression was used to examine the strength of the relationships between variables (Pace, 2017).

Theoretical Framework

This research set out to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto and the perceived level of success for agile software development projects. To test this relationship, the critical success factor (CSF) theory from Rockart (1979) was employed. CSF theory utilizes a process to identify the limited number of factors that must be completed satisfactorily in order to achieve success (Rockart, 1979). Chow and Cao (2008) made use of the CSF theory to identify which factors significantly impact project success. The current study altered the model from Chow and Cao to test the relationship between each agile principle and the perceived level of success for agile software development projects. This section discusses CSF theory and explains why it was the best theory for the current study. Additionally, it introduces the actors, variables, and relationship between each.

Theories

This section introduces the CSF theory and its precursor: success factors. Additionally, existing research connecting the CSF theory to agile software development projects along with the research framework used in Chow and Cao (2008) is presented. Afterwards, a discussion outlining a correlation between the research from Chow and Cao, which test the validity of CSF for agile software development, and the current research is provided. The research framework from Chow and Cao served as the foundation for the current study's theoretical framework. Finally, the research framework is included along with a detailed explanation of how it deviates from the framework used in Chow and Cao.

Introduction of Success Factors. Daniel (1961) introduced the concept of success factors in response to his belief that managers in many businesses made strategic and operational decisions using financial data instead of the data needed to support good decision making. Managers did this because they could not produce relevant information in a timely manner. Daniel asserted that many organizations lacked the information systems needed to track the data required to plan, operate, and control the company. To address the issue, he professed that businesses should design their information systems and reports around the key jobs that contribute to the organization's success, and that many of these key jobs overlapped businesses across an entire industry. These key jobs are considered success factors when they are completed exceptionally well and the results consistently conclude with a positive outcome for the business (Daniel, 1961). Daniel's theory on success factors is significant because it sets the stage for future research that there is a subset of businesses process across an industry that always results in success when executed appropriately.

Introduction of Critical Success Factors. Anthony et al. (1972) extended on the notion of success factors from Daniel but concluded that success factors are not industry-specific. Instead, they emphasized that success factors vary between companies within the same industry, as well as between managers within the same organization. This indicates that there are additional sources of success factors beyond the industry alone. To understand why one succeeds, the organization must have a thorough understanding of the strategy and decisions that lead to success in order to repeat the outcome (Anthony et al., 1972). This work set the stage for Rockart and a team at Massachusetts Institute of Technology (MIT) to research methods used to identify CSF in an organization (Rockart, 1979).

Stemming from the success factor concepts described in Daniel (1961) and Anthony et al. (1972), the idea of CSF was introduced in Rockart (1979). Rockart with Anthony et al. (1972) that success factors are specific to every manager since each manager has unique goals, but highlights that CSFs differ from success factors because CSFs are "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization" (p. 85). Conversely, if CSF results are meager, the outcome will be undesirable. CSF research from Rockart spanned two years and the results support that the CSF approach is effective at helping executives identify their critical information needs.

Critical Success Factors in Agile Software Development. Chow and Cao (2008) employed the CSF theory introduced in Rockart (1979) to test the significance of success factors and their impact on agile software development project success. After reviewing literature on both successful and failed agile projects, they identified 12 potential CSFs, grouped into five dimensions, which influence the success of agile software development projects. Additionally, they used four dimensions—quality, scope, time, and cost—to measure the perceived success of an agile software development project. Note shows the 12 factors, grouped by the five dimensions, and the four components of agile software development project success from Chow and Cao—which served as the hypotheses of their research. Chow and Cao concluded that only half of the 12 hypothesized CSFs—team environment (quality), team capability (timeliness, cost), customer involvement (scope), project management process (quality), agile software engineering techniques (quality, scope), and delivery strategy (scope, timeliness, cost) —have a significant relationship on the perceived success of agile software development projects.

Figure 1

Hypothesized Critical Success Factors and Components of Success

Organizational Factors	Components of Perceived Agile Software Development Project Success
• Management Commitment • Organizational Environment • Team Environment [1] People Factors • Team Capability [1,2] • Customer Involvement [1] Process Factors • Project Management Process [1] • Project Definition Process Technical Factors • Agile Software Techniques [1,2] • Delivery Strategy [1,2] Project Factors • Project Nature • Project Type • Project Schedule	• Quality • Scope • Time • Cost
[1] impacted one or more dimensions of project success [2] identified as a Critical Success Factor	

Note: Data compiled from Chow and Cao (2008).

Link to the Current Research. This non-experimental, quantitative, correlational study examined if a relationship exists between deviating from the 12 agile principles and the perceived level of success for agile software development projects by altering the CSF framework from Chow and Cao (2008), who investigated 12 independent variables in their study. Eight of these independent variables correlate to at least one of the 12 agile principles, while the remaining four independent variables do not relate to any of the agile principles. Figure 2 highlights the relationship between Chow and Cao's independent variables and the 12 agile principles.

Figure 2

Correlation Between Chow and Cao (2008) Hypothesized CSF and Agile Principles

CSF (corresponding agile principle)	Agile Principles
Organizational Factors • Management Commitment (5) • Organizational Environment (2, 5, 6, 11, 12) • Team Environment (6, 11) People Factors • Team Capability (5) • Customer Involvement (1, 4) Process Factors • Project Management Process (2, 6, 7, 8) • Project Definition Process (n/a) Technical Factors • Agile Software Techniques (9, 10) • Delivery Strategy (1, 3) Project Factors • Project Nature (n/a) • Project Type (n/a) • Project Schedule (n/a)	1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software. 2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage. 3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale. 4. Business people and developers must work together daily throughout the project. 5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done. 6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation. 7. Working software is the primary measure of progress. 8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely. 9. Continuous attention to technical excellence and good design enhances agility. 10. Simplicity--the art of maximizing the amount of work not done--is essential. 11. The best architectures, requirements, and designs emerge from self-organizing teams. 12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

To test the relationship that each agile principle has with the perceived level of success for agile software development projects, the current study altered the framework found in Chow and Cao (2008) so that each agile principle served as an independent variable. The altered model eliminated the four hypothesized CSFs (project definition process, project nature, project type, and project schedule) from the Chow and Cao research framework that failed to correlate to an agile principle because each was determined to have no significance in determining the perceived success of an agile software development project. Although two other hypothesized CSFs (organizational environment and management commitment) from Chow and Cao were also deemed insignificant, other research contradicts these findings (Aldahmash, 2018; Jung et al., 2009). Since the existing research does not agree and both organizational environment and management commitment correlate to an agile principle, those elements were represented in the current study's altered model. In addition, the hypothesized CSFs from the Chow and Cao framework that correlate to multiple agile principles (organizational environment, team environment, customer involvement, project management process, agile software techniques, and delivery strategy) were replaced with the corresponding agile principles so that each principle could be test independently. Five agile principles (1, 2, 5, 6, and 11) related to more than one of the hypothesized CSFs in Chow and Cao. To eliminate redundancy, these principles were only included once in the altered framework for the current study. Figure 3 highlights these changes:

- CSF management commitment persisted since it corresponds with the fifth agile principle
- CSF organizational environment was replaced with welcome changes (agile principle 2) and reflection (agile principle 12; the fifth, sixth, and eleventh principles are better represented by other CSFs)

- CSF team environment persisted (the CSF was also associated with the sixth agile principle, face-to-face collaboration, which is represented in the bullet point below for project management process).
- CSF team capability was removed since it only corresponds with the fifth agile principle which is better represented by CSF management commitment
- CSF customer involvement was replaced with frequent collaboration (agile principle 4; the first agile principle was not included because it is better represented by delivery strategy)
- CSF project management process was replaced with face-to-face collaboration (agile principle 6), measure progress by work (agile principle 7), and sustainable development (agile principle 8). Welcome changes (agile principle 2) was not included since it is better represented by CSF organizational environment)
- CSF project definition process was removed since it does not correlate to an agile principle and was determined to be insignificant
- CSF agile software techniques was replaced with technical excellence (agile principle 9) and simplicity (agile principle 10)
- CSF delivery strategy was replaced with satisfaction via continuous delivery (agile principle 1) and working software (agile principle 3)
- CSF project nature, project type, and project schedule were each removed since they do not correlate to an agile principle and were determined to be insignificant

Figure 3

Correlation Between Altered Hypothesized CSF and Agile Principles

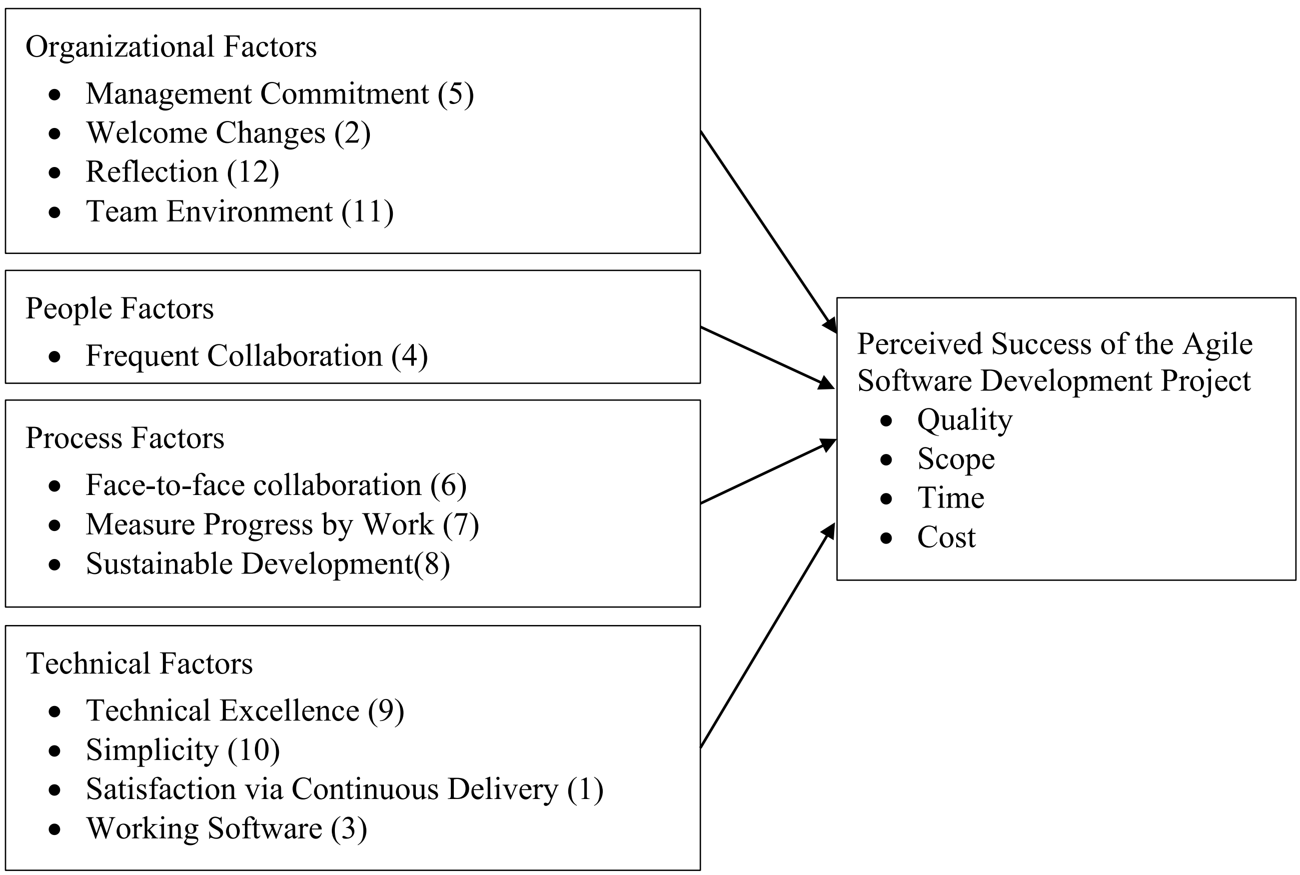
CSF (corresponding agile principle)	Agile Principles

Organizational Factors
• Management Commitment (5)
• ~~Organizational Environment (2, 5, 6, 11, 12)~~
  o Welcome Changes (2)
  o Management Commitment (5)
  o Face-to-face Collaboration (6)
  o Team Environment (11)
  o Reflection (12)
• ~~Team Environment (6, 11)~~
  o Face-to-face Collaboration (6)
  o Team Environment (11)
People Factors
• ~~Team Capability (5)~~
  o Management Commitment (5)
• ~~Customer Involvement (1, 4)~~
  o Customer Satisfaction via Continuous Delivery (1)
  o Frequent Collaboration (4)
Process Factors
• ~~Project Management Process (2, 6, 7, 8)~~
  o Welcome Changes (2)
  o Face-to-face Collaboration (6)
  o Measure Progress by Work (7)
  o Sustainable Development (8)
• ~~Project Definition Process (n/a)~~
Technical Factors
• ~~Agile Software Techniques (9, 10)~~
  o Technical Excellence (9)
  o Simplicity (10)
• ~~Delivery Strategy (1, 3)~~
  o Customer Satisfaction via Continuous Delivery (1)
  o Working Software (3)
Project Factors
• ~~Project Nature (n/a)~~
• ~~Project Type (n/a)~~
• ~~Project Schedule (n/a)~~
	1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
	2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
	3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
	4. Business people and developers must work together daily throughout the project.
	5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
	6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
	7. Working software is the primary measure of progress.
	8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
	9. Continuous attention to technical excellence and good design enhances agility.
	10. Simplicity--the art of maximizing the amount of work not done--is essential.
	11. The best architectures, requirements, and designs emerge from self-organizing teams.
	12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Adapting the framework presented in Chow and Cao (2008), which is based on the CSF theory introduced in Rockart (1979), was most appropriate for this research because the identified CSFs correlate to at least one of the principles in the Agile Manifesto. Figure 4 shows the adapted model that was used to guide this research.

Figure 4

Adapted CSF Model for the Current Study



Actors

This research surveyed IT professionals and IT project managers within publicly and privately funded North Carolina higher education institutions to examine if a relationship exists between deviating from agile principles and the perceived level of success for agile software development projects. These actors were selected because higher education institutions are being pushed to increase value while maintaining or reducing cost (Pathak & Pathak, 2010). However, many higher education institutions have experienced increased IT costs due to growing demands. Some of these demands push institutions to use technology to create competitive advantages, such as improving student retention, or to use technology to provide the support for various pedagogical methods that helps prepare students for the workforce (Sliep & Marnewick, 2020). Leadership at higher education institutions utilize various tactics to respond to these demands and achieve a competitive advantage, but one method used by software development managers is to implement agile practices (Cram, 2019).

Variables

The 12 agile principles identified in Beck et al.'s (2001) work, correlate to the CSFs from Chow and Cao (2008) as shown in Figure 4 served as the independent variables for this study. The independent variables were identified by altering the Chow and Cao framework as outlined above. The perceived level of project success served as the dependent variable in the altered model. The four dimensions of perceived level of project success that were measured are quality, scope, time, and cost. Although other definitions of project success exist (Standish Group, 2015), using the same four components as other research (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018) allowed me to triangulate the research results.

Relationships Between Theories, Actors, and Variables

Introduced in Rockart (1979), CSFs are defined as "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization" (p. 85). CSF theory was validated by Rockart and a team from MIT after working with executives over a 2-year span (Rockart, 1979). Researchers from Chow and Cao (2008) utilized the CSF theory to test the significance of potential CSFs and their impact on the perceived level of success for agile software development projects. Their research concluded that half of the hypothesized CSFs were significant in determining the perceived level of success for agile software development. Despite the numerous studies that have been completed on CSF for agile software development projects (Ahimbisibwe et al., 2015; Aleem et al., 2016; Chiyangwa & Mnkandla, 2017; Garousi et al., 2019; Shakya & Shakya, 2020; Tam et al., 2020; Yousef, 2022), most projects continue to be challenged or fail (Standish Group, 2015). The Standish Group (2020) reported that 69% of all IT projects are either challenged (50%) or failed (19%), but IT projects managed using agile methods (42%) are over three times more likely to succeed than projects managed using waterfall (13%) methods. Using the CSF theory to examine if a relationship exists between deviating from the 12 agile principles and the perceived level of success for agile software development projects may help organizations increase their success rate with agile software development projects. To examine the relationship, this research altered the Chow and Cao framework so that each agile principle was represented as an isolated independent variable. Using the Chow and Cao survey instrument, participants were asked questions pertaining to the independent variables and dependent variable, which enabled me as the researcher to investigate if deviating from any agile principles has an impact on a participant's perceived level of success. The Spearman's rho and multiple linear regression statistical tests were used to analyze the data.

Summary of the Research Framework

Researchers from Chow and Cao (2008) utilized the CSF theory introduced by Rockart (1979) to identify the minimum number of elements needed to be completed satisfactorily in order to lead to the success of an agile software development project. Although Chow and Cao concluded that CSFs identified in literature that did not correlate to agile principles had no significance in determining project success, they were unable to distinguish which agile principles most significantly impacted project success because several of their independent variables map to more than one agile principle. Altering their model to eliminate CSFs not associated with agile principles and breaking apart CSFs associated with more than one principle enabled me as the researcher of this study to determine if deviating from agile principles impacts the perceived level of project success.

Definition of Terms

This section identifies key terms that are not common knowledge or have special meaning in this research (Kornuta & Germaine, 2019). These terms are defined to provide clarity and to help avoid confusion. Defining key terms is significant because the definitions help readers understand and digest the research properly (Simon & Goes, 2017). This research utilizes a few terms that can have different meaning in separate contexts. Key terms referenced within this study are defined below.

Agile Manifesto

The Agile Manifesto is a collection of four values and 12 principles created by 17 practitioners (Beck et al. 2001) representing different software development methodologies (Cram, 2019). These practitioners pulled common best-practices from their respective methodologies with the goal of improving the software development process (Hohl et al., 2018). The manifesto is often credited with sparking the agile movement by strengthening and organizing existing methods of software development (Campanelli & Parreiras, 2015).

Agile Principles

Agile principles refer to the 12 principles defined by Beck et al. (2001) in the Agile Manifesto. These principles are oriented around customer collaboration, delivering working software, team members and the team environment, and welcoming change (Cram, 2019). The 12 Principles behind the Agile Manifesto are listed in Figure 5 below.

Figure 5

Principles behind the Agile Manifesto (Beck et al., 2001)

Agile Principles
1. Customer satisfaction through early and continuous delivery of software.
2. Welcome requirement changes at any point in the development process.
3. Deliver working software frequently.
4. Daily collaboration between the requestor and software developers.
5. Supporting and entrusting the project team to get the job done.
6. Face-to-face collaboration.
7. Measure progress through the delivery of working software.
8. Sustainable development; maintain a constant pace.
9. Continuous attention to technical excellence and good design.
10. Simplicity.
11. Self-organizing teams.
12. Regular reflection, adjusting behavior accordingly.

Agile Software Development

Agile software development is an interactive software development approach utilizing iterative development cycles for the purpose of quickly delivering software that meets customer needs (Faisal Abrar et al., 2020). It improved traditional waterfall methodologies by shifting the focus from using pre-defined processes, tools, documentation, and rigid planning to being more customer oriented, collaborative, and responsive to change (Beck et al., 2001). Although iterative frameworks existed in the late 20th century, the use of agile methods became more prevalent after the Agile Manifesto was introduced.

Critical Success Factors

Critical success factors are the minimal number of undertakings that need to be completed satisfactorily to deliver a successful outcome (Rockart, 1979). They are important because CSFs identify the significance of the relationships between dependent and independent variables. Since the mid-2000s, research studying agile software development success has primarily focused on examining the relationships between CSFs for agile software development and project success (Ahimbisibwe et al., 2015; Aldahmash, 2018; Chow and Cao, 2008; Garousi et al., 2019; Misra et al., 2009; Montequin et al., 2014; Stankovic et al., 2013). This is significant because many of these studies do not agree on the CSFs for agile software development.

Higher Education Institutions

Within this document, the phrase “higher education institutions” includes any post-secondary, degree-granting institution that offers students federal financial aid and programs of study that conclude with an associate’s, baccalaureate, or higher degree (Institute of Education Sciences, 2020). According to the National Center for Education Statistics (n.d.), there were 3,486 degree-granting post-secondary institutions in the United States in 2020. To contain the scope, the current study references publicly or privately funded, not-for-profit, degree-granting post-secondary institutions when referring to higher education institutions.

Project Success

Many definitions of project success exist. Although it can simply be defined as completing a project successfully, the dimensions in which success is measured differ across existing research. The Standish Group’s annual CHAOS Report has been cited extensively in existing research on the subject (Ahimbisibwe et al., 2017; Amponsah & Darmoe, 2014; Arcos-Medina & Mauricio, 2020; Hughes et al., 2017; Pace, 2019), but even that group changed its definition of project success in 2015. Originally defined as completing a project on-time, on-budget, and on-target (Standish Group, 1994), the Standish Group switched to using on-time, on-budget, and with satisfactory results as the dimensions to measure project success in 2015. Although many researchers have cited CHAOS Reports in their studies, those researchers often employ their own measurement for project success within their research (Ahimbisibwe et al., 2017). Some researchers employ a self-reporting assessment of project success, which is subjective based on the survey participants' unique view of project success (Serrador & Pinto, 2015), but many use quality, scope, time, and cost to measure success (Ahimbisibwe et al., 2017; Chow & Cao, 2008; Stanberry, 2018). This definition aligns more closely with the Standish Group's (2015) modern definition of project success since quality and scope (on-target) can shape a customer's satisfaction. This research used four dimensions—quality, scope, time, and cost—to define and measure the perceived level of project success so that results can be triangulated with existing research.

Traditional Software Development

Traditional software development is the management of a software development project using a methodology that relies on a linear life cycle (Ahimbisibwe et al., 2017). The waterfall method is a commonly practiced traditional software development method. Traditional software development methods include five process phases: initiating, planning, executing, monitoring and controlling, and closing (Project Management Institute, 2012). They are plan-driven and are often less suited for projects with fluid business requirements (Ahimbisibwe et al., 2015).

Assumptions, Limitations, Delimitations

Assumptions, limitations, and delimitations disclose the boundaries and scope of a study. Assumptions are information that is accepted as being true without being verified (Kornuta &

Germaine, 2019), limitations are items the researcher is unable to control that could influence the outcome or generalizability of the research (Lunenburg & Irby, 2014), and delimitations define the scope for the research (Kornuta & Germaine, 2019). All studies have assumptions, limitations, and delimitations, so it is important for researchers to document them and describe measures that will be taken to control their impact on the outcome of the study (Simon & Goes, 2017). Identifying the assumptions, limitations, and delimitations in a study can improve a reader's understanding of the research by helping them see the study through the lens of the researcher. They can also aid with future research on the subject by divulging the shortfalls in the existing research. As the researcher of this study, I document and describe the assumptions, limitations, and delimitations of this study below.

Assumptions

Assumptions are information that is presumed to be truthful without being verified (Kornuta & Germaine, 2019). Within research, assumptions are made with the nature, analysis, and interpretation of the data, and should be identified and described in quantitative research to convey their risk to the study (Lunenburg & Irby, 2014). Documenting assumptions is significant because they can affect the inferences a reader can draw from the research. They can influence the foundation of the study or the researcher's understanding of the data. Assumptions made in this study are outlined below.

Adequate Sample Size. The first assumption made in this study was that the sample size was representative of the population. Cochran (1977) identifies four strategies researchers can use to determine an appropriate sample size. These strategies include the researcher using the results of existing studies conducted on the same population, using a pilot study to test the results and then applying what was learned to create the sample, dividing the sample into two groups so that the results from the first group can be used to determine the number of responses needed from the second group, and leveraging a mathematical equation to estimate the same. To my knowledge, no existing research has been done on the same population as in this study, so the first strategy could not be used. The second and third strategies identified in Cochran do not favor small populations. The population for this research included IT professionals and IT project managers at degree-granting, public or private, not-for-profit higher education institutions in North Carolina. One hundred twenty-four institutions met this criterion in 2022 (National Center for Education Statistics, n.d.). Using information obtained by visiting these institutions' public, online directories, I estimated the cumulative population in September 2022 was approximately 3,957 IT professionals and IT project managers; therefore, the population is not appropriate for the second and third strategies. A fifth strategy suitable for small populations that was not identified by Cochran is to conduct a census and survey the entire population. This method eliminates sampling error but was not used in this research because it can be costly and time consuming (Israel, 1992). The final strategy, which was employed in the current study, is to leverage a mathematical equation to determine the sample size.

Two common formulas used to determine a sample size are Yamane formula and the unnamed formula published by National Education Association (NEA; 1960) article. The NEA formula, shown in Figure 6, has been widely adopted by researchers and was popularized in 1970 after Krejcie and Morgan (1970) developed a table that allowed researchers to quickly identify the sample size based on a 95% confidence level and 5% sampling error. A population proportion of 0.5 is used because it provides the maximum sample size (Krejcie & Morgan, 1970). Similarly, the Yamane formula, shown in Figure 7, assumes the confidence level is 95% and the population proportion is 0.5. Simon and Goes (2017) claim that the golden standard for quantitative research is to use a 95% confidence level and 5% sampling error; therefore, either of the aforementioned formulas could be used to calculate the sample size.

Figure 6

NEA Formula for Determining Sample Size (Krejcie & Morgan, 1970)

$$s = \frac{x^2 (N) (P) (1 - P)}{d^2 (N\text{-}1) + x^2 (P) (1 - P)}$$

s = required sample size

x^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841)

N = the population size

P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size)

d = the degree of accuracy expressed as a proportion (0.05)

Figure 7

Yamane formula (Adam, 2020)

$$n = \frac{N}{1+(N*d^2)}$$

n = maximum sample size

N = population size

d = margin of error (degree of accuracy)

As previously mentioned, the population of the current research is approximately 3,957. Using the Yamane formula (Adam, 2020), the sample size of the study should be 363 participants. Similarly, the NEA formula referenced in Krejcie and Morgan (1970) with a 95% confidence level and 5% degree of accuracy indicates the sample size should be 350 participants. Although both formulas calculate a similar sample size, Adam (2020) indicates the Yamane formula is an approximation and less accurate. Therefore, the NEA formula referenced in Krejcie and Morgan was used to identify the sample size for this study. I assumed this formula accurately calculated the maximum sample size needed for the given population.

Survey Instrument. The next assumption made was that the survey instrument used was an appropriate instrument for collecting data. The instrument used to collect data from survey participants was an online questionnaire that contained questions with a 7-point Likert scale. Likert scale surveys are the most acceptable and commonly used instrument for measuring a participant's assessment (Allen & Seaman, 2007). There is no optimal number of Likert scale choices (Matell & Jacoby, 1971), but the 7-point scale that was used in this study has been validated in prior studies by Chow and Cao (2008), Brown (2015), and Stanberry (2018). Since the survey was validated in other research, I did not utilize a pilot group to verify the survey's appropriateness.

Honest and Objective Responses. The third assumption made in this study was participants were honest and objective with their survey responses. Social desirability bias occurs when participants respond in a way that portrays themselves in a favorable way opposed to answering in an authentic way that reflects their attitudes, values, and behaviors (Larson, 2019). Participants could have been reluctant to admit when an agile software development project they were responsible for failed or was challenged. To encourage honest and genuine responses from survey participants, I clearly communicated that there was no risk or compensation to survey participants based on their responses. Additionally, the survey was self-administered online opposed to in-person. Impression management can occur when surveys are conducted in-person which can contribute to social desirability bias (Larson, 2019). Participation was also voluntary, so users were not motivated to answer in a particular way. Finally, to encourage non-bias responses, survey participants' identities remained anonymous. Research concludes that anonymization is a significant factor that effects a research participant's decision to share data (Schomakers et al., 2020). As the researcher conducting this study, I communicated this prior to participants starting the survey to encourage honest and objective survey responses.

Limitations

Limitations are factors outside the control of the researcher that could impact the findings or generalizability of the research (Lunenburg & Irby, 2014). They often include constraints pertaining to the data (Kornuta & Germaine, 2019), but could also be introduced by the study's design and method. Limitations convey potential weaknesses in the study that could affect the researcher's conclusions, so it is necessary for scholars to convey how they intend to curb them (Simon & Goes, 2017). It is important to note that while researchers can put some controls in place to limit the effect of limitations, many cannot be totally controlled or eliminated (Simon & Goes, 2017). Limitations of the current study are detailed below.

Expansive Population. The general problem to be addressed is the failure of organizations adhering to agile principles resulting in unsuccessful software development projects. The population of organizations managing software development projects spans across most industries and most nations, so including all organizations in the population is not feasible. Simon and Goes (2017) noted that researchers often have to settle for a subset of a population because it is not practical or possible to study the entire population. To manage this limitation, the scope has been refined for the current study to exclude businesses outside degree-granting, not-for-profit, public or privately funded higher education institutions in North Carolina who use agile methodologies for software development projects from the population. Higher education institutions were selected for this study because many are leveraging technology and agile software development to respond to the need to deliver more value to students at an affordable cost (Pathak & Pathak, 2010; Peppard, 2010). Therefore, the specific problem that was addressed was the failure of organizations within the publicly and privately funded North Carolina higher education sector adhering to agile principles resulting in unsuccessful software development projects.

Research Participants' Experience with Agile. The second limitation to this study was the level of experience the research participants have with agile. Inexperience is a significant factor that contributes to failed IT projects (Nawi et al., 2011); it is the leading cause of failed agile projects (VersionOne, 2012). Other research indicates that those with an abundance of experience with agile methodologies are more likely to tailor a method (Giudice, 2015, as cited in Cram, 2019) and potentially deviate from agile principles. As researcher of this study, I had no control over the amount of experience research participants had with agile software development projects, but did capture the participants' level of experience with agile software development through the survey instrument. This allowed me to convey the information using descriptive statistics in the study's findings.

Researcher Inexperience. Another limitation of the current study was my inexperience as a researcher conducting quantitative studies. This research was my first study of this capacity, and it contributed to this dissertation project. Inexperience can affect the design and data analysis within a study. New researchers must be aware of cognitive biases such as the anchoring effect and confirmation bias. Anchoring effect is when an initial piece of information influences subsequent decisions, and confirmation bias is when a researcher unconsciously gives more weight to results that align with preexisting views (McRaney, 2012). To mitigate this limitation, I worked closely with my dissertation chair and dissertation committee to ensure the integrity of the study and findings.

Delimitations

Delimitations shape the scope and set boundaries for research (Kornuta & Germaine, 2019). They are self-imposed by researchers to minimize the variables that could affect the research (Lunenburg & Irby, 2014). Delimitations often arise in response to limitations in the study (Simon & Goes, 2017). Two delimitations of the current study pertain to the refined scope and the actors in the study. Each delimitation is described in detail below.

Refined Scope. As previously mentioned, it is not practical or possible to include all organizations managing software development projects in the population of the current study. The scope was refined to only include North Carolina degree-granting, not-for-profit, publicly or privately funded higher education institutions who use agile methodologies for software development projects in the population. Using a subset of the universal population makes research more feasible, but results may not be generalizable to the full population (Lunenburg & Irby, 2014). Since the sample in the current study was pulled from a subset of the population (i.e., it only included higher education institutions instead of all businesses using agile methods on software development projects), I was cautious not to generalize the results of the research towards all agile software development projects. I also call for additional research investigating the variation between groups of respondents to determine if the difference between industry or nation explains any of the variance in the results across studies.

Actors. Some agile methodologies have seen such success that they have been used outside the software development industry. Scrum, a commonly used agile methodology, has been practiced and proven successful in fields such as marketing, sales, education, human resources, communications, and geology (Oprins et al., 2019). However, in many of these applications, the implementation of Scrum was altered from its defined rituals to meet the need of the industry and organization (Oprins et al., 2019). Since the general problem addressed is the failure of organizations adhering to agile principles resulting in unsuccessful software development projects, I needed to ensure as the researcher conducting this study that only the perspectives of IT professionals and IT project managers who have completed a software development project using an agile methodology were included in the study. To do this, I shaped the scope and set boundaries by targeting IT professionals and IT project managers from North Carolina degree-granting, not-for-profit, publicly or privately funded higher education institutions to survey. Research participants were also informed of the boundaries prior to completing the survey to reduce the risk of receiving feedback from individuals without agile experience as well as those outside the IT or project management profession.

Significance of the Study

This study is significant to organizations who manage software development projects using agile methods. As the researcher of this study, I examined if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of project success. Findings from this study reveal insights from the experiences of participating IT professionals and IT project managers employed by publicly or privately funded North Carolina higher education institutions and inform institutions which agile principles project teams should adhere to in order to maximize their chance of project success. This is significant to higher education institutions because a growing interest in online education combined with budgetary constraints has executive leadership using agile software development to respond to changing demands (Peppard, 2010). Maximizing an institution's ability to succeed with software development projects can contribute to operational excellence and fiscal sustainability and improve its overall value to students.

Reduction of Gaps in the Literature

Despite existing research on CSFs for agile software development projects (Bogopa & Marnewick, 2022; Brown, 2015; Chiyangwa & Mnkandla, 2017; Chow & Cao, 2008; Garousi et al., 2019; Meenakshi et al., 2020; Shakya & Shakya, 2020; Sheffield & Lemétayer, 2013; Stanberry, 2018; Stankovic et al., 2013; Syeda, 2018; Tam et al., 2020), many businesses continue to experience low project success rates (Standish Group, 2020). One study concludes that project success rates for agile-led projects have improved slightly over the past five years, from 39% in 2015 (Standish Group, 2015) to 42% in 2020 (Standish Group, 2020), but 58% of agile software development projects are still unable to satisfy the budget, timeline, and customer. Furthermore, failed projects that were either cancelled or never used also increased from 9% to 11% between 2015 and 2020 (Standish Group, 2015, 2020). This could be due to existing research on CSFs for software development projects not agreeing on which factors influence project success (Chow & Cao, 2008; Garousi et al., 2019). Some researchers recognize that observing agile principles can contribute to project success (Cram, 2019; Serrador & Pinto, 2015), but there is a gap in literature exploring if a relationship exists between project success and deviating from the 12 agile principles. Additionally, scholars have called for further research investigating the significance of deviating from agile principles (Eloranta et al., 2016). This study aimed to fill this gap and identify which agile principles, if any, have the most significant impact on project success.

Implications for Biblical Integration

In Genesis 1:26-28 and 2:15 (*Good News Bible*, 2001), God placed mankind on Earth to work and care for His garden. He created man in His likeness, and desires for him to further cultivate and build upon His creation. Keller emphasized this: "God left creation with deep untapped potential for cultivation that people were to unlock through their labor" (Keller & Alsdorf, 2012, p. 36). In this sense, cultivation is about using the skills God provides to advance our world. Agile methodologies cultivated and advanced the world of software development. They improved traditional waterfall methodologies by shifting the focus from using pre-defined processes, tools, documentation, and rigid planning to being more customer oriented, collaborative, and responsive to change (Beck et al., 2001). Agile methodologies also often result in improved project success rates for software development projects (Standish Group, 2020). This research aimed to further advance the benefits reaped from agile methodologies by exploring if a relationship exists between deviating from agile principles and project success. Based on the relationship identified by this study, project managers know which principles should be strictly adhered to in order to increase their chance of satisfying the quality, scope, timeline, and cost of a software development project.

From a theological lens, this research is also significant because it aligns with God's desire for mankind to serve one another. Many of the principles behind the Agile Manifesto focus on improved customer service. The first principle notes that a software developer's highest priority is to satisfy the customer, the second principle welcomes changing requirements if the changes improve the customer's competitive advantage, the third principle delivers results more quickly, and the fourth principle calls for more collaboration between the developer and business user (Beck et al., 2001). The Bible highlights God's will for people to use the skills bestowed on them from God to serve others (*Good News Bible*, 2001, 1 Peter 4:7-11, 5:1-4). Peter writes that we must use the special gifts God bestowed on us for the good of others (1 Peter, 4:10). We are to care for our peers and work for the benefit of others, not work for personal gain (1 Peter, 5:1-4). Keller and Alsdorf (2012) emphasize God's desire for people to serve others through their work. They acknowledged that people should see their work as a method of servicing God and their neighbor, that work's purpose is to exalt something greater than themselves, and that work is the method for making ourselves useful to others. By identifying which principles are more closely related to project success, this research aimed at serving agile software development teams and their stakeholders.

Benefit to Business Practice and Relationship to Cognate

This research is related to the Information Systems cognate because it investigated if a relationship exists between deviating from agile principles and project success for software development projects. Software is an essential component to many organizations (Arcos-Medina & Mauricio, 2020), yet many businesses are still unable to successfully implement software development projects (Standish Group, 2020). One publication estimated that failed and challenged software development projects cost businesses nearly $260 billion in 2020 (Consortium for Information & Software Quality, 2020). The outcome of this research could have a significant financial benefit for North Carolina higher education institutions who leverage agile methodologies to manage software development projects. In fiscal year 2019, North Carolina universities and community colleges spent over $47.7 million on development and applications support (North Carolina Office of the State Controller, 2019). The Standish Group (2020) concluded that approximately 58% of all IT projects failed or were challenged during this same timeframe. If the cost of projects were distributed evenly and 58% of North Carolina university and community college projects funded during the 2019 fiscal year were unsuccessful, then the state invested over $27 million on projects that were unable to satisfy the budget, timeline, and customer. This is significant because the surge in undergraduate and postbaccalaureate students enrolling in degree-granting post-secondary institutions is plateauing. Although there was a 16% increase in enrollment for undergraduate and 24% increase for postbaccalaureate programs between 2003 and 2017, research predicts that there will only be a 3% increase in enrollment for both programs from 2017 to 2028 (Institute of Education Sciences, 2020). Enrollment also decreased by 5% between 2009 and 2019 (Institute of Education Sciences, 2021), meaning college and university budgets likely decreased. This research stands to help institutions know which agile principles software development teams should avoid deviating from to improve their chance at project success and make better use of financial resources.

Summary of the Significance of the Study

Low IT project success rates have plagued businesses for decades (Hughes et al., 2017). Although success rates have nearly doubled from 16% to 31% between 1994 and 2020, nearly one out of every five IT projects is still cancelled or not used and half are unable to satisfy the customer, timeline, and budget requirements (Standish Group, 2015, 2020). These low project success rates significantly impact higher education institutions that have experienced declining budgets caused by a recent reduction in undergraduate and postbaccalaureate enrollment. Following God’s will for people to cultivate His creations and serve others, this research builds on the existing knowledge of agile principles and their relationship with project success for the purpose of improving the success rate of software development projects that use agile methods. The goal of this research was to identify if deviating from agile principles has an impact on project success so that software development teams know which principles they should adhere to in order to improve their chance at success. This is significant because improved project success rates provide a financial benefit to organizations and a spiritual reward for individuals. Businesses benefit financially by improving their overall return on investment on IT projects. Individuals benefit spiritually because successful projects reinforce the purpose and value of their work. Keller highlighted the need to do fulfilling work when he wrote: “Without meaningful work we sense significant inner loss and emptiness” (Keller & Alsdorf, 2012, p. 37). The current study adds to the existing body of knowledge on agile software development and project success while aligning with biblical principles by offering insight into which agile principles project teams should avoid deviating from to improve their chance at project success.

A Review of the Professional and Academic Literature

Low IT project success rates have plagued businesses for many years and both scholars and practitioners have investigated methods for improving project outcomes. Practitioners have introduced many software development techniques, such as eXtreme Programming and Scrum, and scholars have conducted numerous studies investigating the relationships between various independent variables and project success. This section reviews professional and academic literature pertaining to relevant business practices, the problem, and related theories. In addition, scholarly literature discussing the independent and dependent variables of the current study are reviewed. Finally, research and scholarly articles on related studies are presented.

Business Practices

Since the turn of the century, innovation and new technology have driven change for many industries. Consumers often expect reduced delivery times without negatively effecting the quality of the product, and businesses who demonstrate an ability to adapt are often able to maintain or attain competitive advantages in their market space. Developing high-quality software at a rapid pace is one method software development companies have used to adapt to evolving market demand (Hohl et al., 2018); however, many companies have struggled to change. This may be due to traditional software development methods being less suited for projects that have fluid business requirements (Ahimbisibwe et al., 2015). In response to the need to establish a responsive, lightweight, and less-documentation-driven software development methodology, a group of professionals met and created the Agile Manifesto. Based on principles defined in the manifesto, agile methodologies can contribute to an improved alignment between business and IT (Hohl et al., 2018) and can help businesses be more responsive to evolving business needs (Aarnink & Kruithof, 2012). This section provides a detailed discussion on the business practices related to the current study by introducing the birth of the Agile Manifesto, presenting common agile methods, and discussing modern business practices of agile software development.

Birth of the Agile Manifesto. At the end of the 20th century, the majority of software development projects resulted in delays, exceeding the budget, having features cut, or being cancelled (Standish Group, 1994). Despite practitioners and scholars agreeing that development methods that were more flexible, iterative, and interactive were more likely to be successful, software development projects continued to experience low success rates (de Souza Bermejo et al., 2014). In 2001, 17 professionals skilled in various software development methodologies met to try and identify a better way to develop software (Beck et al., 2001). Pulling from their experiences with lightweight, responsive methodologies such as eXtreme Programming (XP), Scrum, Dynamic Systems Development Method, Adaptive Software Development, Crystal, Feature Driven Development, and Pragmatic Programming, these 17 professionals focused on the similarities between their respective methods to identify characteristics that contribute to successful software development (Beck et al., 2001; Batarseh et al., 2018; Hohl et al., 2018). The outcome of their work is the Agile Manifesto (Beck et al., 2001). Shown in Figure 8 and Figure 9, respectively, the manifesto contains four core values and 12 principles which promote successful software development. Although a few lightweight, adaptable software development methodologies already existed, the manifesto delivered a unified vision and an overwhelming shift away from the traditional software development paradigm by formally introducing agility to the software development industry (Faisal Abrar et al., 2020). It fortified the agile movement by organizing the best practices that contributed to success across existing methods (Campanelli & Parreiras, 2015).

Figure 8

Core Values of the Manifesto for Agile Software Development (Agile Manifesto)

Core Values of the Manifesto for Agile Software Development
1. **Individuals and interactions** *over* processes and tools.   2. **Working software** *over* comprehensive documentation.   3. **Customer collaboration** *over* contract negotiation.   4. **Responding to change** *over* following a plan.

Figure 9

Principles Behind the Agile Manifesto

Principles behind the Agile Manifesto

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity--the art of maximizing the amount of work not done--is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

The Agile Manifesto is not a software development method, nor it is intended to be a cookbook for project success; however, it does establish a core philosophy for agile software development methods through its values and principles (Cram & Newell, 2017). It provides a system development approach for how software development projects are managed (Cram, 2019). Several agile software development methods exist, each emphasizing a unique set of characteristics, but they all align with the principles and core values of the manifesto (Arcos-Medina & Mauricio, 2020). Many agile methods also aim to improve the working conditions for software developers, which has contributed to their widespread adoption (Hohl et al., 2018).

Scrum and XP, two commonly practiced agile methods, are introduced in the next section (Arcos-Medina & Mauricio, 2020; Cram & Newell, 2017).

Common Agile Methodologies. Several software development approaches have been labeled agile. Although each approach contains a unique collection of development practices, these practices all reinforce the 12 fundamental principles of the Agile Manifesto (Cram, 2019; Faisal Abrar et al., 2020). This supports the claim that it is the underlying values and principles that contribute to the success of the various agile methods and not their unique set of practices (Lockard & Gifford, 2017c, as cited in Hohl et al., 2018). The most commonly practiced agile software development methods are Scrum, XP, and a hybrid methodology which mixes practices from both XP and Scrum. Each of these methods is introduced below.

Scrum. Scrum is the most widely adopted agile software development method (Arcos-Medina & Mauricio, 2020). A core focus of Scrum is to maximize a team's output in a short, predefined period of time. Unlike traditional methods, Scrum emphasizes heuristic processes built around communication and collaboration (Batarseh et al., 2018). It is lightweight, meaning there is more focus on the work produced than management procedures, but Scrum is intended to follow a specific set of tasks to maximize output (Sambare & Gupta, 2017). Most organizations implementing Scrum strive to improve their responsiveness, flexibility, and reliability (Annosi et al., 2016). To do this, Scrum focuses on software management practices more than software development practices (Alsaqqa et al., 2020). It is most suitable for environments where it is difficult to plan ahead because its characteristics allow development teams to quickly respond to evolving business needs and environmental unpredictability (Annosi et al., 2016); however, Scrum favors small and medium sized teams because it is less scalable for larger organizations (Rodríguez et al., 2019).

Scrum was introduced in software development via Schwaber (1997) and some believe it was based on the Takeuchi and Nonaka product development methodology because they both consist of small, high performing teams (Annosi et al., 2016). Although Scrum is used heavily within software development, it is not a software development technique. Rather, scrum is a method for managing the project and tasks associated with software development (Eloranta et al., 2016; Hohl et al, 2018). A goal of Scrum is to deliver a process that increases the development team's flexibility, which enables them to be more responsive to evolving business requirements as they take shape throughout the development process (Schwaber, 1997). The Scrum process consists of development sprints, which are short time periods with a defined desired outcome, a feature set of specific tasks to be developed within the defined sprint, and a backlog list of tasks to be prioritized for future sprints (Ahimbisibwe et al., 2015). In line with the 12th principle from the manifesto, a retrospective is done at the end of each Scrum sprint to identify items that can be improved (Eloranta et al., 2016). Other agile principles emphasized in Scrum processes include customer satisfaction through early and continuous delivery of software, welcome requirement changes at any point in the development process, deliver working software frequently, daily/frequent collaboration between the requestor and software developers, supporting and entrusting the project team to get the job done, measuring progress through the delivery of working software, sustainable development, simplicity, and self-organizing teams.

***eXtreme Programming*.** The second most widely adopted agile software development method is XP (Arcos-Medina & Mauricio, 2020). XP emphasizes customer and developer satisfaction, which contributes to its popularity (Sambare & Gupta, 2017). XP is also known for improving the quality of code being developed because of its rigorous automated testing practices (Alsaqqa et al., 2020). Similar to Scrum and other agile methods, XP is best suited for situations where a customer's requests and business needs change frequently (Xu, 2009); however, XP's unique set of practices distinguish it from other agile methods. The most notably recognized practices that are unique to XP include pair programming, collective ownership, small releases, and continuous integration (Arcos-Medina & Mauricio, 2020; Hohl et al., 2018). The 12 practices that comprise XP are: the planning game, small releases, metaphor, simple design, continuous testing, refactoring, pair programming, collective code ownership, continuous integration, 40-hour week, onsite customer, and coding standards (Arcos-Medina & Mauricio, 2020; Xu, 2009).

Although XP is the second most widely adopted agile software development method, it is not appropriate for all development environments (Beck, 2000). Organizational culture is the biggest barrier impacting the success of XP projects. Cultures that require a significant amount of documentation for outlining the business need and viable solutions up front or require a high-level of auditability are not well-suited for XP (Beck, 2000; Williams, 2010). Additionally, while XP allows customers to replace and select user stories to be developed during iterative releases, the unplanned nature of XP also makes it difficult for teams to accurately estimate time and cost (Sambare & Gupta, 2017). Furthermore, XP entails a significant amount of customer involvement, which can be time-consuming (Williams, 2010). If a project gets off schedule, the nature of XP is to investigate what is wrong with the procedure or calendar opposed to adding extra resources. XP does not work well with teams larger than 10 developers, and developers are not expected to exceed a 40-hour work week (Beck, 2000; Sambare & Gupta, 2017).

***Hybrid Methods*.** Both Scrum and XP offer benefits to software development teams, but no methodology can guarantee a project's success. For example, a project team adheres to a rigid, iterative processes with Scrum, but many projects include a great deal of variability such that some processes are not easily defined or repeatable (Neelu & Kavitha, 2021). Similarly, XP uses processes where developers interact with customers frequently and swarm project deliverables to develop the minimally viable product as quickly as possible, but paired programming and frequent customer involvement are not always feasible (Neelu & Kavitha, 2021). To account for variation in culture and other nuances in an organization, many businesses adopt practices from more than one agile method to form a hybrid methodology that meets their specific needs (Cram & Newell, 2017; Williams, 2010;. Although agile tailors can combine practices from any agile methodology, Scrum and XP are two methods that organizations frequently combine to form a hybrid method (Neelu & Kavitha, 2021). This is likely because these methods complement each other by catering to iterative and incremental development (Mattioli et al., 2015). Combining practices from Scrum and XP enables organizations to exploit the unique advantages of both. Hybrid Scrum and XP models often adopt Scrum practices for project planning and management and XP practices to support improved quality and technical excellence (Arcos-Medina & Mauricio, 2020; Fitzgerald et al., 2006; Neelu & Kavitha, 2021).

The daily practices of Scrum and XP align with many of the principles within the Agile Manifesto. Although these methods are unique and have experienced individual success, a blended method has proven to be successful in unique instances like global software development (Jain & Suman, 2017). This reinforces the notion that it is the underlying agile values and principles that contribute to a method's success and not the unique processes (Fitzgerald et al., 2006; Lockard and Gifford, 2017c, as cited in Hohl et al., 2018). The current research aimed to test if there is a relationship between deviating from these principles and project success which could reinforce the practice of tailoring existing agile methods to form a new hybrid method.

Business Practices of Agile Software Development. Many organizations seek to implement some form of agile software development in an effort to achieve a competitive advantage (Denning, 2016). Although using an agile method to manage a software development project does not guarantee a successful outcome, research supports that IT projects of all sizes are most successful when they employ an agile method (Standish Group, 2020). Defining project success as on time, on budget, and satisfying the customer, the Standish Group (2020) concluded that 42% of agile led projects were successful, whereas only 13% of traditionally managed projects were successful. Agile methods are most successful in small (59%) and medium (34%) projects but are still nearly 2.5 times more effective in large (19%) projects as they are in similarly sized waterfall-led (8%) projects (Standish Group, 2020). Figure 10 shows the project resolution by delivery method for various sized projects. A successful resolution indicates all three of the measurements of success—on time, on budget, satisfying the customer—were achieved, a challenged resolution indicates only one or two of the three measurements of success were achieved, and a failed resolution indicates the project was cancelled or not used.

Figure 10

Project Resolution by Delivery Method Note: (Standish Group, 2020, p. 31)

Project Size	Method	Successful	Challenged	Failed
All	Agile	42%	47%	11%
	Waterfall	13%	59%	28%
Large	Agile	19%	56%	25%
	Waterfall	8%	56%	36%
Medium	Agile	34%	53%	13%
	Waterfall	9%	66%	25%
Small	Agile	59%	36%	5%
	Waterfall	45%	46%	9%

In addition to improved project success rates, other factors that prompt businesses to adopt agile methods include facilitating increased customer engagement, utilizing iterative frameworks that adapt more easily to change, and restructuring the development process so that working software is released more frequently (Cram, 2019). Agile methods, however, are not best suited for all software development teams or all projects. Instead, agile methodologies work best on projects where deliverables and tasks fluctuate, when the project team has a high level of expertise, and when the customer commits to being actively engaged throughout the project's lifespan (Ahimbisibwe et al., 2015). An absence of these characteristics could impact project success. Although these characteristics help provide a framework for selecting an agile or traditional approach, research supports that an organization's and project team's experience with a specific method is a significant factor that contributes to the approach selected (Ahimbisibwe et al., 2015).

Practitioners acknowledge that changing from a traditional plan-driven approach to a more flexible, iterative process can be difficult (Annosi et al., 2016). Several agile software development methods exist, so selecting a method that aligns with an organization's culture can contribute to a project's success. In Chiyangwa and Mnkandla (2017), the authors note that some project managers are unable to select an appropriate agile method because they lack the knowledge and experience to do so. This lack of knowledge and experience may contribute to agile tailoring—a prevalent trend where organizations implementing agile software development methodologies blend traditional traits with agile traits or blend characteristics from various agile methods. Agile software development tailoring is "the adaptation of the method to aspects, culture, objectives, environment and reality of the organization adopting it" (Campanelli & Parreiras, 2015, p. 87). Some organizations tailor processes to improve on an existing methodology, whereas others do it inadvertently because they lack experience. When done properly, tailoring can help an organization by eliminating unnecessary practices from the development process, but businesses should be cautious because bad tailoring can lead to increased cost from wasting time and resources (Akbar, 2019). Possessing expertise in multiple agile methodologies and rationalizing any process changes can help increase the effectiveness of agile tailoring (Conboy & Fitzgerald, 2010).

Cram (2019) draws attention to the fact that while tailoring is becoming increasingly common, deviating from defined agile practices can make it challenging to determine the relative benefits of a specific agile method. Organizations often tailor agile methods without understanding the consequences (Eloranta et al., 2016). Some scholars suggests that organizations should be cautious when tailoring to ensure agile principles are still adhered to (Cram, 2019; Eloranta et al., 2016), whereas others conclude that agile principles must be followed to avoid conflicts that result in decreased productivity (Siddique & Hussein, 2016). However, some agile practices, such as paired programming, go against company culture—leaving the organization with a dilemma to change culture or change an agile practice (Cram, 2019). This research seeks to offer insight into which agile principles influence the perceived success of software development projects so future IT leaders can avoid deviating from those principles which have a significant impact on project success.

The Problem

The general problem to be addressed is the failure of organizations adhering to agile principles resulting in unsuccessful software development projects. Research indicates agile led IT projects have a higher success rate than waterfall led projects, at rates of 42% and 13% respectively, but 58% of agile led projects are still challenged or fail (Standish Group, 2020).

Some classify a project as challenged if it does not satisfy all three success criteria—on time, on budget, customer satisfaction—and failed if it does not satisfy any of the three success criteria (Standish Group, 2020). The high rate of failed and challenged agile-led IT projects could be due to projects being mislabeled such that projects not adhering to agile principles are being misrepresented as being agile. Eloranta et al. (2016) explained that many companies claiming to be agile in software development are merely utilizing some agile practices. In other cases, organizations are intermingling practices from agile methods and traditional plan-driven methods (Giudice, 2015, as cited in Cram, 2019). This aligns with the observation that more agile tailoring occurs as more companies adopt agile approaches (Cram, 2019). Some researchers highlight that while it may be justified, organizations intending to tailor agile principles should be wary about the impact any changes will have on success and to the overall value of the agile method (Cram, 2019). Other researchers state that to be successful, agile principles must be strictly followed (Agile Uprising, 2016), insinuating that tailoring which diverges from the principles defined in the manifesto should not be done.

Like many organizations, higher education institutions are being challenged to preserve costs and increase the overall value to students (Pathak & Pathak, 2010). Fueled by budgetary constraints and an evolving market where the demand for online education has increased, executive leadership is now looking at leveraging technology and new methods to meet demand (Peppard, 2010). In many cases, these IT leaders sought to utilize agile practices to attain a competitive advantage (Cram, 2019; Denning, 2016). One study discovered that organizations that adhere to agile practices have lower costs, increased productivity, enhanced quality, and better customer satisfaction (Misra et al., 2009). Another study found that software development projects utilizing agile methods improve customer satisfaction by producing a higher quality product, but worsen budget and time performance (Suetin et al., 2016). This could be caused by improper agile tailoring since some researchers assert that not adhering to agile principles can lead to conflicts that result in decreased productivity (Siddique & Hussein, 2016). Similarly, other researchers caution that although deviating from agile principles is common, they should be avoided to prevent undesired outcomes over time (Eloranta et al., 2016). Additional research is needed to investigate the significance of deviating from agile principles (Eloranta et al., 2016). Examining if a relationship exists between deviating from the 12 agile principles outlined in the manifesto and the perceived level of success with agile software development projects completed at North Carolina higher education institutions may help organizations leveraging technology and new methods to attain a competitive advantage increase their project success rate.

Theories

Theories help rationalize an expectation and justify a prediction of how an independent variable influences a dependent variable (Creswell, 2014). They advance the knowledge of a particular subject by developing an explanation (Thomas, 1997). The current study employed the CSF theory to explore if a relationship exists between deviating from the 12 agile principles and project success. This section presents the CSF theory, its predecessor, Success Factors theory, and an alternate theory—Technology Acceptance Model (TAM) —that could be used to understand why IT professionals and IT project managers deviate from or fail to adopt certain agile principles.

Success Factor Theory. In 1961, Daniel asserted that many companies were not able to provide management with timely, adequate information to support good decision-making. He emphasized that businesses often base strategic and operational decisions on financial data because they do not have information systems in place to track the relevant data needed to plan, operate, and control the organization. As a solution, he introduced the idea that businesses should design information systems and information system reports that focus on factors which contribute to competitive success. Daniel believed that a unique set of success factors existed across an industry, meaning if this set of homogeneous tasks were done exceptionally well the company would be successful. Although this set of key jobs vary between industries, Daniel asserted that there are between three and six success factors for most industries.

Daniel’s concept of success factors remained unexplored until Anthony et al. (1972) applied the concept to design a management control system. Anthony et al. emphasized that management control systems inherently identify key success factors that affect profitability (Leidecker & Bruno, 1984). They extend on Daniel’s concept noting that there are often six key success factors that determine organizational success, but the factors are not constant nor are they predictable based on the industry (Leidecker & Bruno, 1984; Rockart, 1979). Anthony et al. emphasized that success factors vary between businesses within a common industry, as well as between managers within the same organization. This indicates that there are additional sources of success factors beyond the industry alone.

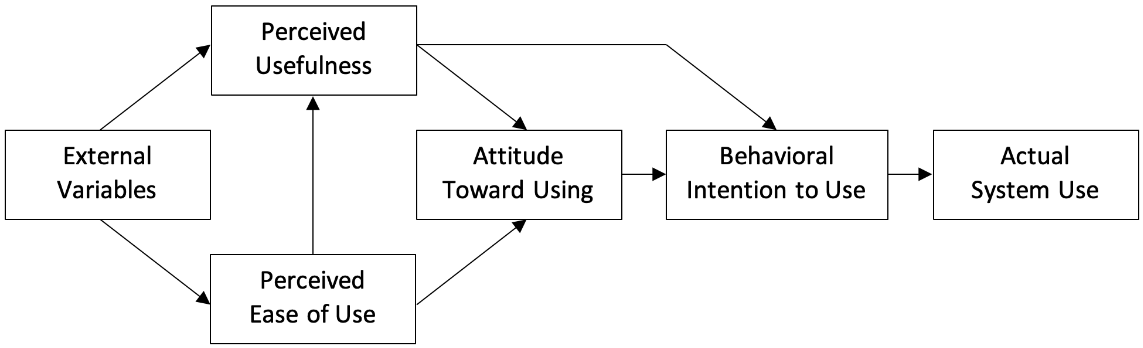
Critical Success Factors Theory. Using the theories from Daniel (1961) and Anthony et al. (1972) as a foundation for his work, Rockart (1979) introduced the concept of CSF. He agreed with Anthony et al. that success factors vary between managers, but highlighted that CSFs differ from success factors because CSFs are “the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization” (p. 85). Conversely, if CSFs results are meager, the outcome will be undesirable. Rockart dedicated a two-year span validating his theory about CSFs by helping executives identify their critical information needs and concluded with positive results (Rockart, 1979).

CSF theory and its derivative, critical failure factor theory, have been widely accepted and used in research spanning many disciplines. As it relates to the current study, Chow and Cao (2008) put Rockart's (1977) CSF theory to use by testing the significance of hypothesized success factors and the resulting impacts on the success of agile software development projects. Shown in Figure 1 on page 22, Chow and Cao identified 12 potential CSFs based on existing literature pertaining to successful and failed agile projects. Their research determined that six of the hypothesized success factors had an impact on one or more dimension of project success, but only three—delivery strategy, team capability, agile software engineering techniques—were deemed to be CSFs. Chow and Cao used stepwise regression analysis to determine which hypothesized factor had the most significant impact on projects success and concluded that the three aforementioned factors could determine the outcome of the project. Other research on CSFs is discussed in the section discussing related studies.

Technology Acceptance Model. The Technology Acceptance Model (TAM) is an alternate framework that could be utilized to understand the acceptance of agile principles for software development projects. Introduced by Davis (1985), the TAM framework is used to understand which factors influence the acceptance of technology. Davis et al. (1989) highlighted that two factors—perceived usefulness and perceived ease of use—primarily influence technology acceptance behaviors. Perceived usefulness refers to the user's perception of how the technology will improve his or her performance and perceived ease of use refers to the user's expectation of the technology being error-free (Davis et al., 1989). Figure 11 shows the independent and dependent variables for the TAM framework.

Figure 11

Technology Acceptance Model (Davis et al., 1989, p. 985)



The TAM framework could be utilized to investigate the adoption of specific agile principles which could provide an explanation for agile tailoring. Although research investigating factors that predict the adoption of agile methodologies in software development exists (Kipreos, 2019), as researcher of the current study, I am not aware of existing research which investigates the adoption of specific agile principles. Similarly, while they did not employ the TAM framework, Chiyangwa and Mnkandla (2017) concluded that performance expectancy factors, namely perceived usefulness, do have a positive effect on success factors in agile software development projects. Perhaps utilizing TAM to investigate the perceived usefulness of the specific agile principles could offer some insight into the decision to deviate from one or more of the 12 agile principles.

Variables

With quantitative correlational studies, researchers collect numeric data on independent and dependent variables to determine if a relationship exists between them (Simon & Goes, 2017). In this section, I convey how the current studies' independent variables, the 12 agile principles defined in the Agile Manifesto, have been included in existing research on CSFs for agile software development projects. Not all research agrees on several of the principles' relationships with project success, and several articles call for additional research on the subject (Ahimbisibwe et al., 2015; Brown, 2015; Chow & Cao, 2008; Garousi et al., 2019; Montequin et al., 2014; Stanberry, 2018; Stankovic et al., 2013). I also present the dependent variable, the survey participants' level of perceived project success. Similarly, research does not consistently use the same definition for project success.

Dependent Variables. The dependent variable for this research is perceived level of project success. As conveyed in the Definitions of Terms section, related studies utilize many different definitions for project success; however, most research includes a variant of producing a quality product, that meets the scope of the request, within the time and budgetary constraints (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). Similarly, the 2015 Standish Group definition, used in Ahimbisibwe et al. (2017), Hughes et al. (2017), Pace (2019), and Arcos-Medina and Mauricio (2020), includes on-time and on-budget, but replaces delivering a good product (quality) and meeting the customer's requirements (scope) with satisfactory results. Aldahmash (2018) also used stakeholder satisfaction, scope, on-time, and in-budget, but added organizational needs. Misra et al. (2009) used increased ability to meet the current customer's requirements (scope), reduced delivery schedule (on-time), increased return on investment (cost), increased flexibility to meet with the changing customer requirements (quality), and improved business process. Ahimbisibwe et al. (2015) and Garousi et al. (2019) were the most granular and include 37 and 24 components of project success respectively, but Ahimbisibwe et al. grouped the 37 components of project success into two categories—process and product—whereas Garousi et al. grouped the 24 components into three categories—process, product, and satisfaction of stakeholders. Although many definitions of project success have been used in existing research, the author used the four components of project success—quality, scope, time, cost—that have been used widely in related studies (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013) so that results can be triangulated.

Independent Variables. Although there is a gap in literature that explores the relationship between project success and deviating from the 12 agile principles, several studies have investigated CSFs for Agile Software Development (Aldahmash, 2018; Ahimbisibwe et al., 2015; Brown, 2015; Chiyangwa & Mnkandla, 2017; Chow & Cao, 2008; Garousi et al., 2019; Misra et al., 2009; Montequin et al., 2014; Sheffield & Lemétayer, 2013; Stankovic et al., 2013; Stanberry, 2018; Syeda, 2018). Many of these studies associate CSFs with one or more of the 12 principles for agile software development, but research does not agree on the relationship between these factors and project success. This section reviews each of the independent variables—the 12 principles from the Agile Manifesto—and spotlights the commonalities and discrepancies of different studies that hypothesized related CSFs for agile software development.

First Principle. The first independent variable is the first agile principle, which states that "our highest priority is to satisfy the customer through early and continuous delivery of valuable software" (Beck et al., 2001, para. 2). This principle emphasizes the need to put the customer and his or her needs first. A customer is satisfied when his or her business needs and perspective are clearly understood, respected, and adhered to throughout the life of the project (Akbar, 2019). One method of staying informed about a customer's business needs and ensuring those are met throughout the project is frequent customer involvement. Many authors hypothesized customer involvement as a CSF for agile software development, but the outcomes of their studies vary. Chow & Cao (2008) concluded that customer involvement has a weak relationship and only influences the scope component of project success, whereas Aldahmash (2018) concluded customer involvement is the second most significant factor in determining project success.

Similarly, Rodríguez et al., (2019) conducted a systematic literature review and Misra et al. (2009) captured the perspective of agile software development practitioners, and each concluded that customer satisfaction does influence project success. However, Brown (2015), Stanberry (2018), and Stankovic et al. (2013) contradicted those findings and concluded that customer involvement has no significant bearing on project success. Although customer satisfaction (satisfactory results) is included in the definition of project success for many studies (Ahimbisibwe et al., 2017; Hughes et al., 2017; Pace, 2019; Arcos-Medina & Mauricio, 2020), the inconsistent outcomes warrant additional research to test if a relationship exists between the first principle for agile software development and project success.

Second Principle. The second independent variable is the second agile principle, which states, “Welcome changing requirements, even late in development. Agile processes harness change for the customer’s competitive advantage” (Beck et al., 2001, para. 3). This principle significantly distinguishes agile software development projects from those managed using traditional project management methods because traditional methods necessitate detailed requirements at the start of the project. Requiring specifications up front often leads to bloated project requirements where unnecessary features are included because customers lack the ability to add or change functionality later (Serrador & Pinto, 2015). This principle embraces the need for shorter development iterations so that customers have the ability to provide feedback that can refine or refactor the requirements for subsequent iterations (Williams, 2010); however, welcoming scope changes throughout the project also introduces the risk of generating cost overrun due to reworking features and functionality (Conforto & Amaral, 2016).

Organizational culture is a factor in welcoming and accepting changes throughout a project (Laufer et al., 2015), and several studies have tested the relationship between organizational culture or organizational environment and project success. Brown (2015) and Aldahmash (2018) concluded that organizational culture/environment are significant in determining projects success, but Chow and Cao (2008), Stankovic et al. (2013), Stanberry (2018), and Garousi et al. (2019) concluded otherwise. Ahimbisibwe et al. (2015) agreed that organizational culture is significant, but also includes the organization's change management skills. The inconsistent results across research support testing whether deviating from this principle has an effect on project success.

Third Principle. The third independent variable is the third agile principle, which states, "Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale" (Beck et al., 2001, para. 4). Alsaqqa et al. (2020) noted that the 3rd principle identifies that the timeline for delivery should be early and continuous. A systematic literature review revealed that delivery speed (velocity) was determined to be the most significant metric in agile software development (Rodríguez et al., 2019). Similarly, in Alahyari et al. (2017), many software development organizations perceive delivery time as being a significant factor for various reasons, including benefiting from the customer's frequent feedback and interdependencies between software development teams. Other research, however, does not agree to the impact that this principle has on project success. Stankovic et al. (2013) and Aldahmash (2018) did not report a significant relationship between delivery strategy and project success, but Brown (2015), Chow and Cao (2008), and Stanberry (2018) did. Misra et al. (2009) concluded that making decisions quickly helped an organization be more agile and successful. In Ahimbisibwe et al. (2015) and Garousi et al. (2019), the urgency of the request was evaluated, but each concluded it was not significant. Evaluating the significance of this principle may shed some insight into the varying results between existing research.

Fourth Principle. The fourth independent variable is the fourth agile principle, which states, "Business people and developers must work together daily throughout the project" (Beck et al., 2001, para. 5). This principle accentuates the need for daily collaboration and frequent communication between the developers and requestors. Frequent collaboration ensures that the development team clearly understands and is adhering to the business requirements, and that all assumptions made during development can be clarified before a project deviates from the desired functionality (Alsaqqa et al., 2020; Williams, 2010). Many researchers relate customer involvement to both this agile principle, as well as the first agile principle (Aldahmash, 2018; Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013) and the results of these studies is conveyed under the First Principle heading. Other research investigated Critical Failure Factors for agile software development and conclude that a lack of teamwork, which directly relates to the fourth principle, is a determining reason for project failure. The continuous delivery of software component of the first principle facilitates the frequent interactions needed for the fourth principle, but these principles have distinct purposes. The first principle's focus is customer satisfaction, whereas the fourth principle reinforces the need for customer involvement. I believe it is important to investigate the significance of this principle separately from the first principle, but acknowledge it may be difficult to triangulate results since many studies have associated the same hypothesized CSF to both the first and fourth principle.

Fifth Principle. The fifth independent variable is the fifth agile principle, which states, "Build projects around motivated individuals. Give them the environment and support they need and trust them to get the job done" (Beck et al., 2001, para. 6). Some research divides this principle into separate hypothesized CSFs—team capability and top-management support/commitment (Aldahmash, 2018; Ahimbisibwe et al., 2015; Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). Of the aforementioned studies, all except Brown (2015) agree that team capability has a positive relationship with projects success. Conversely, of these studies, only Ahimbisibwe et al. (2015) and Brown conclude that top-level management support has a significant relationship with projects success. Abdelaziz et al. (2019) concluded that a lack of management commitment was not a Critical Failure Factor for agile software development projects, but Amponsah and Darmoe (2014) concluded that management's willingness to commit the necessary resources and authority to a project team does have an impact on project success. Many of these studies evaluated projects of varying scope and size, which could contribute to the inconsistent results. Given the inconsistent conclusions, additional research is needed to evaluate the impact deviating from the fifth principle has on project success.

Sixth Principle. The sixth independent variable is the sixth agile principle, which states, "The most efficient and effective method of conveying information to and within a development team is face-to-face conversation" (Beck et al., 2001, para. 7). This principle emphasizes the need for direct, synchronous communication between people (Alsaqqa et al., 2020). Direct communication reduces the risk of misunderstanding that can result in other forms of asynchronous, written communication. While face-to-face communication is most suitable, other collaboration tools that support synchronous communication may be viable alternatives (Arcos-Medina & Mauricio, 2020; Jain & Suman, 2017). Two studies concluded that the project management process, size and location of the team and the team distribution are not influential on project success—meaning that face-to-face communication is not significant. (Cram, 2019; Misra et al., 2009). Other studies disagreed and concluded that communication and project management process are significant (Ahimbisibwe et al., 2015; Aldahmash, 2018; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). Since research does not agree on the impact the sixth principle has on projects success, it is necessary to test if deviating from this principle has an effect on project success.

Seventh Principle. The seventh independent variable is the seventh agile principle, which states, "Working software is the primary measure of progress" (Beck et al., 2001, para. 8). This principle highlights the need to break down the project into smaller pieces so that working software can be delivered more frequently (Alsaqqa et al., 2020). Aldahmash (2018) related delivery strategy to both the third and seventh agile principle. His research concluded that delivery strategy was insignificant in determining project success, but other studies concluded that delivery strategy influences the scope and timeliness components of projects success (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018). Chow and Cao (2008) and Brown (2015) also found that delivery strategy has an effect on the cost component of project success, whereas Stanberry (2018) discovered delivery strategy also has an effect on the quality component of project success. None of the reviewed research on CSFs for agile software development exclusively agreed on which components of project success delivery strategy influenced. The inconsistent conclusions made it difficult to triangulate this study's results, but it supported the need to investigate if deviating from the seventh principle has an effect on project success.

Eighth Principle. The eight independent variable is the eighth agile principle, which states, "Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely" (Beck et al., 2001, para. 9). Alsaqqa et al. (2020) conveyed that the eighth principle promotes delivering high-quality work through a constant rhythm of work. This principle reduces the risk of developer burnout and high-pressure scenarios that could contribute to more error-prone code. Williams (2010) extended on this and noted that the eighth principle contributes to employee retention, preventing unplanned disruptions to projects caused by employee turnover, and promotes ingenuity and creativity because team members are not fatigued. Aldahmash (2018) associated agile development techniques with the eighth, ninth, and tenth agile principle, but other research associates projected management process with the eighth principle (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). The results of the studies investigating project management process are included above in the section titled Sixth Principle, but Aldahmash (2018) concluded that development techniques do have a moderate influence on project success.

Ninth Principle. The ninth independent variable is the ninth agile principle, which states, "Continuous attention to technical excellence and good design enhances agility" (Beck et al., 2001, para. 10). The ninth principle conveys the need for development teams to focus on creating error-free code using a design that supports changes. In addition to Aldahmash (2018), mentioned above, several other studies associated software development techniques with the ninth and tenth agile principles (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013;). The results from Chow and Cao (2008) aligned with the results from Aldahmash, but Brown (2015) and Stanberry (2018) concluded that software development technique have no effect on project success. Ahimbisibwe et al. (2015) and Garousi et al. (2019) associated the hypothesized variable project team's experience with the software development method with the ninth principle, and only the first study concluded that this factor has a significant impact on project success. The diverse conclusions support the need to investigate if a relationship exists between deviating from the ninth agile principle and project success.

Tenth Principle. The tenth independent variable is the tenth agile principle, which states, "Simplicity—the art of maximizing the amount of work not done—is essential" (Beck et al., 2001, para. 11). As previously mentioned, several investigations associated software development technique with the tenth principle, and the results of those studies are mentioned above in the section titled Ninth Principle. The tenth principle is unique though because it sets the focus on creating simple processes and simple designs. This principle aims to have the development team create a simple product that is dynamic enough to handle future changes (Alsaqqa et al., 2020). Agile software development is an iterative process and the tenth principle challenges practitioners to focus on the task at hand while future features are addressed in subsequent iterations. Research is split on the significance agile software techniques has on project success, but simplifying the work done in each iteration prevents unnecessary development caused by changes and enhancements to future requirements (Ahimbisibwe et al., 2015). The current study aimed to help identify if a relationship exists between deviating from the tenth agile principle and project success.

Eleventh Principle. The eleventh independent variable is the eleventh agile principle, which states, “The best architectures, requirements, and designs emerge from self-organizing teams” (Beck et al., 2001, para. 12). The eleventh principle stresses the need for less bureaucracy so that team members can contribute in areas they have experience and expertise with. It conveys the need for agile team members to share the project responsibilities and independently determine the best approach to resolving the problem or meeting the business need (Alsaqqa et al., 2020). Ahimbisibwe et al. (2015) stressed that this principle is effective when project teams are small and team members have a high-level of expertise. Several studies investigated if a relationship exists between the team environment and projects success, but only Chow and Cao (2008) concluded that it has a bearing on the quality component of project success, and Yousef (2022) concluded that it has a bearing on the timeliness and cost dimensions. Other studies concluded that the team environment has no relationship with projects success (Brown, 2015; Garousi et al., 2019; Stanberry, 2018; Stankovic et al., 2013). Although many studies did not identify this principle as having a significant relationship with project success, the current study added to the body of knowledge and contradicted existing research.

Twelfth Principle. The twelfth independent variable is the twelfth agile principle, which states, “At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly” (Beck et al., 2001, para. 13). The twelfth principle stresses the need for continuous improvement. Reflection is done throughout a project so that project teams can work to improve subsequent project tasks as well as improve future projects. Williams (2010) emphasized that teams reflect upon what worked and what did not work at the end of each iteration in order to pivot and make improvements to future iterations. Studies have related both organizational environment and organizational culture to the twelfth agile principle. Organizational environment was determined to not have a significant bearing on project success (Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013); however, Brown (2015) identified that this principle has an influence on the cost factor of project success. Similarly, Garousi et al. (2019) concluded that organizational culture has no influence on project success, but other research concluded differently (Ahimbisibwe et al., 2015; Aldahmash, 2018). Given that research does not agree on the impact the twelfth principle has on projects success, it is necessary to test if deviating from this principle has an effect on project success.

Related Studies

Researchers and practitioners have pursued a solution for improving project success rates for many years. Although research validates that agile methodologies improve project success rates (Serrador & Pinto, 2015), many software development projects continue to experience unfavorable outcomes (de Souza Bermejo et al., 2014). This section is designed to present information on studies related to the topics of agile software development and project success. Specifically, research pertaining to CSFs in agile software development and agile tailoring is presented.

Critical Success Factors in Agile Software Development. CSFs are the minimal number of tasks that must be completed satisfactorily to deliver a successful outcome (Rockart, 1979). CSFs are pertinent to the current study because existing research identifies some agile principles as CSFs for project success. This section introduces research on CSFs in agile software development.

Leveraging a subset of data from an existing global survey of agile practitioners, Montequin et al. (2014) ranked critical success and critical failure factors based on their perceived impact on project success. They acknowledged that adequate project and phases planning, change acceptance, and a clear vision and goals were considered the top three CSFs. Similarly, they concluded that competitors, continuous or dramatic change to initial requirements, and customers' requirements being inaccurate, incomplete, or not defined were the top three critical failure factors (Montequin et al., 2014). None of the top three CSFs relate to one of the agile principles defined in the Agile Manifesto and only one of the top critical failure factors relates to an agile principle from the manifesto (continuous or dramatic change to initial requirements relates to the 2nd agile principle); however, the critical failure factor insinuates that change caused the failure whereas the agile principle specifies project teams should welcome changing requirements, even late in development. Perhaps the absence of any agile principles being a top CSF in Montequin et al.'s research indicates that practitioners do not believe agile principles have a significant effect on project success; however, one limitation to their study is that out of 611 validated survey responses, Montequin et al.'s sample only included 26 of the responses in their analysis. Their sample population also only included information and communication technology projects from Spain. Additional research should be done on a larger sample of the population to validate Montequin et al.'s findings.

Tiwana and Keil (2004) concluded that using the wrong methodology is the most critical risk that contributes to failure for software projects. This, combined with Wysocki's (2009) findings that project managers continue to use traditional methodologies even though only 20% of projects contain traits of traditional projects, may contribute to the high percentage of challenged and failed agile software development projects. Although various project management methodologies exist, Howell et al. (2010) asserted that the absence of a theory and decision support tool to pair project types with a corresponding methodology are barriers that prevent managers from exploring other methods. In response, Ahimbisibwe et al. (2015) developed a contingency fit model for software development project success. Their model is based on project characteristics, environment, and management methodology, and it is unique because they considered CSFs from both traditional and agile methodologies. Their research consisted of reviewing 148 relevant articles that spanned a 12-year period, followed by identifying and grouping 37 CSFs into three categories: organizational factors, team factors, customer factors. Each factor was ranked based on the number of times it appeared in the reviewed literature, and then the list was consolidated to remove redundant factors. They theorized that 15 factors across the three categories have a positive effect on the success of software development projects. Many of these factors have a similar essence as several principles from the Agile Manifesto—top management support (agile principle 5), organizational culture (agile principles 2 and 12), project planning and controlling (agile principle 8), leadership (agile principle 5), change management (agile principle 2), internal project communication (agile principle 6), team's experience with the software development management (agile principle 9), team composition (agile principle 11), and user participation (agile principle 4). They also acknowledged that their model is conceptual and needs empirical testing to validate its usefulness, but their conclusion supported that many of the principles from the Agile Manifesto are CSFs and, therefore, should not be deviated from.

Garousi et al. (2019) responded to Ahimbisibwe et al. (2015) call and used quantitative research to test a variation of their conceptual model. Garousi et al. sought to rank CSFs of software development projects based on their effect on project success. They reportedly adopted Ahimbisibwe et al.'s conceptual model because it was more granular and contained more CSFs than comparable models. Using data collected from 101 software development companies in Turkey, Garousi et al. concluded that the top three CSFs were the project team's experience with the methodology, project team's expertise with the task, and project monitoring and controlling. There was no significant correlation between the rankings of CSFs in these two studies. This is significant because it signifies that there is not a positive relationship between the number of times a particular CSF is mentioned in existing literature and the impact that CSF has on project success.

Misra et al. (2009) conducted a similar study to identify factors that influence the success of agile software development projects by capturing the perspectives of software development practitioners. Their research was unique because it is reportedly the first large-scale study on the subject where survey participants crossed industries. They reviewed existing literature on agile software development and developed a framework and hypothesized 14 factors which influence project success, and defined project success using five criteria: reduced delivery schedule, increased return on investment, increased ability to meet customer requirements, increased flexibility to handle changing requirements, and improved business processes. After surveying practitioners, Misra et al. concluded that nine of the 14 hypothesized factors had a statistically significant relationship with project success. These nine factors are customer satisfaction, customer collaboration, customer commitment, decision time, corporate culture, control, personal characteristics, societal culture, and training and learning. Additionally, open-ended survey responses indicated there were four success factors that were not hypothesized because they did not emerge from existing literature. The four success factors revealed from survey responses that were not hypothesized are: learning from failure, timing issues, other team characteristics, and use of tools (Misra et al., 2009). The five hypothesized factors they did not identify as statistically significant are team distribution, team size, planning, technical competency, and communication and negotiation; however, they confess that more research is needed to disprove these factors since some open-ended feedback from survey participants and other research contradicts their findings.

Recognizing that most research on CSFs for agile software development was anecdotal, researchers from Chow and Cao (2008) sought to identify CSFs for software development projects through a quantitative study. Pulling from existing literature, they compiled a list of 36 CSFs and 19 critical failure factors. They performed reliability analysis and factor analysis on these lists and reduced them down to 12 hypothesized CSFs. Figure 2 on page 23 above shows how the hypothesized factors from Chow and Cao relate to the 12 agile principles. After collecting data on 109 agile software development projects, Chow and Cao performed multiple regression analysis on the dataset to identify the significance each factor had on the different dimensions of perceived project success and to determine the relative importance of each factor.

They concluded that six of the 12 hypothesized factors impacted at least one dimension of project success and were candidates to be considered CSFs. The six factors are: team environment (quality dimension), team capability (timeliness and cost dimensions), customer involvement (scope dimension), project management process (quality dimension), agile software engineering techniques (quality and scope dimensions), and delivery strategy (scope, timeliness, and cost dimensions). Of these, only three (delivery strategy, team capability, agile software engineering techniques) were deemed CSF (Chow & Cao, 2008). Their findings were significant because it concluded that several anecdotal success factors, such as strong executive support and project type, were not significant in determining project success. Furthermore, they concluded that agile principles 1, 3, 5, 7, 9, and 10 all were CSFs, and agile principles 4, 6, 8, and 11 are significant at determining at least one dimension of project success. In addition to motivating me to conduct the research presented in this paper, Chow and Cao's research influenced or served as the foundation for many other studies (Aldahmash, 2018; Brown, 2015; Stanberry, 2018; Stankovic et al., 2013; Syeda, 2018). These studies are reviewed below.

Stankovic et al. (2013) utilized Chow and Cao's (2008) framework and survey instrument to identify CSFs for agile software development projects in companies located in the Southeastern European region, but their research did not confirm any of the hypothesized CSFs identified in Chow and Cao. Additionally, although Chow and Cao concluded that project definition process, project nature, and project schedule were insignificant at determining any dimension of perceived project success, Stankovic et al. found that all three of these factors influenced at least one dimension of project success. They concluded that the independent variable project nature has an influence on the timeliness and cost dimensions and the independent variables project management process, project definition process, and project schedule have an influence on the cost dimension. The only common conclusion between the two studies is that management commitment, organizational environment, and project type have no influence on any dimension of perceived project success. Stankovic et al. suggested that their findings may have contrasted the original outcomes because of the percentage of survey participants who worked in a distributed environment. Other limitations include the disproportion of agile methodologies utilized by survey respondents, the absence of some agile methodologies being represented in the sample, and the smaller sample size.

Unlike other studies, in addition to identifying CSFs in agile software development projects, Aldahmash (2018) sought to identify their significance at each phase in a project. He asserted that since agile methods employ iterative steps and development occurs at each iteration, then success of agile software development should be considered at each iteration in the project. He also reviewed existing literature to identify CSFs, and although some are named differently, each directly correlates to a hypothesized CSF from Chow and Cao (2008). For example, both studies included delivery strategy, team capability, top management support/commitment, agile software development techniques, customer involvement, project management process/approach, and organizational culture/environment as independent variables. Aldahmash included communication as the eight hypothesized factor, whereas Chow and Cao included team environment as their eight hypothesized factor, but both studies correlated their factors back to principles from the Agile Manifesto. Aldahmash also utilized the survey instrument from Chow and Cao to collect data, but concluded that communication, customer involvement, and team capability were the most significant success factors in agile software development projects. His study also revealed that communication, customer involvement, team capability, organizational culture, and agile software development technique became increasingly significant, while project management process and delivery strategy became less significant as the agile project progressed through its iterations.

Although Chow and Cao (2008) contributed to the body of knowledge on CSFs for agile software development, they acknowledged an underrepresentation from U.S.-based projects was a limitation to their study. This is significant because agile software development practices are more mature in the United States and there are more agile practitioners in the United States than any other nation (Brown, 2015; Chow & Cao, 2008). In response, Brown (2015) replicated the Chow and Cao study using data from U.S.-based respondents only. His research included conducting multiple regression analysis and stepwise regression analysis on the data collected and each resulted with some common factors which contribute to project success; however, results from Brown differed drastically from Chow and Cao. Brown concluded that project type (quality, scope, timeliness, cost), project nature (quality, scope, timeliness, cost), project schedule (scope, cost), management commitment (quality, cost), project definition process (quality), and delivery strategy (scope, timeliness, cost) are all significant factors which contribute to project success. The only common conclusion between Brown (2015) and Chow and Cao (2008) is that delivery strategy contributes to the scope, timeliness, and cost dimensions of project success. Brown acknowledged that the difference between the targeted populations in the two studies may explain the inconsistency in the results, and suggested that the types of projects and the organizational and individual experiences could justify the differences between U.S.-based and global respondents. He went on to call for additional research to include a global perspective.

Both Chow and Cao (2008) and Brown (2015) identified a limitation to their respective studies was a possible bias caused by the high concentration of responses for a specific agile methodology. In response, Brown called for additional research to be done on a specific methodology to see if the results varied. Other studies also advocated for further research on CSFs for successful implementations of Scrum in distributed teams (Dyba & Dingsøyr, 2008; Matalonga et al., 2013). In response, Stanberry (2018) extended on the research from Chow and Cao (2008) and Brown (2015), but focused on the responses of practitioners from U.S.-based global businesses who employed Scrum methodology to complete large and distributed agile software development projects. Stanberry concluded that delivery strategy (quality, scope, timeliness), team capability (quality, scope), project definition process (timeliness, cost), project nature (scope), and project management process (cost) are all significantly related to at least one dimension of project success. All three studies agreed that delivery strategy is significant at determining project success but did not agree on the dimensions of projects success that delivery strategy influences. Although the three studies did not agree on the effect all independent variables have on project success, many of the factors that emerged as being CFSs did align with principles from the Agile Manifesto. Additional research on other agile methods, noting the degree in which the method had been tailored, could offer additional insight into CSFs for agile software development projects to see if additional agile principles are significant at determining project success.

Agile Tailoring. In addition to research on CSFs, other relevant research centers around agile tailoring, which is the process of customizing an agile method to meet the specific needs of a company or project (Akbar, 2019). Tailoring occurs at the individual project level, as well as at an organizational level. Aligning with the twelfth agile principle—project teams should regularly reflect to identify ways to become more effective and adjust accordingly—some changes may be warranted, but others are made without properly evaluating the impact of the change (Eloranta et al, 2016). Some literature suggests that project managers should tailor with caution to ensure that the essence of agile is not lost (Cram, 2019). The current study may offer insight to organizations choosing to tailor agile methods by investigating if a relationship exists between deviating from the 12 agile principles and project success. If a principle has a strong relationship with project success, an organization should be wary of tailoring processes that support that principle. This section presents existing research on agile tailoring.

Zakaria et al. (2015) conducted a systematic literature review on software process tailoring to investigate the state of the domain of process tailoring. They highlighted that there is no single framework for tailoring software processes, which is likely because no two projects are alike. They found that although some teams tailor agile methods to lighten the process, many organizations adopt an unstructured, ad hoc approach to tailoring. Additionally, they also learned that tailoring is also frequently done because team members revert back to a former process or select a process that is most familiar to them. The authors agree with other research (Magdaleno, 2010) and emphasize that agile tailoring is not a simple process and does not come without risk. Agile tailoring requires immense experience and commitment from project team members (Huratado & Bastarrica, 2009). These complexities make it difficult to develop a framework that would be valid across projects and across agile methods.

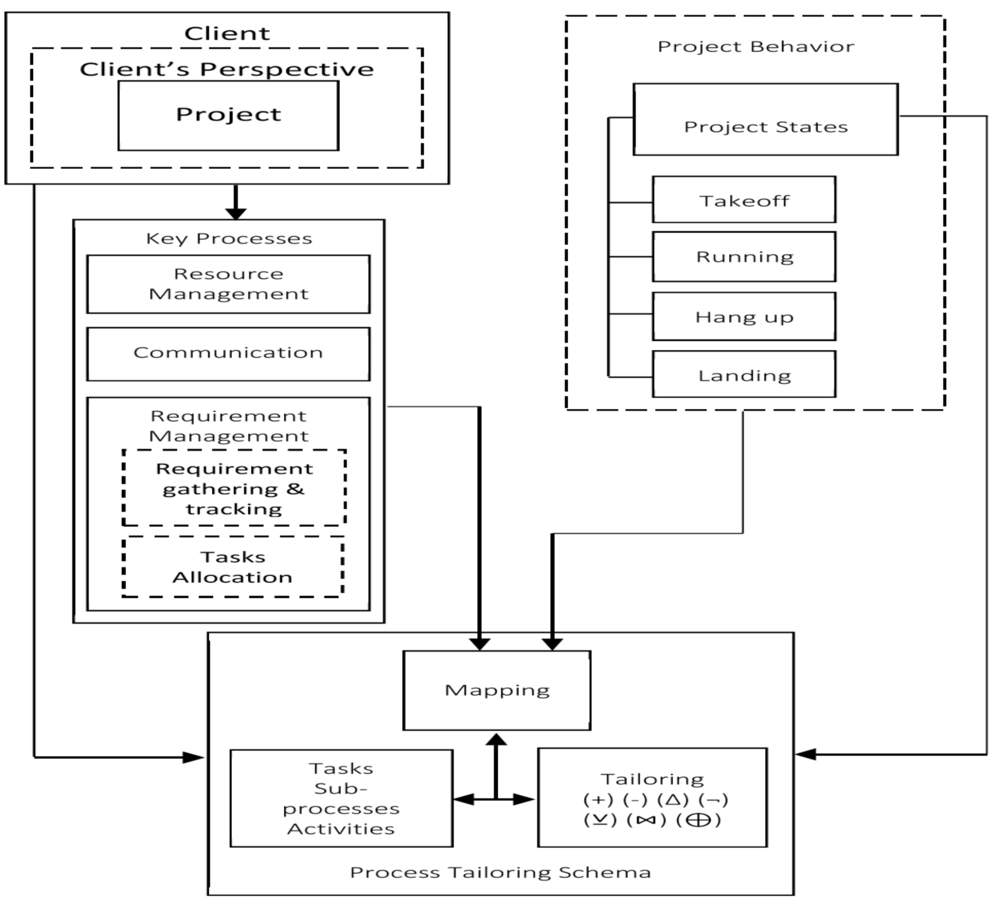
Xu and Ramesh (2008) highlighted that existing research on process tailoring for software development projects often compares agile to traditional tailoring approaches. They recognized a gap in research on tailoring strategies specific to agile processes and noted that no framework detailing a procedure for tailoring an agile software process exists. This gap in research often leads to an ad-hoc tailoring approach, so they illustrated a four-step process for tailoring an agile software process. First, the project manager evaluates the project goals and environment to gain a clear understanding of goals and characteristics of the project, team, stakeholder, and organization. This is followed by an assessment of the various challenges the project faces, and then a decision is made on a process tailoring strategy (add, downsize, drop/skip, expand, redefine, replace). Finally, the project manager must validate, execute, and evaluate the tailored software process to ensure it was effective at meeting the desired outcome (Xu & Ramesh, 2008). Xu and Ramesh focused on the third step—the process tailoring strategy—in relation to the project challenges. After reviewing five challenge categories (resource, communication, requirements management, political, and technical), they developed a framework to help practitioners identify challenges and develop tailoring strategies to mitigate them. They concluded that some tailoring strategies are better suited for specific challenges. They also highlighted that project teams cannot tailor their strategy at the start of a project, but instead tailoring must occur throughout the project. This is significant to this research because it aligns with the 12th agile principle—at regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly (Beck et al., 2001).

Akbar (2019) author supported the need to tailor software processes based on project requirements, but indicated that a lack of a formalized approach hindered its widespread acceptance. He argued that existing research on process tailoring failed to consider agile characteristics like welcoming changing requirements and rapid development cycles. In response, he developed a process tailoring framework for agile software development processes. In line with the principles from the Agile Manifesto, Akbar's framework focuses on the customer and project. Shown in **Error! Reference source not found. Error! Reference source not found.**, the framework maps key processes (resource management, communication, requirement management) of the customer with four states of the project (takeoff, running, hang up, landing).

The framework develops an agile process tailoring schema by integrating the aforementioned key processes and project states with tailoring operations (add, delete/skip, modify, split and select, merge, shrink, wrap up). Details of the schema are not presented by Akbar since he cited a need for additional research to validate it. Akbar’s work was significant because it introduced the need to only tailor key processes within an agile software development project based on the needs of the client at a specific project state. This compliments the work from Xu and Ramesh (2008) by supporting the notion that agile tailoring should not occur at the start of a project but must occur throughout the project.

Figure 12

Theoretical Process Tailoring Framework (Akbar., 2019, p. 139859)



Eloranta et al. (2016) acknowledged the rapid adoption rate for agile software development, but asserted that many companies claiming to be agile have merely implemented some agile practices and do not strictly adhere to agile principles and practices. For example, they discovered that three of 11 companies interviewed claim to follow Scrum practices but did not consistently run development sprints—a fundamental practice of the Scrum method. Focusing on organizations who reportedly use the Scrum methodology, Eloranta et al. collected data and investigated destructive anti-patterns by software development companies. They selected Scrum as the agile method to research because it is a rigid framework that is intended to be adhered to in order to achieve the desired benefits. After collecting their data, they identified 14 anti-patterns across the organizations and noticed that some anti-patterns led to others later in the development process. To be considered an anti-pattern, an organization's practice had to deviate from Scrum recommendations, the practice had to be reported in at least three of the 18 teams interviewed, and the practice had to have an adverse outcome. Although many of the deviations were injurious to the organizations, Eloranta et al. agreed that some anti-patterns are warranted and end well; however, they did not attempt to present any conclusions about how ruinous the identified anti-patterns are. Their work is significant to the current research because it supports that for some agile methodologies, namely Scrum, deviating from the method's framework and principles can be have an unfavorable outcome for the organization.

Summary of the Literature Review

Both scholars and practitioners agree that IT project success rates are low. Although some research supports that agile-led IT projects outperform traditionally led projects, over half of agile-led projects remain challenged or fail (Standish Group, 2020). A substantial amount of research pursuing solutions for improving project success rates of agile software development projects exists, but many studies do not agree on which independent variables significantly influence project success. This is likely due to the variance in datasets. Montequin et al. (2014) only included 26 of 611 responses in their analysis to focus on information and communication technology projects from Spain, Garousi et al. (2019) only included data from software development companies in Turkey, Stankovic et al. (2013) only focused on companies located in the southeastern European region, and Brown (2015) only used data from U.S.-based respondents. Some of these authors acknowledged that the difference in geographic region, as well as the unique agile methods used by survey participants, may account for the inconsistent results. Although the results varied between studies, many of the CSFs discovered in individual studies do relate to agile principles. Similarly, scholars do not concur on whether or not tailoring agile practices is advantageous, neutral, or detrimental to project success. Some research cautioned practitioners from deviating from agile principles (Cram, 2019; Siddique & Hussein, 2016), whereas other research suggested that tailoring is acceptable if the business need warrants the change (Akbar, 2019; Xu & Ramesh, 2008;. This study aims to add to the body of knowledge and help determine if deviating from any of the agile principles has an impact on project success. Results could identify CSFs for agile software development projects, as well as support the notion to tailor or not tailor agile principles.

Summary of Section 1 and Transition

Section 1 introduced the foundation of the current study and explicated how the study stands to benefit business practice while aligning with biblical views. Within it, I (as author of this study) described the business problem and presented a case explaining why additional research is needed to examine if a relationship exists between deviating from the 12 agile principles and the perceived level of success for agile software development projects. Based on the problem, three primary research questions and 12 sub-questions, one for each of the 12 agile principles, were created to guide the research. To answer these research questions, I investigated and reported on various research paradigms, designs, and methods that were considered for the current study, and then conveyed why a fixed, correlational design and quantitative method are the best options to employ. Section 1 also described how the theoretical framework from Chow and Cao (2008) was altered and utilized.

In addition to providing a foundation for the current study, the first section also provided a thorough review of existing academic literature pertaining to the business problem. A background on the Agile Manifesto and its impact on project success was conveyed, and some of the more common agile methods, like Scrum and eXtreme Programming (XP), were introduced. Information on each of the independent and dependent variables was reviewed and results from existing research were compared. Although many studies investigating relationships between independent variables and project success exist, most have arrived at different conclusions and have called for additional research on the topic. Section 2 below includes the details of the current project, which sought to contribute to the body of knowledge and offer insight into which agile principles influence the success of agile software development projects so future IT leaders can avoid deviating from principles that impact project success.

Section 2: The Project

The prior section presented the foundation of the study by conveying that low IT project success rates is a problem that has plagued businesses for many years. A gap in existing literature was revealed, which supports a need to explore if a relationship exists between deviating from agile methods and project success. Section 2 herein outlines the current study by reiterating the purpose, conveying my role as researcher, and discussing the design and method to be used. It includes a blueprint of the research by incorporating information on the research participants, a description of the eligible population, and a discussion on the sampling method and desired sample size. I also discuss the data collection plan, communicate how the data was analyzed to test the hypotheses, and convey how the reliability and validity of the data was test.

Purpose Statement

The purpose of this quantitative correlational study is to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. This study focused on higher education institutions because many colleges and universities are challenged to increase their value to students while maintaining or reducing their cost of attendance (Pathak & Pathak, 2010). A growing interest in online education, combined with budgetary constraints, probed executive leadership to look at using technology and other new methods to respond to evolving demands (Peppard, 2010), but the demand to create a competitive advantage for an organization and provide an environment that prepares graduates for the workforce of today and tomorrow has university IT departments facing increased costs (Sliep & Marnewick, 2020). As a result, many IT leaders have seen their daily duties shift from being more operationally natured to being more strategic (Pinho & Franco, 2017), which led some software development managers to implement agile practices to obtain a competitive advantage (Cram, 2019; Denning, 2016). This may be due to agile projects being over three times more successful than waterfall projects; however, 69% of IT projects are still considered unsuccessful (Standish Group, 2020). Eloranta et al. (2016) highlighted that deviating from agile principles is common but should be avoided because it can be destructive over time. Similarly, Cram (2019) warned that as hybrid approaches—those containing a blend of both agile and traditional methods—gain popularity, IT project managers need to select the appropriate mix of agile principles with other approaches to be successful. This research seeks to add to the body of knowledge and offer insight into which agile principles outlined in the Agile Manifesto influence the success of software development projects so future IT leaders can proactively avoid deviating from principles that have a significant impact on project success.

Role of the Researcher

The role of the researcher begins with identifying a business problem and designing a study around that problem in order to solve or explain it. Once the problem is identified, the researcher selects an appropriate design and methodology to investigate it (Creswell, 2014). Some designs and methods are considered to be more subjective based on the researcher's involvement in data collection (Simon & Goes, 2017). For example, with qualitative studies, the researcher can inject his or her personal experiences when making interpretations and deductions because they are often the instrument (Stake, 2010); however, in quantitative, non-experimental, correlational studies like the current study, the researcher is able to remain detached and objective by using surveys or similar instruments to capture quantitative data on independent and dependent variables in their natural environment (Simon & Goes, 2017). After the design and methodology are selected, the researcher must identify the population to be investigated and the sampling procedure to be used (Creswell, 2014). This is followed by data collection and analysis (Creswell, 2014).

In addition to the research process, it is the researcher's responsibility to uphold and adhere to ethical guidelines (Simon & Goes, 2017). The Belmont Report outlines three basic ethical principles for researchers to abide by: respect for persons, beneficence, and justice (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). These three principles can be summarized as requiring informed consent, ensuring the benefit outweighs the risk to the subject(s) involved, and certifying that research subjects are selected impartially (Beauchamp, 2020). Additionally, to adhere to ethical standards, researchers must also expose any known bias they could introduce into the study and convey how those biases was addressed (Simon & Goes, 2017). Adhering to these ethical guidelines helps protect research participants as well as the integrity of the study.

Research Methodology

The research methodology is a blueprint of a study, used by researchers to navigate through the process of moving from the research questions to an outcome (Abutabenjeh & Jaradat, 2018). It is used to outline the process for inquiry to be employed in a study. Two components of the research methodology are the research design and the research method (Creswell, 2014). Various research designs and methods were discussed in detail in Section 1, the Nature of the Study, above. The following sections review the design and method used to guide the current study.

Discussion of Fixed Design

The preferred design to use for this study was a non-experimental, fixed, correlational design. A quantitative design approach was most appropriate because the current study required me as the researcher to investigate the relationships between independent and dependent variables. Specifically, the study collected data on the use of the 12 agile principles and the perceived level of success for agile software development projects that already transpired. While both experimental and non-experimental designs can be used in quantitative research, an experimental design utilizes control and treatment groups to manipulate variables to determine their impact on an outcome that has not occurred. With the current study, I did not have the ability or authority to administer a control group for software development projects using agile methodologies; therefore, an experimental design was not appropriate. Unlike experimental designs, non-experimental designs use instruments to collect data on prior events so that researchers can analyze that data and make generalizations about the population (Creswell, 2014). This was most appropriate for the current study because collecting data on prior projects did not require me as researcher to manipulate variables that were uncontrollable, and allowed me to collect data on more projects in a shorter time span.

Two common types of research for non-experimental design are correlational research and casual-comparative research (Creswell, 2014). Casual-comparative was not appropriate because the current study did not compare independent variables between groups in an effort to deduce a cause-and-effect relationship between variables (Simon & Goes, 2017). Instead, this study aimed to investigate the relationship between the 12 agile principles and the success of agile software development projects. Correlational research was used to measure and describe the relationship between independent variables (Creswell, 2014); therefore, it was most appropriate for the current study.

Discussion of Chosen Method

This research sets out to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the success of software development projects; therefore, the preferred method to use is quantitative. Quantitative research utilizes numerical data to test a hypothesis (Simon & Goes, 2017), so numeric data was collected on the independent and dependent variables and analyzed using quantitative techniques. Shown in Figure 3 on page 26, the 12 agile principles served as the independent variables in the current study. Using a modified version of the Chow and Cao (2008) survey, ordinal data was collected using a 7-point Likert survey. Ordinal scales, such as Likert surveys, contain categorized responses that have an ordered relation with each other (Göb et al., 2007). While the responses can be ranked, the distance between them has no value or is not measurable (Sullivan & Artino, 2013). Ordinal scales are often used to collect the opinion or disposition of someone (Göb et al., 2007), which was appropriate for the current study because participants were asked the extent to which they agreed or disagreed with questions pertaining to each independent variable. Shown in Table 1 below, the ordinal scale used for each independent variable was: 1) Strongly Disagree, 2) Disagree, 3) Somewhat Disagree, 4) Neither Disagree or Agree, 5) Somewhat Agree, 6) Agree, 7) Strongly Agree, or N/A) Not Applicable / Do Not Know.

An ordinal scale was also used to capture the disposition of survey participant's perceived level of project success—the dependent variable. For each component of project success (quality, scope, time, cost), participants were asked their perception of the project's outcome. Also shown in Table 1, the ordinal values used for the dependent variable are: 1) Very Unsuccessful, 2) Unsuccessful, 3) Somewhat Unsuccessful, 4) Neutral, 5) Somewhat successful, 6) Successful, or 7) Very Successful. Using the same four components of perceived success as other research (Chow & Cao, 2008; Brown, 2015; Stanberry, 2018) allowed me to triangulate the results of the current study.

Table 1

Variable Description

Variable	Variable Type	Data Type	Range
Perception of success for the quality of the project	Dependent	ordinal	1 – Very unsuccessful 2 – Unsuccessful 3 – Somewhat unsuccessful 4 – Neutral 5 – Somewhat successful 6 – Successful 7 – Very successful
Perception of success for the scope of the project	Dependent	ordinal	1 – Very unsuccessful 2 – Unsuccessful 3 – Somewhat unsuccessful 4 – Neutral 5 – Somewhat successful 6 – Successful 7 – Very successful
Perception of success for the timeliness of the project	Dependent	ordinal	1 – Very unsuccessful 2 – Unsuccessful 3 – Somewhat unsuccessful 4 – Neutral 5 – Somewhat successful 6 – Successful 7 – Very successful
Perception of success for the cost of the project	Dependent	ordinal	1 – Very unsuccessful 2 – Unsuccessful 3 – Somewhat unsuccessful 4 – Neutral 5 – Somewhat successful 6 – Successful 7 – Very successful
1st Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree

Variable	Variable Type	Data Type	Range
			6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
2nd Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
3rd Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
4th Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
5th Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree

Variable	Variable Type	Data Type	Range
			6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
6th Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
7th Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
8th Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
9th Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree

Variable	Variable Type	Data Type	Range
			6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
10th Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
11th Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know
12th Agile Principle	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree N/A – Not Applicable/Do Not Know

Discussed in Section 1 above, this study was guided by 15 hypotheses. The first three hypotheses corresponded with the primary research questions, RQ1, RQ2, and RQ3, and the remaining 12 hypotheses corresponded with the 12 sub-questions, RQ3a – RQ3L. Using data collected on the independent and dependent variables, I used correlation analysis and multiple linear regression to analyze the data and determine if the null hypotheses should be rejected. Each hypothesis was tested independently. I planned to use Pearson's correlational coefficient to examine the strength and direction of the relationship between the independent and dependent variables (Pace, 2017); however, all of the variables did not have a linear relationship, so Spearman's rank-order correlation test was used instead. When data analysis revealed that a relationship existed between the independent and dependent variables, I was able to reject the null hypotheses. Next, I used multiple linear regression analysis to examine the strength of the relationships between the variables. When a significant relationship existed, I accepted the alternative hypotheses.

Summary of Research Methodology

The research method and design help guide a study and either solve or contribute to the problem at hand (Simon & Goes, 2017). The current study leveraged a quantitative method and fixed, correlational design to test the hypotheses and examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. Each agile principle served as an independent variable and research participants were surveyed using a modified version of the Chow and Cao (2008) survey tool to capture their experience about an agile-led software development project that they participated on. The survey tool utilized an ordinal scale to capture numeric data from participants regarding how well they adhered to each principle, as well as their perceived level of project success as it relates to the quality, scope, timeline, and cost of the project. Correlation analysis and multiple linear regression was used to analyze the data to convey the direction and strength of relationships between variables (Pace, 2017; Syeda, 2018). Correlation analysis does not indicate a cause and effect relationship between independent and dependent variables, but it does indicate if a relationship exists between them as well as the direction of that relationship (Seeram, 2019). The selected research design and method helped provide a framework that was used to investigate the problem and test the hypotheses.

Participants

Research participant eligibility was confined to IT professionals and IT project managers currently employed at North Carolina degree-granting, not-for-profit, public or privately funded higher education institutions who have completed a software development project using an agile method. Participants were selected at random from the population which was identified using directory information accessible on the public websites of qualifying institutions; therefore, participants must have had access to the email address published on their employer's website and check their email during the window of time in which the survey was open. Additionally, participants must have had access to the Internet to complete the online survey, possess the skills to complete an online survey, be willing to voluntarily complete a survey without receiving any compensation, and completed at least one IT project that was managed using an agile method. As researcher of this project, I must also have been considerate of the needs of vulnerable populations (Creswell, 2014). To ensure responses from vulnerable populations were excluded from survey results, qualifying participants must have been at least 19 years of age and provided electronic consent prior to completing the survey. Participants were also asked to base their responses on an agile project, in which they have an in-depth knowledge about, that was completed at a qualifying higher education institution. To reduce the risk of including responses on non-agile software development projects in the survey results, examples of commonly used agile methods were provided to participants and participants were asked to attest to their eligibility at the start of the survey. Some of the IT professionals and IT project managers selected at random to partake in this research were not eligible to participate because they had not completed an agile project and others willingly chose not to respond. To account for nonresponses, I continued to select additional participants at random from the population until an adequate number of survey responses were received. Some research (Khazaal et al., 2014; Schaurer & Weiß, 2020) supports the claim that online-only, self-selected surveys can introduce selection bias or coverage bias, so I was cautious in generalizing the results.

Population and Sampling

For many studies, collecting feedback from an entire population is not practical or impossible. The process can be too costly and time consuming (Israel, 1992). When data collection from an entire population is not feasible, researchers use a process called sampling. Sampling is the process of getting feedback from a portion of the population in a manner that the responses are representative of the entire population (Stevens et al., 2006). This section discusses the population and sampling procedure for the current study.

Discussion of Population

The population of the current study is IT professionals and IT project managers currently employed at North Carolina degree-granting, not-for-profit, public or privately funded higher education institutions who have completed a software development project using an agile method. To help identify the population, a list of qualifying institutions was created using data extracted from the National Center for Educational Statistics's (NCES; n.d.) Integrated Postsecondary Education Data System (IPEDS) database. The IPEDS database is the appropriate source because it contains aggregate data about post-secondary institutions and is collected by the Institute of Education Sciences (n.d.)—the research division of the U.S. Department of

Education. To generate the list of qualifying institutions, data on all North Carolina higher education institutions were downloaded from NCES and institutions without the desired characteristics—degree-granting, not-for-profit, public or privately funded higher education institutions—were excluded. As of August 14, 2022, 124 of 167 North Carolina higher education institutions from the NCES IPEDS database, possess the desired traits of the population for this research. Appendix A: North Carolina Degree-Granting, Not-for-Profit, Public or Privately Funded Higher Education Institutions displays the projected list of qualifying institutions which was generated by excluding 41 private for-profit institutions from the complete list (31 of which were also nondegree-granting, primarily postsecondary institutions); excluding one additional nondegree-granting, primarily postsecondary institution despite the control of the institution being private not-for-profit; and excluding one institution based on the sector of the institution being categorized as an administrative unit. I was able to obtain the contact information of the chief information officer (or equivalent position) or the contact information of the full IT department for all but nine of the 124 institutions. Using this information, I estimated the population to be approximately 3,957 IT professionals and IT project managers.

Discussion of Sampling

For most studies, it is not practical or feasible to survey the full population. In order to make inferences about a population without the means of surveying the entire population, researchers use a technique called sampling (Simon & Goes, 2017). Several sampling methods exist—e.g., random, stratified, systematic, cluster, snowball, and convenience—but the current study employed probability sampling using a single stage random method. Random probability sampling provides each member of the population an equal probability of being selected to participate, which is significant because it allows researchers to make generalizations about their population (Creswell, 2014). A single-stage sampling procedure was the best fit for this study because I had access to the names and contact information of the sampling frame (Creswell, 2014). A sampling frame is the list of participants that the random sample was pulled from. Ideally, the sampling frame corresponds with the target population without any individuals being represented more than once; however, researchers often have to use a subset of the target population for their research (Stevens et al., 2006). An appropriate sampling frame is as inclusive and equally representative as possible with minimum duplication (Stevens et al., 2006).

The sampling frame for the current study is all IT professionals and IT project managers in North Carolina degree-granting, not-for-profit, public or privately funded higher education institutions whose directory information is available online through their college's or university's website. For institutions that did not make their directories publicly available online, I contacted the corresponding chief information officer or equivalent position, and requested the contact information of qualifying individuals. Between September 4, 2022, and September 22, 2022, I visited the websites of qualifying institutions (see Appendix A: North Carolina Degree-Granting, Not-for-Profit, Public or Privately Funded Higher Education Institutions) and was able to obtain the contact information of the full IT department or the chief information officer (or equivalent position) for all but nine institutions. I estimated the population at the time of the study was approximately 3,957 IT professionals and IT project managers. Appendix B: IT Professional and IT Project Manager Count by Qualifying Institution shows the count of IT professionals and IT project managers for each qualifying institution.

After the sampling frame is identified, a researcher must determine the sample size. The size of the sample is reflective of the accuracy of the sample (Stevens et al., 2006). Two factors that help determine an adequate sample size are the margin of error and the confidence level. The margin of error represents how accurate the samples' answers are in relation to the full populations' answers, and the confidence level indicates the level of trust for this margin of error (Creswell, 2014). For the current study, a census surveying the entire population was not employed. Although a census of the population eliminates sampling error, it was not used in this research because it can be costly and time-consuming (Israel, 1992). This method is most suitable for small populations. Four other strategies Cochran (1977) identified that researchers use to determine an appropriate sample size are:

- using the results of existing studies conducted on the same population
- dividing the sample into two groups so that the results from the first group can be used to determine the number of responses needed from the second group
- using a pilot study to test the results and then applying what was learned to create the sample
- leveraging a mathematical equation to estimate the sample

To my knowledge, no existing research has been done on the population of the current study, so the first strategy could not be used. The second strategy provides the most reliable estimates for the second sample, but it was not used since it is time consuming. The third method would have required me to cluster the population into two groups that were representative of each other. This method was not used because it introduces a risk of bias if the two clusters are not representative of each other (Cochran, 1977). The fourth method—to leverage a mathematical equation—is the most commonly used method to determine a sample size and was used for the current study (Simon & Goes, 2017).

Two common formulas used to determine a sample size are Yamane formula and the unnamed formula published in NEA (1960). The NEA formula, shown in Figure 6, has been widely adopted by researchers and was popularized in 1970 after Krejcie and Morgan (1970) developed a table that allowed researchers to quickly identify the sample size based on a 95% confidence level and 5% sampling error. A population proportion of 0.5 is used because it provides the maximum sample size (Krejcie & Morgan, 1970). Similarly, the Yamane formula assumes the confidence level is 95% and the population proportion is 0.5. Simon and Goes (2017) indicated that the golden standard for quantitative research is to use a 95% confidence level and 5% sampling error; therefore, either of the aforementioned formulas could be used to calculate the sample size.

The sample frame for the current study consisted of 3,957 IT professionals and IT project managers. Using the NEA formula, the sample size of this research was 350 individuals, as shown in Figure 13 below. Similarly, the sample size for the current study using the Yamane formula with a 95% confidence level and 5% degree of accuracy, would have been 363 people—see Figure 14 below. Although both formulas calculate a similar sample size, the Yamane formula is an approximation and less accurate (Adam, 2020). Therefore, the NEA (1960) formula referenced in Krejcie and Morgan (1970) was used to identify the sample size for this research. Fowler (2009) cautioned that response rates should be an additional consideration in determining an appropriate sample size, so I monitored and documented the response rates of the current study to ensure the data was generalizable.

Figure 13

Study's Computed Sample Using NEA formula (Krejcie & Morgan, 1970)

$s = \dfrac{x^2 (N) (P) (1 - P)}{d^2 (N - 1) + x^2 (P) (1 - P)}$	$350.2 = \dfrac{3.841(3957) (0.5) (1 - 0.5)}{.05^2 (3957\text{-}1) + 3.841(0.5) (1 - 0.5)}$
s = required sample size 3.841 = x^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level 3,957 = N = the population size 0.50 = P = the population proportion 0.05 = d = the degree of accuracy expressed as a proportion	

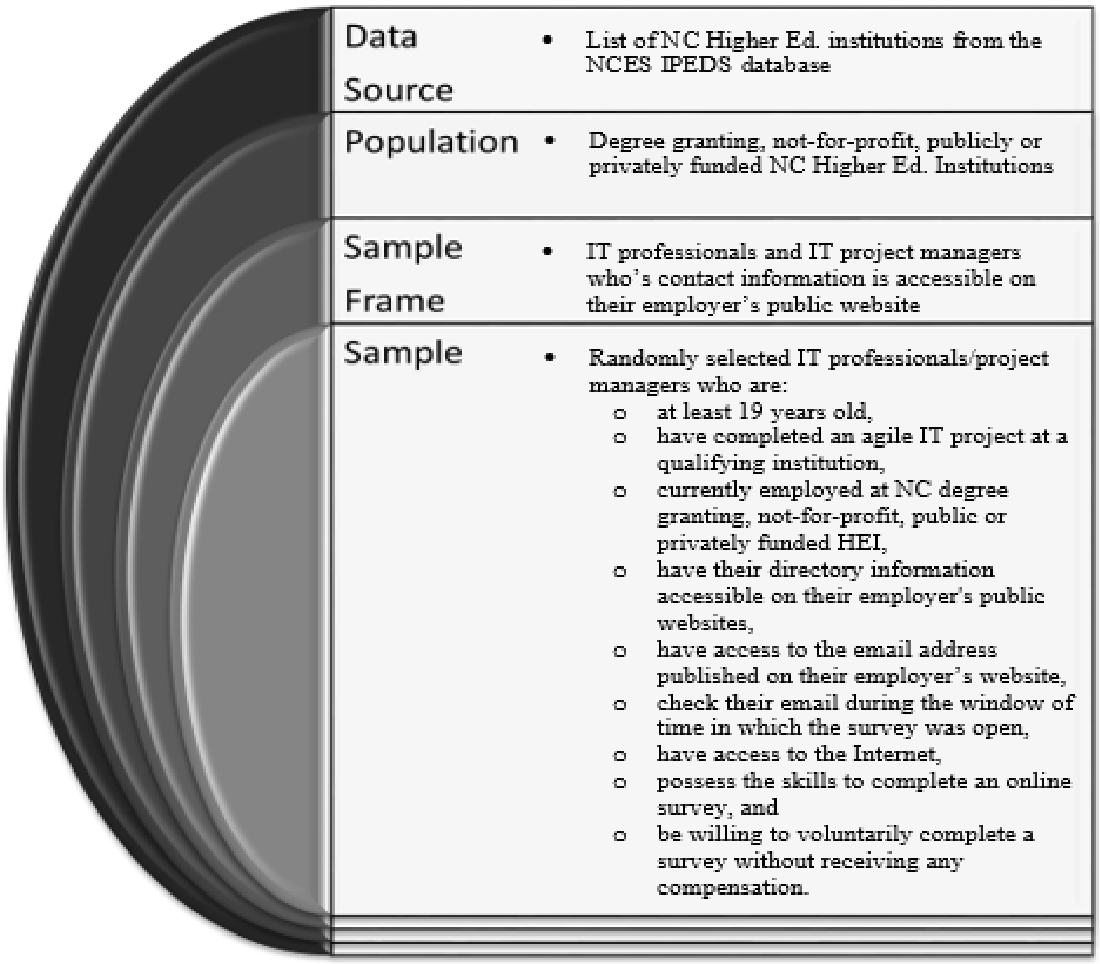
Figure 14

Study's Computed Sample Using Yamane formula (Adam, 2020)

$n = \dfrac{N}{1 + (N * d^2)}$	$363.28 = \dfrac{3957}{1 + (3957 * 0.05^2)}$
363 = n = maximum sample size 3,957 = N = population size 0.05 = d = margin of error (degree of accuracy)	

Figure 15

Process to Identify Sample



Summary of Population and Sampling

This section describes the population and outlines the sampling process for the current study. Figure 15 above provides a visual of the process of moving from the NCES IPEDS data source to identify the eligible population, followed by defining the sampling frame, and ending with a sample for the current study. In the described process, each eligible participant from the sample frame had an equal chance to provide feedback which allowed the responses to be generalizable to the broader population (Simon & Goes, 2017). Although various methods exist to determine an adequate sample size, the NEA (1960) formula referenced in Krejcie and Morgan (1970) was employed. The next section discusses the data collection and organization process for the current study.

Data Collection & Organization

Quantitative research utilizes data sets, often collected through surveys and experiments, to test hypotheses (Creswell, 2014). The significance of the research hinges on the quality of the data being collected and the accuracy of the measurement of the variables (Simon & Goes, 2017). Collecting data securely, handling the data appropriately, and using the data for its intended purpose must all be addressed when designing a study. Failing to do so can jeopardize the integrity of the research. This section discusses the data collection plan, the survey instrument, and the data organization plan for this research.

Data Collection Plan

Quantitative data was collected using an online survey which is described in the next section, titled Instruments. The online survey collected ordinal data using a 7-point Likert scale. Ordinal scales employ categorized responses that have an ordered relation with each other, but the distance between the values is insignificant (Göb et al., 2007; Sullivan & Artino, 2013). They are often used to collect a participant’s opinion or disposition on a topic (Göb et al., 2007). This aligns with the need of the current study because participants were asked the extent to which they agree or disagree with questions pertaining to each independent and dependent variable. Table 1 on page 91 above shows the ordinal scales to be used to collect data on the independent and dependent variables in the current study. For independent variables, responses ranged between: 1) Strongly Disagree, 2) Disagree, 3) Somewhat Disagree, 4) Neither Disagree or Agree, 5) Somewhat Agree, 6) Agree, 7) Strongly Agree, or N/A) Not Applicable / Do Not Know. For dependent variables, the ordinal values used were: 1) Very Unsuccessful, 2) Unsuccessful, 3) Somewhat Unsuccessful, 4) Neutral, 5) Somewhat successful, 6) Successful, or 7) Very Successful.

Survey participants were selected at random from the sampling frame and invited to participate in the current study via an email sent to the participants' college or university email address that is published in their employer's public, web-accessible employee directory. These emails informed participants about the purpose of the survey, informed them of the requirements to participate in the study, and invited them to participate in the study by providing a link to the online survey. Survey participants' identities remained anonymous; however, participants were asked to provide non-identifying information about themselves and their employer so that I could describe the sample when the presenting the findings. Collecting data anonymously is a common and simple approach used to avoid pressuring those selected from the sample to participate in the survey, and is a significant factor that influences a research participant's decision to share data (Schomakers et al., 2020; Simon & Goes, 2017). The survey tool used with this research was Qualtrics, which is a third-party survey software that collects and stores data securely (Qualtrics, 2022a, 2022b). The survey was posted online until the desired number of responses were received. Since some IT professionals and IT project managers selected to participate declined the invitation to participate in the study and others did not possess experience with agile projects, additional people were selected from the sampling frame until the desired number of responses were received.

Instruments

The current study make use of a modified version of the Agile Software Development Project Survey created for Chow and Cao (2008). This survey instrument was developed to capture agile professionals' opinions on CSFs that help agile software development projects succeed. Many of these proposed CSFs correlate to at least one of the 12 principles from the Agile Manifesto, which is described in greater detail within the section titled "Link to the Current Research" located under the "Theoretical Framework" heading on page 22. These correlations support the Chow and Cao survey instrument being a good fit for this research. The original and modified survey instruments are presented below, and my permission to utilize the instrument is shown in Appendix D: Chow and Cao (2008) Permission.

Original Survey Instrument. The Agile Software Development Project Survey was developed by Chow and Cao (2008) to capture agile professionals' opinions on CSFs that help agile software development projects succeed. The survey consists of 57 questions and is broken into four sections. The first section collects demographic data and information about the participant's selected agile project, the second section is for success factors, the third on the perception of project success, and the fourth allows participants to provide additional comments or thoughts. To elaborate on each of these sections, Section 1 is separated into two sub-sections. The first, Section 1.1, includes five questions about the selected agile project, and the second, 1.2, consists of eight questions about the research participant and the participant's organization. Some questions in Section 1.1 and 1.2 are not required, and viable question responses include both free text (e.g. company name) as well as pre-determined ranges/options (e.g. ranges for the number of employees at the respondent's company). The second section collects responses pertaining to success factors of agile projects and is broken into five sub-sections, one for each dimension the authors of Chow and Cao investigated—organizational (questions 14-21), people (questions 22-27), process (questions 28-36), technical (questions 37-45), and project (questions 46-52). This section collects ordinal data using a Likert scale that includes the following options:

1) Strongly Disagree, 2) Disagree, 3) Somewhat Disagree, 4) Neither Disagree or Agree, 5) Somewhat Agree, 6) Agree, 7) Strongly Agree, or N/A) Not Applicable / Do Not Know. Similarly, Section 3 uses four questions to collect ordinal data on the perception of success for the selected agile project. The ordinal values used in section three are: 1) Very Unsuccessful, 2) Unsuccessful, 3) Somewhat Unsuccessful, 4) Neutral, 5) Somewhat successful, 6) Successful, or 7) Very Successful. The fourth and final section consists of one open ended question and is used to collect additional feedback and comments from survey participants. Table 2 shows a summary of the Chow and Cao survey instrument and Appendix C: Chow and Cao (2008) Survey Instrument shows the full survey.

Table 2

Summary of Chow and Cao (2008) Survey

Section	Section Description	Questions	Response Type
1	Demographics		
1.1	Agile project	1 - 5	Nominal data
1.2	Participant and organization	6 - 13	Nominal data
2	Success factors of the agile project		
2.1	Organizational dimension	14 - 21	Ordinal data
2.2	People dimension	22 - 27	Ordinal data
2.3	Process dimension	28 - 36	Ordinal data
2.4	Technical dimension	37 - 45	Ordinal data
2.5	Project dimension	46 - 52	Ordinal data
3	Perception of success of the agile project	53 - 56	Ordinal data
4	Additional comments	57	Nominal data

Chow and Cao (2008) began their research by narrowing a list of 39 possible success factors down to 12 independent variables using reliability analysis and factor analysis. Since their study was exploratory in nature, reliability analysis for each independent variable was essential to guarantee a high level of reliability. Using Cronbach’s alpha method and two rounds of reliability analysis, they were able to narrow the list of possible CSFs to the 12 independent variables shown in Figure 1 on page 22. While Stankovic et al. (2013), Brown (2015), and Stanberry (2018) all used the survey instrument from Chow and Cao to extend on their respective research, only Stankovic et al. performed additional reliability analysis on the independent variables. Cronbach's alpha was also used by Stankovic et al. to test the reliability of question groups that contained multiple questions for a single independent variable and to test the reliability of the collection of factors (organizational, people, process, technical, project) for each dimension. Question groups underwent additional reliability testing of the following independent variables: management commitment (questions 14, 15), organizational environment (questions 16-19, 21, 44), team environment (questions 20, 26, 49, 50), team capability (questions 22-25, 45), customer involvement (questions 27, 35, 36), project management process (questions 29-34), project definition process (questions 28, 51, 52), agile software techniques (questions 37-41), and delivery strategy (questions 42, 43). Since project nature (question 46), project type (question 47), and project schedule (question 48) were each associated with one question only, no additional reliability testing was needed on their corresponding question groups.

The results of the Cronbach's alpha test between Stankovic et al. (2013) and Chow and Cao (2008) differ for some of the individual question groups, but align for the dimensions. Both studies support the reliability of the question groups for all dimensions except the project dimension, which contains the independent variables: project nature, project type, and project schedule. Stankovic et al. concluded that the question group for the project dimension has low reliability; however, they chose to keep these independent variables in their study and employed the survey instrument without making any changes. Similarly, Chow and Cao also had a low

Cronbach's alpha for the Project Dimension, but decided to leave all three in the study after a principal component factor analysis with Varimax rotation was performed.

Chow and Cao (2008) also performed content validity on the 12 hypothesized success factors, and verified the reliability of the survey instrument by administering a pilot study to five smaller groups within the population. To help reduce bias, they requested that only individuals knowledgeable in agile methodologies and agile software development projects participate. This helped reduce bias by filtering out those responses that would skew the survey results. The pilot produced responses from 37 participants, and their feedback was incorporated into the final survey prior to inviting the sampling frame to participate. I was unable to find evidence that Stankovic et al. (2013), Brown (2015), or Stanberry (2018) did any additional validation.

Modified Survey Instrument. The survey instrument used by this study is a derivative of the survey instrument used in Chow and Cao (2008). Those authors investigated 12 independent variables to determine if they were CSFs for agile software development. Many of these factors correlate with at least one of the 12 principles from the Agile Manifesto. These correlations are discussed in greater detail within the section titled "Link to the Current Research" located under the "Theoretical Framework" heading on page 22 of this document. Figure 2 on page 23 herein shows how these hypothesized CFSs relate to the 12 agile principles. The association between these CSFs and the agile principles supports the Chow and Cao survey instrument, with a few modifications, being a good fit to collect data for this research. This section describes the survey instrument to be used with the current study and highlights the changes that are needed from the original survey that was described in the prior section. A change log documenting the details of all changes to the original survey is shown in Appendix E: Change Log for the Modified Survey.

The modified survey instrument to be employed started with an attestation to ensure all participants met the criteria to participate, which was: an IT professional or an IT project manager that was (at the time of the survey) employed at a North Carolina degree-granting, not-for-profit, public or privately funded higher education institution, and who had completed a software development project using an agile method. If a survey respondent disagreed with the attestation, the survey ended, and the person was informed that he or she was not eligible to participate. If a respondent agreed, he or she was advanced to the survey. This differed from the original survey but was necessary to reduce the risk of receiving feedback from individuals without agile experience, as well as those outside the IT or project management profession.

Similar to the original, the modified survey also consisted of four sections. Section 1 collected demographic and project data, Section 2 was for success factors, Section 3 was for the perception of project success, and Section 4 allowed participants to provide additional comments or thoughts. On both survey instruments, the first section collected nominal data about the participant and the agile project the survey responses are based on, but the modified version contained 12 changes. Appendix E: Change Log for the Modified Survey outlines these changes, which include rewording some questions, adding questions, and removing questions. The changes were necessary to ensure all questions were pertinent to the population and the current research. These changes did not impact the validity of the survey instrument because data from Section 1 was only used to describe the sample in the presentation of the findings and was not used to test the hypotheses.

In the modified survey, Section 2 also collected responses pertaining to success factors of agile projects and it was broken into the same five sub-sections. The same Likert scale was used to collect ordinal data on the independent and dependent variables, but the wording for one question was updated for it to be relevant to the current study, and six questions had to be removed. The questions removed were specific to the Chow and Cao (2008) success factors: project definition process, project nature, project type, and project schedule. Discussed within the section titled “Link to the Current Research” located under the “Theoretical Framework” heading of this document (page 22), these success factors did not correlate to an agile principle and were removed from the conceptual framework since they were determined to be insignificant in Chow and Cao. Since all remaining questions in Section 2 were validated by Chow and Cao, additional validity testing was not necessary notwithstanding having removed those six unnecessary questions. The remaining two survey sections—Section 3 and Section 4—mirrored the original survey instrument. Incorporating these changes reduced the length of the survey to 50 questions. Table 3 provides a summary of the data that was collected using the modified survey instrument, and a copy of the modified survey is available in Appendix F: Survey Instrument. Based on estimates from Brown (2015), I estimated it would take participants approximately 15 minutes to complete the online survey.

Table 3

Summary of the Survey Instrument

Section	Section Description	Questions	Response Type
1	Demographics		
1.1	Agile project	1 - 4	Nominal data
1.2	Participant and organization	5 - 12	Nominal data
2	Success factors of the agile project		
2.1	Organizational dimension	13 - 20	Ordinal data
2.2	People dimension	21 - 26	Ordinal data
2.3	Process dimension	27 - 34	Ordinal data
2.4	Technical dimension	35 - 43	Ordinal data
2.5	Project dimension	44 - 45	Ordinal data
3	Perception of success of the agile project	46 - 49	Ordinal data
4	Additional comments	50	Nominal data

Data Organization Plan

Data was collected, organized, and secured using the survey tool Qualtrics, which is a third-party survey software that collects and stores data securely (Qualtrics, 2022a, 2022b). Additionally, Qualtrics is the web-based survey software sanctioned by Liberty University (2022). Using the university's approved software tool helped ensure the data was not accessed by those unauthorized to view or use the data. Qualtrics allows researchers to import a list of email addresses and then randomly select and invite participants from the list to complete a survey, but this feature was not enabled in my license of the software. I had to pivot and use a combination of tools to randomly select and invite participants to complete the survey. Instead, I used Microsoft Excel to import the email addresses from the sampling frame, which was obtained using the techniques described in the "Population and Sampling" section above, and randomly assigned email addresses a number. The list was then sorted by the randomly assigned number and separated into segments, which were used to solicit participation. These email addresses were then imported into MailChimp.com, and email campaigns were created to invite users to participate in the study. Survey responses were kept anonymous to eliminate the risk of exposing respondents' identities. Qualtrics provided me with functionality to monitor the number of survey responses received, which informed me when additional email campaigns were needed to generate more responses. Once a sufficient number of responses were received, the survey was closed.

Summary of Data Collection & Organization

This section provides a thorough description of the data collection plan, the survey instrument, and the data organization plan for this research. It conveys how ordinal data was collected securely through an online Qualtrics survey using a modified version of the Agile

Software Development Project Survey created for Chow and Cao (2008). Additionally, a detailed explanation outlining how and why the Chow and Cao survey was modified for the current study, as well as why it was an appropriate instrument, is provided. The next section provides additional detail about the data analysis.

Data Analysis

The presented study intends to investigate the relationship between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects. The data analysis section describes the independent and dependent variables for this study, discusses descriptive statistics that are used to describe the data collected, and outlines how this data was used to test the hypotheses. This research is guided by 15 hypotheses which correspond with the three primary research questions and 12 sub-questions. Data was collected on 12 independent variables and four dependent variables to test these null and alternative hypotheses. These variables and hypotheses are discussed in greater detail below.

The Variables

This study collected data on five dependent and 12 independent variables to test the hypotheses. Four of the five dependent variables represent the four dimensions of a participant's perceived level of project success: quality, scope, time, and cost. These four variables were used to triangulate results with existing research (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013) and to compute the fifth dependent variable—project success—which was used to test the hypotheses. The fifth dependent variable was calculated by computing the mean value of quality, scope, time, and cost. The survey instrument described on page 105 was utilized to capture ordinal data on each dependent variable using the following range: 1) Very

Unsuccessful, 2) Unsuccessful, 3) Somewhat Unsuccessful, 4) Neutral, 5) Somewhat successful, 6) Successful, or 7) Very Successful.

The 12 independent variables represent the agile principles from the Agile Manifesto, with each agile principle representing an individual independent variable. Similarly, the survey instrument was used to capture ordinal data on the level in which projects deviated from each agile principle. The range used for all 12 independent variables is: 1) Strongly Disagree, 2) Disagree, 3) Somewhat Disagree, 4) Neither Disagree or Agree, 5) Somewhat Agree, 6) Agree, 7) Strongly Agree, or N/A) Not Applicable / Do Not Know. Table 4 describes the dependent and independent variables and identifies which survey questions align with each variable.

Table 4

Variables

Variable	Variable Type	Data Type	Range	Survey Question(s)
(DV1) Perception of success for the quality of the project	Dependent	ordinal	1 – Very unsuccessful 2 – Unsuccessful 3 – Somewhat unsuccessful 4 – Neutral 5 – Somewhat successful 6 – Successful 7 – Very successful	46
(DV2) Perception of success for the scope of the project	Dependent	ordinal	1 – Very unsuccessful 2 – Unsuccessful 3 – Somewhat unsuccessful 4 – Neutral 5 – Somewhat successful 6 – Successful 7 – Very successful	47

Variable	Variable Type	Data Type	Range	Survey Question(s)
(DV3) Perception of success for the timeliness of the project	Dependent	ordinal	1 – Very unsuccessful 2 – Unsuccessful 3 – Somewhat unsuccessful 4 – Neutral 5 – Somewhat successful 6 – Successful 7 – Very successful	48
(DV4) Perception of success for the cost of the project	Dependent	ordinal	1 – Very unsuccessful 2 – Unsuccessful 3 – Somewhat unsuccessful 4 – Neutral 5 – Somewhat successful 6 – Successful 7 – Very successful	49
(DV5) Perception of project success	Dependent	ordinal	1 – Very unsuccessful 2 – Unsuccessful 3 – Somewhat unsuccessful 4 – Neutral 5 – Somewhat successful 6 – Successful 7 – Very successful	Mean of 46, 47, 48, 49
(IV1) 1st Agile Principle - Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	Mean of 26, 41

Variable	Variable Type	Data Type	Range	Survey Question(s)
(IV2) 2nd Agile Principle - Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	Mean of 17, 27, 28
(IV3) 3rd Agile Principle - Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	40
(IV4) 4th Agile Principle - Business people and developers must work together daily throughout the project.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	Mean of 33, 34
(IV5) 5th Agile Principle - Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	Mean of 13, 14, 20, 21, 22, 23, 24, 42, 43

Variable	Variable Type	Data Type	Range	Survey Question(s)
(IV6) 6th Agile Principle - The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	Mean of 16, 19, 31
(IV7) 7th Agile Principle - Working software is the primary measure of progress.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	30
(IV8) 8th Agile Principle - Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	Mean of 29, 32
(IV9) 9th Agile Principle - Continuous attention to technical excellence and good design enhances agility.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	Mean of 35, 37, 39

Variable	Variable Type	Data Type	Range	Survey Question(s)
(IV10) 10th Agile Principle - Simplicity--the art of maximizing the amount of work not done--is essential.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	Mean of 36, 38
(IV11) 11th Agile Principle - The best architectures, requirements, and designs emerge from self-organizing teams.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	Mean of 15, 25, 44, 45
(IV12) 12th Agile Principle - At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.	Independent	ordinal	1 – Strongly Disagree 2 – Disagree 3 – Somewhat Disagree 4 – Neither Disagree or Agree 5 – Somewhat Agree 6 – Agree 7 – Strongly Agree 8 – Not Applicable/Do Not Know	18

Descriptive Statistics

Descriptive statistics help describe data using summaries (Shi & McLarty, 2009), and are used to describe the measure of central tendency and dispersion of the data (Marshall & Jonker, 2010). This study captured ordinal data on the independent and dependent variables, so some methods of measurement are more applicable. Two common methods used to describe the central tendency measurements of ordinal data are median and mode (Marshall & Jonker, 2010). The median is the mid-point of the dataset, and the mode is the response that occurs most often. Both the median and mode were used to describe the central tendency of the data in this research. Four common methods used to describe the measure of dispersion of data are frequency distribution, relative frequency, maximum and minimum, and range (Marshall & Jonker, 2010). The frequency displays the distribution count of responses across valid responses and the relative frequency displays the distribution percentile. The current study describes the measure of dispersion of data using all four methods: frequency distribution, relative frequency, maximum and minimum, and range.

Hypotheses Testing

The current study set forth to investigate the relationship between the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects. The 12 agile principles served as the independent variables (IV1 – IV12) and each dimension of project success (quality, scope, time, and cost) represented the dependent variables (DV1 – DV4). Additionally, the dependent variable perceived level of project success (DV5) was calculated by computing the mean of these four dimensions. Data collected on these independent and dependent variables was used to test the hypotheses. Fifteen hypotheses guide this research. The first three hypotheses correspond with the primary research questions, RQ1, RQ2, and RQ3 (see page 6), and the remaining 12 hypotheses correspond with the 12 sub-questions, RQ3a – RQ3L. The null and alternative hypotheses for the current study and a strategy for testing each hypothesis are described below.

Hypotheses H1o and H1a. The first hypothesis in this study is directly related to the first research question (RQ1), which aimed to investigate if organizations can improve software development project success rates by adhering to agile principles. The null and alternative hypotheses are shown below. I planned to use Pearson's correlation analysis to test the null hypotheses, but a linear relationship did not exist between all independent and dependent variables. Instead, the Spearman's rank-order statistical test was used. Correlation analysis is used to test the direction and strength of a relationship between variables (Mendenhall & Sincich, 2014). The values of a correlation coefficient (r) range between -1 and 1. Variables have a positive relationship (an increase in the independent variable would result in an increase in the dependent variable) if r is greater than zero, a negative relationship (an increase in the independent variable would result in a decrease in the dependent variable) if r is less than zero, and no relationship (an increase in the independent variable has no bearing on the dependent variable) if r is equal to zero (Rebekić et al., 2015). To test the hypotheses, data collected on independent variables IV1 – IV12 and dependent variable DV5 was loaded into the statistical package SPSS, which was then used to calculate the Spearman's rho value. When a relationship existed between the independent and dependent variables, I rejected the null hypothesis. To triangulate the results with other research, dependent variables DV1-DV4 were also analyzed to investigate which dimensions of project success have a relationship with the independent variables IV1 – IV12.

When the null hypothesis was rejected, regression analysis was done to test the strength of the relationship between the independent and dependent variables to determine if the alternative hypothesis can be accepted. Regression analysis is used to determine the strength of the relationship between variables (Mendenhall & Sincich, 2014). When the strength of the relationship is significant, the alternative hypothesis is accepted. Data on variables IV1 – IV12 and DV5 were loaded into the statistical package SPSS to test the fit of the model. The null and alternative hypotheses for research question (RQ1) are:

H1o: Organizations can not improve software development project success rates by adhering to agile principles.

H1a: Organizations can improve software development project success rates by adhering to agile principles.

Hypotheses H2o and H2a. The second hypothesis in the current study is directly related to the second research question (RQ2), which aimed to investigate to what extent adhering to the 12 agile principles helps organizations improve software development project success rates. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. When the null hypothesis was rejected, regression analysis was done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong, positive relationship between independent variables and the dependent variable supports the alternative hypothesis. The null and alternative hypotheses for research question (RQ2) are:

H2o: There is no relationship between adhering to the 12 agile principles and the success of agile software development projects.

H2a: There is a relationship between adhering to the 12 agile principles and the success of agile software development projects.

Hypotheses H3o and H3a. The third hypothesis in the current study is directly related to the third research question (RQ3). The hypothesis aimed to investigate if there is a correlation between deviating from the 12 agile principles and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. When the null hypothesis was rejected, regression analysis was done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between independent variables and the dependent variable supports the alternative hypothesis. The null and alternative hypotheses for research question (RQ3) are:

H3o: There is no relationship between deviating from the 12 agile principles and the success of an agile software development project.

H3a: There is a relationship between deviating from the 12 agile principles and the success of an agile software development project.

Hypotheses H4o and H4a. The fourth hypothesis in this research is directly related to the first sub-question for research question three (RQ3a), which aimed to investigate if there is a correlation between deviating from the first agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. If the null hypothesis had been rejected, regression analysis would have been done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between the independent variable and the dependent variable would have supported the alternative hypothesis. The null and alternative hypotheses for research question (RQ3a) are:

H4o: There is no relationship between deviating from the agile principle early and continuous delivery of software and the success of an agile software development project.

H4a: There is a relationship between deviating from the agile principle early and continuous delivery of software and the success of an agile software development project.

Hypotheses H5o and H5a. The fifth hypothesis in the current study is directly related to the second sub-question for research question three (RQ3b), which aimed to investigate if there is a correlation between deviating from the second agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. If the null hypothesis had been rejected, regression analysis would have been done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could have been accepted. A strong linear relationship between the independent variable and the dependent variable would have support the alternative hypothesis. The null and alternative hypotheses for research question (RQ3b) are:

H5o: There is no relationship between deviating from the agile principle welcoming requirement changes at any point in the development process and the success of an agile software development project.

H5a: There is a relationship between deviating from the agile principle welcoming requirement changes at any point in the development process and the success of an agile software development project.

Hypotheses H6o and H6a. The sixth hypothesis in this study is directly related to the third sub-question for research question three (RQ3c), which aimed to investigate if there is a correlation between deviating from the third agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. If the null hypothesis had been rejected, regression analysis would have been done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between the independent variable and the dependent variable would have supported the alternative hypothesis. The null and alternative hypotheses for research question (RQ3c) are:

H6o: There is no relationship between deviating from the agile principle delivering working software frequently and the success of an agile software development project.

H6a: There is a relationship between deviating from the agile principle delivering working software frequently and the success of an agile software development project.

Hypotheses H7o and H7a. The seventh hypothesis in this research is directly related to the fourth sub-question for research question three (RQ3d), which aimed to investigate if there is a correlation between deviating from the fourth agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. If the null hypothesis had been rejected, regression analysis would have been done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between the independent variable and the dependent variable would have supported the alternative hypothesis. The null and alternative hypotheses for research question (RQ3d) are:

H7o: There is no relationship between deviating from the agile principle daily collaboration between the requestor and software developers and the success of an agile software development project.

H7a: There is a relationship between deviating from the agile principle daily collaboration between the requestor and software developers and the success of an agile software development project.

Hypotheses H8o and H8a. The eighth hypothesis in the current study is directly related to the fifth sub-question for research question three (RQ3e), which aimed to investigate if there is a correlation between deviating from the fifth agile principle and project success for software development projects. The null and alternative hypotheses are below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. When the null hypothesis was rejected, regression analysis was done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between independent variables and the dependent variable supports the alternative hypothesis. The null and alternative hypotheses for research question (RQ3e) are:

H8o: There is no relationship between deviating from the agile principle supporting and entrusting the project team to get the job done and the success of an agile software development project.

H8a: There is a relationship between deviating from the agile principle supporting and entrusting the project team to get the job done and the success of an agile software development project.

Hypotheses H9o and H9a. The ninth hypothesis in the current study is directly related to the sixth sub-question for research question three (RQ3f), which aimed to investigate if there is a correlation between deviating from the sixth agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. When the null hypothesis was rejected, regression analysis was done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between independent variables and the dependent variable supports the alternative hypothesis. The null and alternative hypotheses for research question (RQ3f) are:

H9o: There is no relationship between deviating from the agile principle face-to-face collaboration and the success of an agile software development project.

H9a: There is a relationship between deviating from the agile principle face-to-face collaboration and the success of an agile software development project.

Hypotheses H10o and H10a. The tenth hypothesis in the current study is directly related to the seventh sub-question for research question three (RQ3g), which aimed to investigate if there is a correlation between deviating from the seventh agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. If the null hypothesis had been rejected, regression analysis would have been done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between the independent variable and the dependent variable would have supported the alternative hypothesis. The null and alternative hypotheses for research question (RQ3g) are:

H10o: There is no relationship between deviating from the agile principle measuring progress through the delivery of working software and the success of an agile software development project.

H10a: There is a relationship between deviating from the agile principle measuring progress through the delivery of working software and the success of an agile software development project.

Hypotheses H11o and H11a. The eleventh hypothesis in the current study is directly related to the eighth sub-question for research question three (RQ3h), which aimed to investigate if there is a correlation between deviating from the eighth agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. If the null hypothesis had been rejected, regression analysis would have been done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between the independent variable and the dependent variable would have supported the alternative hypothesis. The null and alternative hypotheses for research question (RQ3h) are:

H11o: There is no relationship between deviating from the agile principle maintaining a constant pace and the success of an agile software development project.

H11a: There is a relationship between deviating from the agile principle maintaining a constant pace and the success of an agile software development project.

Hypotheses H12o and H12a. The twelfth hypothesis in the current study is directly related to the ninth sub-question for research question three (RQ3i), which aimed to investigate if there is a correlation between deviating from the ninth agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. If the null hypothesis had been rejected, regression analysis would have been done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between the independent variable and the dependent variable would have supported the alternative hypothesis. The null and alternative hypotheses for research question (RQ3i) are:

H12o: There is no relationship between deviating from the agile principle continuous attention to technical excellence and good design and the success of an agile software development project.

H12a: There is a relationship between deviating from the agile principle continuous attention to technical excellence and good design and the success of an agile software development project.

Hypotheses H13o and H13a. The thirteenth hypothesis in the current study is directly related to the tenth sub-question for research question three (RQ3j), which aimed to investigate if there is a correlation between deviating from the tenth agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson's correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. When the null hypothesis was rejected, regression analysis was done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between independent variables and the dependent variable supports the alternative hypothesis. The null and alternative hypotheses for research question (RQ3j) are:

H13o: There is no relationship between deviating from the agile principle simplicity and the success of an agile software development project.

H13a: There is a relationship between deviating from the agile principle simplicity and the success of an agile software development project.

Hypotheses H14o and H14a. The fourteenth hypothesis in the current study is directly related to the eleventh sub-question for research question three (RQ3k), which aimed to investigate if there is a correlation between deviating from the eleventh agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson’s correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman’s rank-order statistical test. Instead, the Spearman’s rank-order statistical test was used. When the null hypothesis was rejected, regression analysis was done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between independent variables and the dependent variable supports the alternative hypothesis. The null and alternative hypotheses for research question (RQ3k) are:

H14o: There is no relationship between deviating from the agile principle self-organizing teams and the success of an agile software development project.

H14a: There is a relationship between deviating from the agile principle self-organizing teams and the success of an agile software development project.

Hypotheses H15o and H15a. The fifteenth hypothesis in the current study is directly related to the twelfth sub-question for research question three (RQ3L), which aimed to investigate if there is a correlation between deviating from the twelfth agile principle and project success for software development projects. The null and alternative hypotheses are shown below. The original design was to use SPSS to analyze the data collected with Pearson’s correlation analysis; however, a linear relationship did not exist between the variables so I had to use the Spearman's rank-order statistical test. Instead, the Spearman's rank-order statistical test was used. If the null hypothesis had been rejected, regression analysis would have been done to test the relationship between the independent and dependent variables to determine if the alternative hypothesis could be accepted. A strong linear relationship between the independent variable and the dependent variable would have supported the alternative hypothesis. The null and alternative hypotheses for research question (RQ3L) are:

H15o: There is no relationship between deviating from the agile principle regular reflection adjusting behavior accordingly and the success of an agile software development project.

H15a: There is a relationship between deviating from the agile principle regular reflection adjusting behavior accordingly and the success of an agile software development project.

Hypotheses Testing Alternatives

Pearson's correlation analysis assumes a linear relationship between variables (Mendenhall & Sincich, 2014). To test if a linear relationship existed between the independent and dependent variables, the statistical package SPSS was used to create scatterplots of the data. The relationship was not linear but did have a monotonic association, so Spearman's rank correlation coefficient was an acceptable alternative statistical test (Sedgwick, 2014). Spearman's rank correlation coefficient can be used when an increase in the independent variable has a consistent change in the dependent variable (increase or decrease), but the rate at which the dependent variable changes can vary (Sedgwick, 2014). Also known as Spearman's rho, this alternate method can be used for both normal and nonnormal distributed data, can identify linear or nonlinear correlations, and is less sensitive to outliers (Zhang & Wang, 2023).

Summary of Data Analysis

This research collected ordinal data on 12 independent and four dependent variables to test to investigate the relationship between the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects. These relationships were investigated by testing 15 hypotheses which correspond with the three primary research questions and 12 sub-questions. This section provided a detailed explanation for the variables and discussed the descriptive statistics that were used to test the quality of the data collected. Additionally, a thorough plan for testing the null and alternative hypotheses for the research and alternative testing conducted if data did not meet the requirements for the proposed statistical test was provided. The next section provides details about the reliability and validity of the instrument.

Reliability and Validity

Non-experimental quantitative studies often utilize survey instruments to collect data to be analyzed. Survey instruments can introduce systematic or random error which can skew the actual measurement of a variable (Watson, 2015). Steps can be done to reduce this variance, but it cannot be completely eliminated (Bowling, 1997). To improve quality and reduce the error in measurement, researchers test an instrument's reliability and validity (Claydon, 2015). Reliability refers to an instrument's measurement being consistent every time it is used (Bannigan & Watson, 2009), and validity refers to an instrument's ability to measure what it is intended to measure (Fitzner, 2007). This section addresses the reliability and validity of the survey instrument to be used in the current study.

Reliability

Reliability checks to ensure an instrument measures an attribute consistently every time it is used (Watson, 2015). Although different forms of reliability analysis exist, internal consistency reliability is most pertinent to the current study. Internal consistency reliability is used to check that groups of questions measure the same statistic (Bannigan & Watson, 2009). Since the survey instrument for the current research uses question groups to collect data on independent variables, I had to ensure a high internal consistency reliability existed to protect the quality of the research. The most commonly employed statistic used to show internal consistency reliability is Cronbach’s alpha coefficient (DeVon et al., 2007).

The survey instrument used in this research has been used in several studies (Brown, 2015; Chow and Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). Chow and Cao (2008) and Stankovic et al. (2013) used Cronbach’s alpha coefficient to check the internal consistency reliability of the survey instrument. The results of the Cronbach’s alpha test between Stankovic et al. (2013) and Chow and Cao (2008) differed for some of the individual question groups, but aligned for the variable dimensions. Both studies support the reliability of the question groups for all dimensions except the project dimension, which contains the independent variables: project nature, project type, and project schedule. Stankovic et al. concluded that the question group for the project dimension had low reliability; however, the researchers chose to keep these independent variables in the study and employed the survey instrument without making any changes. Similarly, Chow and Cao also had a low Cronbach’s alpha for the project dimension, but decided to leave all three in the study after a principal component factor analysis with Varimax rotation was performed. The model-altered survey instrument for the current study eliminated the project dimension and the questions associated with these variables (project nature, project type, and project schedule) since these variables did not align with the principles from the Agile Manifesto. Since these variables had a low Cronbach alpha coefficient in Chow and Cao (2008) and Stankovic et al. (2013) and the remaining factors had an acceptable Cronbach's alpha, additional reliability testing was not needed for the current study.

Validity

Validity refers to an instrument's ability to accurately measure the attribute it is intended to measure (Roberts & Priest, 2006). Multiple forms of validity exist, but two broad measures of validity are external validity and content validity. External validity pertains to the generalizability of the study's results. A discussion of the sampling technique is discussed on page 98, but I used random probability sampling to ensure each member of the population had an equal probability of being selected to participate in the current study. This technique addressed the external validity of the study and allowed me to make generalizations about the population (Creswell, 2014). Content validity leverages the expertise of experts in the study to conclude that the questions are complete and sufficiently cover the construct (DeVon et al., 2007; Fitzner, 2007). Chow and Cao (2008) tested content validity during the pilot study and incorporated expert feedback into the final survey to ensure the questions adequately covered the paradigm.

Summary of Reliability and Validity

Reliability and validity are techniques used to validate the dependability of a study and demonstrate the rigor of the research process (Roberts & Priest, 2006). They are necessary in quantitative research to prove an instrument consistently measures the phenom it is intended to measure. Various methods, such as Cronbach's alpha coefficient, can be used by researchers to measure the internal consistency of an instrument (Bannigan & Watson, 2009), and adjustments can be made to instruments to improve the reliability and validity if they are unacceptably low (Watson, 2015). The current study intends to use a proven survey instrument that was found to have an acceptable Cronbach's alpha coefficient and was validated by existing peer-reviewed research.

Summary of Section 2 and Transition

The purpose of this quantitative correlational study is to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. Section 2 provided a blueprint outlining how the current research answered the core research questions that guided the study and contributed to the existing body of knowledge on the subject. Section 2 reiterated the purpose of the study being presented and defined the role of the researcher. In this quantitative, non-experimental, correlational study, the researcher remained objective by using an online survey to collect quantitative data on the independent and dependent variables. The survey instrument described within this section was utilized to collect ordinal data on these independent and dependent variables. This is most appropriate for the study because ordinal scales can be used to collect the opinion or disposition of someone (Göb et al., 2007).

Section 2 also discussed the population, provided a detailed description of eligible participants, and outlined how the sampling frame was identified. The sampling frame for the study consisted of 3,957 IT professionals and IT project managers, so the required sample size was 350 participants. The NEA (1961) formula, shown in Figure 6 and referenced in Krejcie and Morgan (1970), was used to calculate the desired sample size for this research. An altered version of the Chow and Cao (2008) survey instrument was used to collect data from survey participants. Nominal data was collected to describe the sample and ordinal data was collected on the variables to test the hypotheses. Using the statistical package SPSS, I used this ordinal data to conduct correlation analysis and test the null hypotheses. When the null hypotheses were rejected, regression analysis was used to see if any alternative hypotheses could be accepted. Discussed within Section 2, these tests were done for all 15 hypotheses that guide the current study.

Lastly, Section 2 discussed the reliability and validity of the instrument. These are significant because ensuring an instrument consistently measures an attribute and can measure the attribute it is intended to measure accurately protect the integrity of the research. The survey instrument to be used in this research has been used in several studies (Brown, 2015; Chow and Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). Both Chow and Cao (2008) and Stankovic et al. (2013) used Cronbach's alpha coefficient to check the internal consistency reliability of the survey instrument, and Chow and Cao did validity testing. Discussed within Section 2, since the current study intends to use a proven survey instrument that was found to have an acceptable Cronbach's alpha coefficient and was validated by existing peer-reviewed research, additional reliability and validity testing is not planned for the current study.

Up next, the final section of this dissertation starts by presenting an overview of the study which summarizes the process and results. This is followed by the presentation of the findings which conveys in detail how the dependent variable for overall project success was calculated using the four dimensions: cost, budget, timeline, and customer satisfaction. The section presents descriptive statistics which provide insights into the study participants, the projects that the responses were based on, and the institution the participants represent. Section 3 also provides a verbose discussion on hypotheses testing and the relationship of the findings. Although the study focused on the relationship between deviating from agile principles and overall projects success, I also did correlation and regression analysis to test relationships between the agile principles and each of the four dimensions of project success so the results could be triangulated with existing research. The results of the triangulation are discussed in Section 3. Finally, the next section provides details about how the information learned from this study can be applied to practice, as well as my reflections.

Section 3: Application to Professional Practice and Implications for Change

The third and final section of this paper brings closure to the study by presenting the findings and practical use of the information learned by conducting the research. This section begins with an overview of the study followed by the presentation of the findings. A description of the survey participants, a description of the data that was collected on the independent and dependent variables, and the results for each of the study's hypotheses are included in the presentation of the findings. Furthermore, this section discusses how the findings connect with other research on the topic and conveys how the findings are applicable to professional practice. Section 3 ends with recommendations for further study and reflections from me as the researcher of this study.

Overview of the Study

This quantitative correlation study examines if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. Using a derivative of Chow and Cao's (2008) survey instrument, ordinal data was collected using a secure online survey platform. Data collected from IT professionals and project managers employed at North Carolina higher education institutions was used to test 15 hypotheses that correspond with the three primary research questions and 12 sub-questions. The first research question is, how do organizations improve software development project success rates by adhering to agile principles? The second question is, to what extent does adhering to the 12 agile principles help organizations improve software development project success rates, and the third question is, what is the relationship between deviating from the use of the 12 agile principles and the success of a software development project? The twelve sub-questions correspond with each of the twelve agile principles from Beck et al. (2001). These sub-questions ask, what is the relationship between deviating from each agile principle and the success of a software development project? Using correlation analysis and regression analysis, this study examined if there is a statistically significant relationship between deviating from the agile principles and project success at the 95% confidence level. The findings are presented below.

Presentation of the Findings

This study sought to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. Using the online survey instrument described in Section 2: The Project, data was collected between June 26, 2023, and October 15, 2023. The initial email campaign invited 940 people from the sampling frame to participate in the study, but the invitation received a very low response rate. After two weeks, 12 people had clicked the embedded survey link, five surveys were started, and two surveys were completed. An individual from the sampling frame informed the researcher that the email inviting them to participate in the research had been identified as spam and was routed to their junk email folder. In response, the researcher scheduled future email campaigns to be sent in smaller batches and removed the hyperlink for the survey URL, prompting participants to copy and paste the link in their preferred web browser. Subsequent email campaigns generated more survey responses, but more responses were needed to generalize the results. Following the study’s design, additional contacts were randomly selected from the sampling frame. In total, 1,872 people from the sampling frame were invited to complete the online survey. Three hundred ninety-nine surveys were started, but 48 were incomplete and not submitted by the participants. The remaining 351 surveys were completed and submitted and were used to test the hypotheses

(*N* = 351). Figure 13 in Section 2 shows where 350 responses were needed to generalize the study's results to the population. The next section describes the process used to compute the independent and dependent variables in SPSS, using the data collected from the survey, and descriptions of the data from the sample.

Computing the Independent and Dependent Variables Using SPSS

SPSS version 29.0.1 for Windows operating systems was used to compute new variables for independent variables 1-12 (IV1 – IV12) and dependent variable 5 (DV5). These variables were created by calculating the mean of the response data from the group of corresponding survey questions shown in Table 4 on page 114. For example, Table 4 shows that IV1 was calculated by computing the mean of questions 26 and 41, and IV2 was calculated by computing the mean of questions 17, 27, and 28. Similarly, DV5 was calculated by computing the mean of questions 46, 47, 48, and 49. Table 4 shows the questions that contributed to the computed mean of each variable.

Prior to computing the independent variables, the survey data was imputed to account for responses of "Not Applicable/Do Not Know" to prevent the assigned numeric value (8) from skewing the calculated means. Responses of 'not applicable' or 'do not know' can be treated like missing values, and if a variable's nonresponses rate is less than 5%, the risk of distorting the estimates is minimal if a mean or similar statistic is utilized in its place (Fowler, 2009). Table 5 and Table 6 show the frequency and relative frequency for responses of "Not Applicable/Do Not Know" for questions 13-46, which were used to compute the independent variables. Relative frequencies range from 0% to 3.13%. Since all are less than 5%, the series mean was used in place of these responses. Alternatively, missing values can be omitted from research or replaced using a variety of imputation strategies such as those mentioned in Wu et al. (2015); however, utilizing the mean of these responses assumes that the response aligns with other responses. No responses were omitted, to ensure that enough responses were included to be able to generalize the results to the population. A description of the process followed to impute the "Not Applicable/Do Not Know" responses to the series mean is explained below.

Table 5

Frequency Distribution for Not App./Do Not Know Responses in Questions 13-33

	N	Frequency	Relative Frequency
Q13	351	1	0.28%
Q14	351	4	1.14%
Q15	351	0	0.00%
Q16	351	1	0.28%
Q17	351	0	0.00%
Q18	351	4	1.14%
Q19	351	1	0.28%
Q20	351	3	0.85%
Q21	351	0	0.00%
Q22	351	0	0.00%
Q23	351	0	0.00%
Q24	351	0	0.00%
Q25	351	0	0.00%
Q26	351	1	0.28%
Q27	351	0	0.00%
Q28	351	0	0.00%
Q29	351	1	0.28%
Q30	351	0	0.00%
Q31	351	0	0.00%
Q32	351	0	0.00%
Q33	351	3	0.85%

Table 6

Frequency Distribution for Not App./Do Not Know Responses in Questions 34-46

	N	Frequency	Relative Frequency
Q34	351	3	0.85%
Q35	351	11	3.13%
Q36	351	11	3.13%
Q37	351	4	1.14%
Q38	351	0	0.00%
Q39	351	1	0.28%
Q40	351	10	2.85%
Q41	351	2	0.57%
Q42	351	1	0.28%
Q43	351	2	0.57%
Q44	351	0	0.00%
Q45	351	2	0.57%

The "Not Applicable/Do Not Know" values for Q13-Q45 were transformed using SPSS by selecting Transform > Recode into Different Variable from the menu. This replaced the original value, 8, with the new value of system-missing. Next, the series mean was added in SPSS by selecting Transform > Replace Missing Values from the menu and choosing the series mean method for each question. The results of the transformed variables were compared with the original frequencies to ensure only "Not Applicable/Do Not Know" values were altered.

After replacing the values of "Not Applicable/Do Not Know" for Q13-Q45, the independent variables were computed using SPSS. This is acceptable because composite scores can be created from ordinal data if the scale of the values representing the ordinal data has meaning (Boone & Boone, 2012; Joshi et al., 2015). Table 4 on page 114 shows the questions that were used to compute the mean composite score for each independent variable (IV1 – IV12).

Dependent variables 1 through 4 (DV1 – DV4) came directly from survey questions 46-49, which captured ordinal data on the four components of project success. The fifth dependent variable (DV5) was created using SPSS by computing the mean composite score of questions 46-49. These questions also utilized a Likert scale where the values representing the ordinal data had meaning, so it is acceptable to create a new composite variable (DV5) from the mean (Boone & Boone, 2012; Joshi et al., 2015).

Descriptive Statistics of Sample Institutions

This section uses descriptive statistics to describe the survey participants and the data collected on the independent and dependent variables. The sample consists of data collected anonymously on 351 projects ($N = 351$). Table 7 shows that survey participants predominantly represent public institutions (relative frequency 86%) opposed to privately funded institutions (relative frequency 14%). This aligns with the breakdown calculated from Appendix A: North Carolina Degree-Granting, Not-for-Profit, Public or Privately Funded Higher Education Institutions and Appendix B: IT Professional and IT Project Manager Count by Qualifying Institution which conveys that 90% of the sampling frame is employed by institutions under public control and 10% is employed by private not-for-profit institutions.

Table 7

Control of Institution

	Count	%
Private	48	14%
Public	303	86%

Table 8 shows the frequency and relative frequency for the sectors represented in the sample. Table 8 conveys that 2% (relative frequency) of respondents are from 2-Year institutions and 98% are from 4-Year (relative frequency 39%), 4-Year and Above (relative frequency 4%), and Above (relative frequency 55%) institution sectors. Using data from Appendix A: North Carolina Degree-Granting, Not-for-Profit, Public or Privately Funded Higher Education Institutions and Appendix B: IT Professional and IT Project Manager Count by Qualifying Institution, 86% of the sampling frame is from 4-year or above institutions and 14% is from 2-year institutions. The relative frequency of 2-year institutions (2%) is lower than the percentage of eligible contacts from the sampling frame (14%) which conveys a skewness towards 4-Year or Above institutions in the sample.

Table 8

Sector of Institution

	Count	%
2-Year	6	2%
4-Year	136	39%
4-Year and Above	15	4%
Above	194	55%

Table 9 and Table 10 show the frequency and relative frequency for the self-reported employment size and student body size of the sample. Questions 6 and 7 on the survey instrument asked the participant to specify the college or university employment size and the college or university student body size, respectively. Using SPSS, data submitted on the college's or university's employment size was grouped into ranges of 500 and data submitted on the college's or university's student body size was grouped into ranges of 5,000. The sample is most representative of institutions with an employment size ranging between 3,501–4,000 (relative frequency 24%) and a student body size ranging from 25,001–30,000 (relative frequency 40%).

Table 9

College or University Employment Size

	Count	%
0-500	54	15%
501-1,000	10	3%
1,001-1,500	5	1%
1,501-2,000	21	6%
2,001-2,500	16	5%
2,501-3000	2	1%
3,001-3,500	3	1%
3,501-4,000	84	24%
4,001-4,500	30	9%
4,501-5,000	4	1%
5,001-5,500	33	9%
5,501-6,000	62	18%
6,000+	27	8%

Table 10

College or University Student Body Size

	Count	%
0-5,000	52	15%
5,001-10,000	20	6%
10,001-15,000	22	6%
15,001-20,000	86	25%
20,001-25,000	8	2%
25,001-30,000	139	40%
30,000+	24	7%

Descriptive Statistics of Sample Agile Projects

Randomly selected individuals from the sampling frame were invited to participate in the study by completing the online survey. Participants who consented and agreed to complete the online survey (*N* = 351) were asked to choose one agile project, either successful or failed, to base their survey responses on. Question 2 asked the participant to identify the agile method used for the selected project. Table 11 shows the frequency and relative frequency of the agile methods from the sample. The predominant agile methods that surfaced from the sample are hybrid (59%) and Scrum (34%). Note that I associated two survey responses of Waterfall and Scrum, one survey response of Waterfall and Agile, and one survey response of Scrum/Hybrid with the "Hybrid" frequency and relative frequency shown in Table 11, since the hybrid method is a combination of both agile and traditional methods (Cram, 2019). Additionally, one survey response of Agile, one response of Waterfall, and two responses of Do Not Know are combined under the "Do Not Know / Other" frequency and relative frequency in Table 11. The hybrid method having the highest relative frequency contradicts earlier studies that concluded XP and Scrum were the most common methods (Chow & Cao, 2008; Brown, 2015; Stanberry, 2018); however, it is possible that project teams from the sample adopted practices from both Extreme Programming and Scrum since Scrum and XP are two methods that organizations frequently combine to form a hybrid method (Neelu & Kavitha, 2021).

Table 11

Agile Method Used

	Count	%
Adaptive Project Framework	3	1%
Extreme Programming	5	1%
Hybrid	206	59%
Lean	2	1%
Paired Programming	11	3%
Scrum	120	34%
Do Not Know / Other	4	1%

Table **12** and Table 13 how the frequency and relative frequency for the size of the project team (number of project team members) and the length of the project (in months) respectively. SPSS was used to group results in ranges incrementing by 5 for the size of project teams and group results in ranges incrementing by 3 for the project duration.

Table 12 shows that most projects from the sample contained 0–5 team members (49%) or 6–10 team members (30%). This is higher than other studies that reported team sizes of less than 10 at 59% (Chow & Cao, 2008) and 23% (Stanberry, 2018). Similarly, samples from other studies report that only 28% (Chow & Cao, 2008) and 13% (Stanberry, 2018) of projects are completed within six months, whereas Table 13 shows that 77% of projects are completed within six months. The sample shows a skewness towards smaller project teams and smaller project durations. These traits are ideal for agile projects since small agile-led projects have the highest success rates (Standish Group, 2020).

Table 12

Size of the Project Team

	Count	%
0-5	171	49%
6-10	106	30%
11-15	32	9%
16-20	16	5%
21-25	5	1%
26-30	5	1%
31+	16	5%

Table 13

Length of the Project (months)

	Count	%
0-3	177	50%
4-6	94	27%
7-9	30	9%
10-12	22	6%
13+	28	8%

Table 14 and Table 15 are the final two tables used to describe the participants from the sample. Table 14 conveys that most participants have less than or equal to 5 years of experience with agile projects (70%) and have worked on no more than 10 agile projects (77%). The survey did not capture the participants' years of experience as an IT professional or IT project manager, so it is unknown if the practice of utilizing agile methods to manage IT projects is a newer practice for experienced IT professionals and IT project managers in North Carolina higher education institutions representing the sampling frame or if the participants simply have less years of experience as IT professionals and IT project managers.

Table 14

Years of Agile Experience

	Count	%
0	35	10%
1	64	18%
2	36	10%
3	35	10%
4	19	5%
5	58	17%
6	14	4%
7	12	3%
8	19	5%
9	7	2%
10+	52	15%

Table 15

Number of Agile Projects

	Count	%
0-5	183	52%
6-10	89	25%
11-15	43	12%
16-20	16	5%
21-25	7	2%
26+	13	4%

Descriptive Statistics of Variables

In addition to describing and summarizing data about the survey participants, descriptive statistics are used to describe the measure of central tendency and dispersion of the independent and dependent variables. Two common methods used to describe the central tendency measurements of ordinal data are median and mode (Marshall & Jonker, 2010). When ordinal data is ranked, the mean can also be useful in describing the central tendency (Boone & Boone, 2012; Morgan et al., 2019), but if the data is skewed and not normally distributed, the median is a better representative of the central tendency (Laerd Statistics, 2023a). Since this study leveraged ordinal data for the variables, the median and mode were used to describe the central tendency of the data. Table 16 shows the central tendency of the independent and dependent variables. The mean and skewness are also shown in Table 16 because the scale of the ordinal data used for the variables had meaning, but several variables display negative skewness which makes the median a better fit for the central location of the data (Laerd Statistics, 2023a).

Table 16

Central Tendency of Variables

	N	Median	Mode	Mean	Skewness	Kurtosis
IV1	351	6.00	6.00	5.92	-1.24	1.88
IV2	351	5.33	5.67	5.25	-0.49	0.19
IV3	351	6.00	6.00	5.28	-0.98	0.48
IV4	351	5.50	6.00	5.27	-0.67	0.25
IV5	351	5.33	5.33	5.29	-0.04	0.07
IV6	351	5.00	5.67	5.13	-0.15	-0.01
IV7	351	5.00	6.00	5.23	-0.74	-0.14
IV8	351	5.50	6.00	5.38	-0.47	-0.45
IV9	351	5.33	5.67	5.32	-0.62	0.49
IV10	351	5.50	5.50	5.27	-0.62	0.00

	N	Median	Mode	Mean	Skewness	Kurtosis
IV11	351	6.00	6.00	5.68	-1.40	3.00
IV12	351	4.21	5.00	4.21	-0.03	-0.97
DV1	351	6.00	6.00	6.01	-2.12	10.57
DV2	351	6.00	6.00	5.87	-2.06	7.02
DV3	351	6.00	6.00	5.43	-1.27	1.22
DV4	351	6.00	6.00	5.42	-1.27	1.37
DV5	351	6.00	6.00	5.68	-1.50	2.92

Dispersion is used to describe the variability of the data (Morgan et al., 2019). It is significant because it conveys how far the data diverges away from the central location of the data (Watson, 2015). Four common methods used to describe the measure of dispersion of data are maximum and minimum, range, frequency distribution, and relative frequency (Marshall & Jonker, 2010). Additionally, the standard deviation is a common measure that is useful (Morgan et al., 2019).

Table 17 displays the ranges, minimums, maximums, and standard deviations for the independent and dependent variables. The frequency distribution and relative frequency distribution for survey questions 13-45, which were used to compute independent variables IV1 – IV12, are shown in Appendix G: Frequency and Frequency Distribution of Survey Questions 13-45. Similarly, Appendix H: Frequency and Frequency Distribution of Survey Questions 46-49 shows the frequency and frequency distribution of survey questions 46-49, which align with dependent variables D1 – DV4.

Table 17

Dispersion of Variables

	N	Range	Min.	Max.	Standard Deviation
IV1	351	5.00	2.00	7.00	1.88
IV2	351	5.33	1.67	7.00	0.19
IV3	351	6.00	1.00	7.00	0.48
IV4	351	5.00	2.00	7.00	0.25
IV5	351	3.11	3.67	6.78	0.07
IV6	351	5.00	2.00	7.00	-0.01
IV7	351	5.00	2.00	7.00	-0.14
IV8	351	4.50	2.50	7.00	-0.45
IV9	351	5.33	1.67	7.00	0.49
IV10	351	4.50	2.50	7.00	0.00
IV11	351	5.00	2.00	7.00	3.00
IV12	351	5.00	2.00	7.00	-0.97
DV1	351	6.00	1.00	7.00	10.57
DV2	351	5.00	2.00	7.00	7.02
DV3	351	6.00	1.00	7.00	1.22
DV4	351	6.00	1.00	7.00	1.37
DV5	351	5.00	2.00	7.00	2.92

Hypotheses Testing

Using data collected on the independent and dependent variables described above, this section communicates the results of the statistical test that was performed to test the current study's hypotheses. This study was designed to use Pearson's correlation analysis to test the null hypotheses; however, Pearson's correlation analysis is only suitable if five assumptions are true (Laerd Statistics, 2023a):

- Your variables should be measured on a continuous scale

- Your continuous variables should be paired, which means that each case has two values: one for each variable
- There needs to be a linear relationship between the two variables
- There should be no significant outliers
- If you wish to run inferential statistics, you also need to satisfy the assumption of bivariate normality

Table 4 on page 114 conveys that all variables are measured on a continuous scale, which satisfies assumption #1. Table 16 shows the central tendency of the data and confirms that all 351 survey responses are included in the independent and dependent variable. Similarly, Appendix G: Frequency and Frequency Distribution of Survey Questions 13-45 and Appendix H: Frequency and Frequency Distribution of Survey Questions 46-49 include the total number for the frequency of Q13-45 and Q46-49 respectively. This information combined satisfies assumption #2. Assumption #3 requires a linear relationship to exist between the variables. Scatterplots can be used to visually display the correlation between variables and check for a linear relationship (Morgan et al., 2019). Appendix I: Scatterplots for Independent and Dependent Variables shows the scatterplots for relationships between the independent and dependent variables. These scatterplots include the linear and quadratic fit lines as well as the R-squared value for each line, and reveal that there is not a linear relationship between many of the independent variables and the dependent variable. Table 18 shows the R-squared values for the linear fit lines and the quadratic fit lines for each correlation between DV5 and IV1 – IV12. When the value of Pearson's r is smaller than ± 0.10, there is no linear relationship between the variables (Morgan et al., 2019). Table 18 shows that the absolute value of Pearson's r is less than 0.10 for independent variables IV1, IV2, IV3, IV8, IV9, and IV12. This indicates that these variables do not have a linear relationship with the dependent variable, DV5. To confirm, the quadratic regression line was also added to the scatterplots in Appendix I: Scatterplots for Independent and Dependent Variables to test if the quadratic regression line is a better fit than a linear regression line. Table 18 shows that the R-squared values are larger in the quadratic regression lines for all independent variables except IV7, where they are equal, so the quadratic regression lines are a better fit for the relationships between DV5 and IV1-IV12. Since there is not a linear relationship between the dependent variable and all 12 independent variables, the third assumption required to use Pearson's correlation analysis has been violated; therefore, it cannot be used.

Table 18

R-Squared Value for DV5 and IV1-IV12

	Linear Fit Line		Quadratic Fit Line	
	R^2	r	R^2	r
IV1	0.005	0.070	0.006	0.077
IV2	0.004	-0.059	0.007	0.084
IV3	0.002	0.044	0.003	0.054
IV4	0.016	0.126	0.021	0.145
IV5	0.017	0.130	0.026	0.161
IV6	0.013	0.115	0.014	0.118
IV7	0.011	0.103	0.011	0.105
IV8	0.000	0.014	0.000	0.016
IV9	0.007	0.086	0.009	0.095
IV10	0.043	0.208	0.070	0.265
IV11	0.052	0.228	0.090	0.300
IV12	0.000	-0.016	0.001	0.024

Since a non-linear relationship exists between many of the study's independent and dependent variables, Pearson's correlation analysis cannot be used to identify the association between variables. An alternate statistical test that can be used to measure the strength and direction of the relationship is Spearman's rank-order correlation (Laerd Statistics, 2023b). Spearman's rank-order correlation coefficient can be used when an increase in the independent variable has a consistent change in the dependent variable (increase or decrease), but the rate in which the dependent variable changes can vary (Sedgwick, 2014). Also known as Spearman's rho, this alternate method can be used for both normal and nonnormal distributed data, can identify linear or nonlinear correlations, and is less sensitive to outliers (Zhang & Wang, 2023). To use Spearman's rank-order correlation to measure the strength and direction of a relationship between variables, data must adhere to three assumptions: the variables are measured on a continuous or ordinal scale; the variables represent paired observations; and there is a monotonic relationship between the variables (Laerd Statistics, 2023b). The data for the current study satisfies all three requirements; therefore, Spearman's rank-order correlation is an acceptable statistical test to measure the strength and direction of the relationship between independent and dependent variables. Table 19 contains the Spearman's rho correlations between the IV1 – IV12 and DV5. These correlations convey the strength and direction of the relationships between project success and adhering to the 12 agile principles and were used to test the null hypotheses below.

Table 19

Spearman's rho for DV5 and IV1 – IV12

		DV5	
	N	Correlation Coefficient	Sig. (2-tailed)
IV1	351	0.071	0.183
IV2	351	– 0.059	0.271
IV3	351	0.098	0.067
IV4	351	0.072	0.176
IV5	351	0.156	0.003
IV6	351	0.130	0.015
IV7	351	0.102	0.057
IV8	351	0.063	0.238
IV9	351	0.029	0.588
IV10	351	0.244	< 0.001
IV11	351	0.300	< 0.001
IV12	351	– 0.037	0.495

Hypotheses H1o and H1a. The first hypothesis in the current study is directly related to the first research question (RQ1). Using independent variables IV1 – IV12 and dependent variable DV5, the hypothesis aimed to investigate if organizations can improve software development project success rates by adhering to agile principles. To determine if there was a statistically significant association between adhering to agile principles and project success, SPSS was used to calculate the Spearman's rank-order coefficient (r_s) between each independent variable (IV1 – IV12) and the dependent variable (DV5). A small, positive relationship exists between DV5 and IV5 ($r_s\,(349) = 0.156$, $p = 0.003$), IV6 ($r_s\,(349) = 0.130$, $p = 0.015$) and IV10 ($r_s\,(349) = 0.244$, $p < 0.001$), and a medium, positive relationship exists between DV5 and IV11 ($r_s\,(349) = 0.300$, $p < 0.001$). This means that there is a correlation between an agile software development project being successful (DV5) and how closely the project team adheres to the agile principles for management commitment (IV5), face-to-face collaboration (IV6), simplicity (IV10), and team environment (IV11). The Spearman's rho statistic also shows a small, positive relationship exists between DV5 and IV3 (r_s (349) = 0.098, p = 0.067) and DV5 and IV7 (r_s (349) = 0.102, p = 0.057), but neither of these relationships are statistically significant at p = .05 (two-tailed). This means that there is a greater than 5% chance that the strength of the relationship between project success (DV5) and the independent variables for delivering working software frequently (IV3) and measuring progress through working software (IV7) occurred by chance. However, since there is a statistically significant relationship between project success (DV5) and the agile principles for management commitment (IV5), face-to-face collaboration (IV6), simplicity (IV10), and team environment (IV11), the null hypothesis, H1o: Organizations cannot improve software development project success rates by adhering to agile principles, can be rejected.

When the null hypothesis is rejected, the study is designed to then use regression analysis to determine the strength of the relationship, and ultimately inform if the alternative hypothesis can be accepted. Multiple regression was conducted to investigate the best prediction of project success (DV5) for agile software development projects based on the four agile principles—management commitment (IV5), face-to-face collaboration (IV6), simplicity (IV10), and team environment (IV11). Only the four independent variables that were previously identified as having a statistically significant association with project success using the Spearman's rank-order coefficient statistical test were included in the multiple regression model. Using SPSS to regress the dependent variable on the independent variables the author confirmed there was independence of residuals, as assessed by a Durbin-Watson statistic of 1.686. The Durbin-

Watson test is used to detect possible autocorrelation between survey responses, and a value close to 2.0 indicates that there is no correlation between residuals (Laerd Statistics, 2023b). Linearity was checked using scatterplots of DV5 against each IV and a scatterplot of the studentized residual against the unstandardized predicted values. Appendix J: SPSS Output for Multiple Regression Analysis contains the scatterplots created with SPSS for these relationships. Table 18 was also referenced to confirm that the Pearson's r value for the relationship between DV5 and IV5, IV6, IV10, and IV11 exceeded ±0.10 to ensure some linear relationship existed between the variables. The Pearson's r values were 0.130, 0.114, 0.207, and 0.228 respectively which indicates there is a small linear relationship between the variables.

After linearity was confirmed visually, homoscedasticity was assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values, and multicollinearity was checked using the Correlations table and Coefficients table created by SPSS. No correlations are above 0.70 so there is not a significant correlation between independent variables (Laerd Statistics, 2023b). The highest correlation is between IV6 and IV10 with a value of 0.39, but all other correlations between independent variables are below 0.01. Additionally, the Tolerance and VIF from the SPSS Coefficients table can be used to check for collinearity. A Tolerance value of greater than 0.1 and a VIF of less than 10 indicates that a study may not have a collinearity problem (Laerd Statistics, 2023b). The Tolerance values for the independent variables range from 0.86 – 0.95 and the VIF ranges from 1.05 – 1.16 for the independent variables, which means there likely is not a collinearity problem. Appendix J: SPSS Output for Multiple Regression Analysis shows the Correlations and Coefficients for the variables.

Next, an investigation for significant outliers, high leverage points, or high influential points was conducted. Five responses (cases 269, 306, 332, 333, 339) had standardized residual values of -3.603, -4.441, -4.132, -3.575, and -3.145, respectively, and were investigated as possible candidate outliers since the values exceeded three standard deviations from the mean (Laerd Statistics, 2023b). To assess the influence that these points had on the regression analysis, Cook's Distances (Cook's D) value was used. SPSS created the Cook's D value (COO_1) when the multiple regression analysis was run and the generated values sorted in both descending and ascending order, as shown in Appendix J: SPSS Output for Multiple Regression Analysis. Cook's D values above 1 should be investigated further, but the calculated values for the current study range between 0.00 – 0.09, indicating that no cases should be considered highly influential (Laerd Statistics, 2023b). To further evaluate the leverage and/or influence these cases have on the study, I checked for leverage points. These leverage values were also generated by SPSS and are shown in in Appendix J: SPSS Output for Multiple Regression Analysis. When leverage values are less than 0.2, they can be considered safe (Laerd Statistics, 2023b). The leverage values for the current study range between 0.00 – 0.07; therefore, all leverage values can be considered safe. The results of the investigations indicated that the five cases that were identified as potential outliers due to their standardized residual being greater than ±3 standard deviations were not highly influential and were therefore not removed from the regression analysis.

The final test was to confirm that the residuals are approximately normally distributed. Normality was confirmed by visual inspection of a histogram and P-P Plots. Shown in Appendix J: SPSS Output for Multiple Regression Analysis, the histogram shows a mostly normal distribution. Although there is a slight negative skewness, the mean (-9.46E-16) is approximately zero and the standard deviation (0.994) is approximately 1.0, which supports that the data is normally distributed (Laerd Statistics, 2023b). The P-P Plot was also used to assist with testing if the residuals are normally distributed. Appendix J: SPSS Output for Multiple Regression Analysis shows the points on the P-P Plot follow closely with the line which supports that the assumption of normality has not been violated.

The combination of variables to predict project success from the agile principles for management commitment, face-to-face collaboration, simplicity, and team environment was statistically significant, $F(4, 346) = 8.532$, $p < 0.001$. The coefficients for the regression analysis are presented in **Table 20**, and the SPSS output is shown in Appendix J: SPSS Output for Multiple Regression Analysis. The agile principles for simplicity (IV10) and team environment (IV11) significantly predict project success when all four variables are included in the model. The adjusted R^2 value was .079 which indicates that 7.9% of the variance in project success was explained by the model. This is between a smaller-than-typical to medium effect (Cohen, 1988). As a result, since adhering to the agile principles for simplicity and team environment had a small, positive effect on project success, the alternative hypothesis was accepted that organizations can improve software development project success rates by adhering to agile principles.

Table 20

Regression Analysis for DV5 and IV5, IV6, IV10, IV11

	Unstandardized Coefficients		Standardized Coefficient			Collinearity Statistics
	B	*SE*	β	*t*	*p*	Tolerance
Constant	3.099	0.505		6.135	< 0.001*	
IV5	0.094	0.083	0.063	1.141	0.254	0.873
IV6	0.047	0.048	0.053	0.965	0.335	0.862
IV10	0.156	0.049	0.167	3.166	0.002*	0.949
IV11	0.180	0.054	0.179	3.343	< 0.001*	0.920

Note: $F(4,346) = 8.532$, $p < 0.001$, adj. $R^2 = 0.079$. Dependent variable: DV5
* Independent variable has $p < 0.05$. Constant, IV10, and IV11 are significant.

Hypotheses H2o and H2a. The second hypothesis in the current study is directly related to the second research question (RQ2), and it aimed to investigate the extent that adhering to the 12 agile principles helps organizations improve software development project success rates. To test the null hypothesis, SPSS was used to calculate the Spearman's rho statistic, which shows the associations between each independent variable (IV1 – IV12) and the dependent variable (DV5). The Spearman's rho for each association is shown in Table 19 on page 156. A small, positive relationship exists between DV5 and IV5 ($r_s(349) = 0.156$, $p = 0.003$), IV6 ($r_s(349) = 0.130$, $p = 0.015$), and IV10 ($r_s(349) = 0.244$, $p < 0.001$), and a medium, positive relationship exists between DV5 and IV11 ($r_s(349) = 0.300$, $p < 0.001$). This means that there is a relationship between how closely the project team adheres to the agile principles for management commitment (IV5), face-to-face collaboration (IV6), simplicity (IV10), and team environment (IV11) and the overall success (DV5) of the agile software development project. Since the relationship exists between the dependent variable and 4 of the 12 independent variables, the null hypothesis, H2o, can be rejected.

The multiple regression analysis used to test the first hypothesis (H1) is also applicable to testing the second hypothesis (H2). This regression analysis conveyed a small to medium relationship exists between project success and adhering to the agile principles for simplicity and team environment, $F(4, 346) = 8.532$, $p < 0.001$, when the variables for management commitment, face-to-face collaboration, simplicity, and team environment are included. The statistically significant relationship between project success (DV5) and simplicity (IV10) and team environment (IV11) results in accepting the alternative hypothesis, H2a. There is a relationship between adhering to two of the 12 agile principles and the success of agile software development projects, but the remaining 10 agile principles have no statistically significant relationship with project success.

Hypotheses H3o and H3a. The third hypothesis in the current study is directly related to the third research question (RQ3), and it investigates if there is a correlation between deviating from the 12 agile principles and project success for software development projects. To test the null hypothesis, SPSS was used to calculate the Spearman's rho statistic, which shows the correlations between each independent variable (IV1 – IV12) and the dependent variable (DV5). The Spearman's rho for each association is shown in Table 19 on page 156. Previously mentioned, a small, positive association exists between DV5 and IV5 ($r_s(349) = 0.156$, $p = 0.003$), DV5 and IV6 ($r_s(349) = 0.130$, $p = 0.015$), and DV5 and IV10 ($r_s(349) = 0.244$, $p < 0.001$), and a medium, positive relationship exists between DV5 and IV11 ($r_s(349) = 0.300$, $p < 0.001$). The positive monotonic relationship between DV5 and independent variables IV5, IV6, IV10, and IV11 means that project teams who adhere more closely to the agile principles for management commitment (IV5), face-to-face collaboration (IV6), simplicity (IV10), and team environment (IV11) are more likely to experience project success (DV5) for agile software development projects. Conversely, the association shows that the more project teams deviated from these independent variables (IV5, IV6, IV10, IV11), the less successful the agile project was. Since the calculated Spearman's rho values indicate positive monotonic associations exist between the dependent variable and four of the 12 independent variables, the null hypothesis, H3o, can be rejected.

The multiple regression analysis used to test the first hypothesis (H1) is also applicable to testing the second hypothesis (H3). This regression analysis conveyed a smaller-than-typical relationship existed between project success and adhering to the agile principles for simplicity and team environment, $F(4, 346) = 8.532$, $p < 0.001$, when the variables for management commitment, face-to-face collaboration, simplicity, and team environment are included. The variables that were statistically significant had a positive monotonic relationship with project success, which means as project teams more closely adhere to these agile principles, they typically experience increased project success (Morgan et al., 2019). Conversely, as teams deviate away from the principles for simplicity and team environment, they typically have decreased project success. Therefore, the alternative hypothesis, H3a, can be accepted as there is a relationship between deviating from two of the 12 agile principles and the success of an agile software development project.

Hypotheses H4o and H4a. The fourth hypothesis in the current study is directly related to the first sub-question for research question three (RQ3a). This hypothesis investigates if there is a correlation between deviating from the first agile principle, satisfying the customer through early and continuous delivery of valuable software (IV1), and project success for software development projects (DV5). Previously mentioned, the scatterplot for the relationship between IV1 and DV5 – see Appendix I: Scatterplots for Independent and Dependent Variables – does not reflect that a linear relationship between exists the variables; therefore, Pearson's correlation analysis could not be used to test the association. Instead, Spearman's rank order statistic was calculated, $r_s(349) = 0.071$, $p = 0.183$. The direction of the correlation is positive, which means that the more closely project team members adhered to the corresponding agile principle, the more likely the project was to be successful; however, the Spearman's rho value is less than 0.10. Since the absolute value of the rho is less than 0.10, there is not a meaningful correlation between the variables (Morgan et al., 2019). Furthermore, the p-value exceeds 0.05, which indicates that the statistical probability of the relationship that was calculated using the Spearman's rho correlation statistic occurred by chance more than 5% of the time. The results align with some studies, but existing research does not agree on the significance this agile principle has on project success. Several studies concluded that there is no association (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013), but more recent research found that customer involvement does have a significant association with project success (Shakya & Shakya, 2020; Tam et al., 2020; Yousef, 2022). To triangulate the results with existing literature, the current study also performed correlation analysis and multiple regression analysis on the 12 agile principles and each of the four dimensions of overall project success: quality, scope, timeliness, and cost. The outcomes of the statistical tests are shown in the section below titled "Relationship of Findings." These results contradict existing research by conveying that a statistically significant association exists between the first principle and the quality dimension of project success ($r_s(349) = 0.143$, $p = 0.007$) but does not exist with any of the other dimensions. Since the results of the current study conclude that no meaningful correlation exists between IV1 and DV5 that is statistically relevant, the null hypothesis cannot be rejected, and the researcher cannot accept the alternative hypothesis. The null hypothesis, H4o: there is no relationship between deviating from the agile principle early and continuous delivery of software and the success of an agile software development project, is accepted.

Hypotheses H5o and H5a. The fifth hypothesis in the current study is directly related to the second sub-question for research question three (RQ3b). This hypothesis investigated if there is a correlation between deviating from the second agile principle, welcoming changing requirements throughout the project (IV2), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_s(349) = –0.059$, $p = 0.271$. The direction of the correlation is negative, which means that the more closely project team members adhered to the corresponding agile principle, the less likely the project was to be successful; however, the Spearman's rho value is less than 0.10. Since the absolute value of the rho is less than 0.10, there is not a meaningful correlation between the variables (Morgan et al., 2019). Furthermore, the p-value exceeds 0.05, which indicates that the statistical probability of the relationship that was calculated using the Spearman's rho correlation statistic occurred by chance more than 5% of the time. The results are congruent with Yousef (2022), which suggests that allowing changes even late into the project could negatively affect the overall success of the project. Since no meaningful correlation exists between IV2 and DV5 that is statistically relevant, the null hypothesis cannot be rejected and the researcher cannot accept the alternative hypothesis. The null hypothesis, H5o: there is no relationship between deviating from the agile principle welcoming requirement changes at any point in the development process and the success of an agile software development project, is accepted.

Hypotheses H6o and H6a. The sixth hypothesis in the current study is directly related to the third sub-question for research question three (RQ3c). This hypothesis investigated if there is a correlation between deviating from the third agile principle, delivering working software frequently (IV3), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_s(349) = 0.098$, $p = 0.067$. The direction of the correlation is positive, and the rho value is approximately 0.10 which means there is a smaller than typical relationship between the variables (Morgan et al., 2019). This weak association reflects that the more closely project team members adhered to the corresponding agile principle, the more likely the project was to be successful; however, the p-value exceeds 0.05, which indicates that the statistical probability of the relationship that was calculated using the Spearman's rho correlation statistic occurred by chance more than 5% of the time. These results of this study align with some research (Aldahmash, 2018; Stankovic et al., 2013), but differ from other studies (Brown, 2015; Chow & Cao, 2008; Misra et al., 2009; Stanberry, 2018). Another study concluded that delivery strategy had a moderately strong association with success on one project, but a moderately weak or very weak association with three others (Tsoy & Staples, 2021). When investigating the impact the third principle has on each dimension of project success, the current study found that there is a statistically significant association with the timeliness dimension (r_s (349) = 0.146, $p = 0.006$), but it was not significant at determining the outcome. Since no meaningful correlation that is statistically relevant exists between IV3 and DV5, the null hypothesis cannot be rejected and the researcher cannot accept the alternative hypothesis. The null hypothesis, H6o: there is no relationship between deviating from the agile principle delivering working software frequently and the success of an agile software development project, is accepted.

Hypotheses H7o and H7a. The seventh hypothesis in the current study is directly related to the fourth sub-question for research question three (RQ3d). This hypothesis investigated if there is a correlation between deviating from the fourth agile principle, frequent collaboration between the project team members (IV4), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_s(349) = 0.072$, $p = 0.176$. The direction of the correlation is positive, which means that the more closely project team members adhered to the corresponding agile principle, the more likely the project was to be successful; however, the Spearman's rho value is less than 0.10. Since the absolute value of the rho is less than 0.10, there is not a meaningful correlation between the variables (Morgan et al., 2019). Furthermore, the p-value exceeds 0.05, which indicates that the statistical probability of the relationship that was calculated using the Spearman's rho correlation statistic occurred by chance more than 5% of the time. These results align with several other studies on the topic (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013), but conflict with more current research on the topic (Shakya & Shakya, 2020; Tam et al., 2020; Yousef, 2022). However, the current study concluded that the fourth agile principle does have a statistically significant association with the quality dimension of project success ($r_s\,(349) = 0.221$, $p < 0.001$). There was no substantial association with any other dimension of project success—scope, timeliness, cost—or overall project success. Since no meaningful correlation that is statistically relevant exists between IV4 and DV5, the null hypothesis cannot be rejected and the researcher cannot accept the alternative hypothesis. The null hypothesis, H7o: there is no relationship between deviating from the agile principle daily collaboration between the requestor and software developers and the success of an agile software development project, is accepted.

Hypotheses H8o and H8a. The eighth hypothesis in the current study is directly related to the fifth sub-question for research question three (RQ3e). This hypothesis investigated if there is a correlation between deviating from the fifth agile principle, management commitment (IV5), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_s(349) = 0.156$, $p = 0.003$. The rho value exceeds 0.10, which indicates there is a small association between IV5 and DV5. Since the rho value is positive, the relationship is a positive monotonic relationship which means that the more closely the project team members adhered to management commitment the more likely the project was to be successful. To validate the association is statistically meaningful, the p-value is reviewed. A p-value less than 0.05 reflects that there is less than a 5% chance that the associations between the independent and dependent variable occurred by chance (Laerd Statistics, 2023b). The p-value for the Spearman's rho statistic for IV5 and DV5 is 0.003, which conveys that the association between the variables is statistically meaningful. The null hypothesis, H8o, can be rejected and the alternative hypothesis, H8a: there is a relationship between deviating from the agile principle supporting and entrusting the project team to get the job done and the success of an agile software development project, can be accepted.

When the null hypothesis is rejected, the study is designed to use regression analysis to test the strength of the relationship between deviating from the agile principle supporting and entrusting the project team to get the job done, i.e., management commitment (IV5), and the success of an agile software development project (DV5). Correlation analysis, like Spearman's and Pearson, indicates there is an association between variables, but does not indicate that there is a causation relationship (Morgan et al., 2019). Regression analysis indicates how well one variable can predict another (Morgan et al., 2019). Simple regression was run using SPSS to investigate how well management commitment predicts project success. There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.696. Linearity was checked using a scatterplot and verified using Pearson's r value. The Pearson's r value is 0.130 which indicates there is a small linear relationship between face-to-face collaboration and project success (Cohen, 1988). The scatterplot and Model Summary that were generated using SPSS are included in Appendix K: SPSS Output for H8a Regression Analysis. Outliers were checked by visual observation of the scatterplot and through Casewise Diagnostics. The Casewise Diagnostics table, shown in Appendix K: SPSS Output for H8a Regression Analysis, indicates that six responses (cases 269, 276, 306, 332, 333, 339) have a standardized residual value of -3.195, -3.384, -4.297, -4.150, -3.693, -3.236, respectively. These cases were investigated as possible candidates for outliers since the values exceeded three standard deviations from the mean (Laerd Statistics, 2023b). To compare the results, the variables were also regressed without the six potential outliers. When these cases were excluded, the Pearson's r value decreased from 0.130 to 0.129—indicating there is slightly less of a correlation between the variables—and the predictor is slightly less significant, $F(1,343) = 5.843$, $p = 0.016$. The decision was made to not exclude these potential outliers from the regression analysis.

Homoscedasticity was assessed by visual inspection of a plot of the standardized residuals versus the standardized predicted values, and normality was confirmed by visual inspection of a histogram and P-P Plots. These diagrams are shown in Appendix K: SPSS Output for H8a Regression Analysis. The results of the regression analysis were statistically significant, $F(1, 349) = 6.031$, $p = 0.015$. The equation to calculate project success = .196 * (management commitment) + 4.645. The R^2 value is 0.017 which means that 1.7% of the variance in project success was explained by management commitment. This is a smaller than typical effect (Cohen, 1988). The coefficients for the regression analysis are shown in Table 21.

Table 21

Regression Analysis for DV5 and IV5

	Unstandardized Coefficients		Standardized Coefficient		
	B	*SE*	β	*t*	*p*
Constant	4.645	0.424		10.942	< 0.001*
IV5	0.196	0.080	0.130	2.456	0.015*

Note: $F(1,349) = 6.031$, $p = 0.015$, adj. $R^2 = 0.017$. Dependent variable: DV5
* Independent variable has $p < 0.05$. Constant and IV5 are significant.

Hypotheses H9o and H9a. The ninth hypothesis in the current study is directly related to the sixth sub-question for research question three (RQ3f). This hypothesis investigated if there is a correlation between deviating from the sixth agile principle, face-to-face collaboration (IV6), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_s(349) = 0.130$, $p = 0.015$. The rho value exceeds 0.10, which indicates there is a small association between IV6 and DV5. Since the rho value is positive, the relationship is a positive monotonic relationship, which means that the more closely the project team members adhered to face-to-face collaboration, the more likely the project was to be successful. To validate the association is statistically meaningful, the p-value is reviewed. A p-value less than 0.05 reflects that less than the associations between the independent and dependent variable occurred by chance (Laerd Statistics, 2023b). The p-value for the Spearman's rho statistic for IV6 and DV5 is 0.015, which conveys that the association between the variables is statistically meaningful. The null hypothesis, H9o, can be rejected and the alternative hypothesis, H9a: there is a relationship between deviating from the agile principle face-to-face collaboration and the success of an agile software development project, can be accepted.

The Spearman's correlation statistic demonstrates an association between the agile variable for face-to-face communication and project success, but regression analysis is needed to investigate if there is a causation relationship between the two variables (Morgan et al., 2019). After rejecting the null hypothesis, simple regression analysis was run using SPSS to investigate how well face-to-face collaboration predicts project success. There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.698. Linearity was checked using a scatterplot and verified using Pearson's r value. The Pearson's r value is 0.115, which indicates there is a smaller-than-typical linear relationship between face-to-face collaboration and project success (Cohen, 1988). The scatterplot and Model Summary that were generated using SPSS are included in Appendix L: SPSS Output for H9a Regression Analysis. Outliers were checked by visual observation of the scatterplot and through Casewise Diagnostics. The Casewise Diagnostics table, shown in Appendix L: SPSS Output for H9a Regression Analysis, indicates that six responses (cases 269, 276, 306, 332, 333, 339) have a standardized residual value of -3.337, -3.254, -4.655, -4.263, -3.563, -3.152 respectively. These cases were investigated as possible candidates for outliers since the values exceeded three standard deviations from the mean (Laerd Statistics, 2023b). To compare the results, the variables were also regressed without the six potential outliers. When these cases were excluded, the Pearson's r value increased from 0.115 to 0.153—indicating there is slightly more of a correlation between the variables—and the predictor is slightly more significant, $F(1,343) = 8.244$, $p = 0.004$. When the results of removing outliers are not statistically significant versus when the responses are included, the researchers may choose to keep the responses in the analysis (Laerd Statistics, 2023b). The decision was made to not exclude these potential outliers from the regression analysis since the results were not significantly different and it would reduce the number of responses below what is needed to generalize the results to the population. Homoscedasticity was assessed by visual inspection of a plot of the standardized residuals versus the standardized predicted values, and normality was confirmed by visual inspection of a histogram and P-P Plots. These diagrams are shown in Appendix L: SPSS Output for H9a Regression Analysis. The results of the regression analysis were statistically significant, $F(1, 349) = 4.687$, $p = 0.031$. The equation to calculate project success = .101 * (face-to-face collaboration) + 5.165. The R^2 value is 0.013 which means that 1.3% of the variance in project success was explained by face-to-face collaboration. This is less than a smaller than typical effect (Cohen, 1988). The coefficients for the regression analysis are shown in Table 22.

Table 22

Regression Analysis for DV5 and IV6

	Unstandardized Coefficients		Standardized Coefficient		
	B	*SE*	β	*t*	*p*
Constant	5.165	0.243		21.286	< 0.001*
IV6	0.101	0.047	0.115	2.165	0.031*

Note: $F(1,349) = 4.687$, $p = 0.031$, adj. $R^2 = 0.013$. Dependent variable: DV6
* Independent variable has $p < 0.05$. Constant and IV6 are significant.

Hypotheses H10o and H10a. The tenth hypothesis in the current study is directly related to the seventh sub-question for research question three (RQ3g). This hypothesis investigated if there is a correlation between deviating from the seventh agile principle, measuring progress through working software (IV7), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_s(349) = 0.102$, $p = 0.057$. The direction of the correlation is positive, and the rho value is approximately 0.10, which means there is a small association between the variables (Morgan et al., 2019). This small association reflects that the more closely project team members adhered to the corresponding agile principle, the more likely the project was to be successful; however, the p-value exceeds 0.05, which indicates that the statistical probability of the relationship that was calculated using the Spearman's rho correlation statistic occurred by chance more than 5% of the time. These results align with Aldahmash (2018), which relates delivery strategy to both the third and seventh agile principle and concluded that the CSF was insignificant in determining project success; however, the current study concluded that the seventh agile principle does have a statistically significant association with the cost dimension of project success (r_s (349) = 0.222, $p < 0.001$). There was no substantial association with any other dimension of project success: quality, scope, or timeliness. Since no meaningful correlation that is statistically relevant exists between IV7 and DV5, the null hypothesis cannot be rejected and the researcher cannot accept the alternative hypothesis. The null hypothesis, H10o: there is no relationship between deviating from the agile principle measuring progress through the delivery of working software and the success of an agile software development project, can be accepted.

Hypotheses H11o and H11a. The eleventh hypothesis in the current study is directly related to the eighth sub-question for research question three (RQ3h). This hypothesis investigated if there is a correlation between deviating from the eighth agile principle, promoting sustainable development so that the project team can maintain a constant pace (IV8), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_s(349) = 0.063$, $p = 0.238$. The direction of the correlation is positive, which means that the more closely project team members adhered to the corresponding agile principle, the more likely the project was to be successful; however, the Spearman's rho value is less than 0.10. Since the absolute value of the rho is less than 0.10, there is not a meaningful correlation between the variables (Morgan et al., 2019). Furthermore, the p-value exceeds 0.05, which indicates that the statistical probability of the relationship that was calculated using the Spearman's rho correlation statistic occurred by chance more than 5% of the time. Since no meaningful correlation that is statistically relevant exists between IV8 and DV5, the null hypothesis cannot be rejected and the researcher cannot accept the alternative hypothesis. The null hypothesis, H11o: there is no relationship between deviating from the agile principle maintaining a constant pace and the success of an agile software development project, can be accepted.

Hypotheses H12o and H12a. The twelfth hypothesis in the current study is directly related to the ninth sub-question for research question three (RQ3i). This hypothesis investigated if there is a correlation between deviating from the ninth agile principle, technical excellence and good design (IV9), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_S(349) = 0.029$, $p = 0.588$. The direction of the correlation is positive, which means that the more closely project team members adhered to the corresponding agile principle, the more likely the project was to be successful; however, the Spearman's rho value is less than 0.10. Since the absolute value of the rho is less than 0.10, there is not a meaningful correlation between the variables (Morgan et al., 2019). Furthermore, the p-value exceeds 0.05 which indicates that the statistical probability of the relationship that was calculated using the Spearman's rho correlation statistic occurred by chance more than 5% of the time. The results align with some studies (Brown, 2015; Stanberry, 2018; Stankovic et al., 2013), but differs from other research (Aldahmash, 2018; Chow & Cao, 2008;). More current research on agile software development success does not factor technical excellence (Shakya & Shakya, 2020), but this could be due to how organizations perceive technical excellence. One study identified technical excellence as a mindset that is underpinned by sustainable development, continuous learning, and teamwork (Alami et al, 2022). Each of these overlap with other agile principles. Since no meaningful correlation that is statistically relevant exists between IV9 and DV5, the null hypothesis cannot be rejected and the researcher cannot accept the alternative hypothesis. The null hypothesis, H12o: there is no relationship between deviating from the agile principle continuous attention to technical excellence and good design and the success of an agile software development project, is accepted.

Hypotheses H13o and H13a. The thirteenth hypothesis in the current study is directly related to the tenth sub-question for research question three (RQ3j). This hypothesis investigated if there is a correlation between deviating from the tenth agile principle, the art of simplicity (IV10), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_s(349) = 0.244$, $p < 0.001$. The rho value exceeds 0.10 but is less than 0.30, which indicates there is a smaller than typical association between IV10 and DV5. Since the rho value is positive, the relationship is a positive monotonic relationship, which means that the more closely the project team members adhered to keeping the project simple, the more likely the project was to be successful. To validate if the association is statistically meaningful, the p-value is reviewed. A p-value less than 0.05 reflects that less than the associations between the independent and dependent variable occurred by chance (Laerd Statistics, 2023b). The p-value for the Spearman's rho statistic for IV10 and DV5 is less than 0.001, which conveys that the association between the variables is statistically meaningful. The null hypothesis, H13o, can be rejected and the alternative hypothesis, H13a: there is a relationship between deviating from the agile principle simplicity and the success of an agile software development project, can be accepted.

After rejecting the null hypothesis, simple regression analysis was run using SPSS to investigate how well the agile principle for simplicity predicts project success. There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.713. Linearity was checked using a scatterplot and verified using Pearson's r value. The Pearson's r value is 0.208 which indicates there is a small linear relationship between simplicity and project success (Cohen, 1988). The scatterplot and Model Summary that were generated using SPSS are included in Appendix M: SPSS Output for H13a Regression Analysis. Outliers were checked by visual observation of the scatterplot and through Casewise Diagnostics. The Casewise Diagnostics table, shown in Appendix M: SPSS Output for H13a Regression Analysis, indicates that four responses (cases 269, 306, 332, 333) have a standardized residual value of -3.542, -4.429, -4.360, -3.855 respectively. These cases were investigated as possible candidates for outliers since the values exceeded three standard deviations from the mean (Laerd Statistics, 2023b). To compare the results, the variables were also regressed without the four potential outliers. When these cases were excluded, the Pearson's r value increased from 0.208 to 0.240—indicating there is slightly more of a correlation between the variables—and the predictor is slightly more significant, $F(1,345) = 21.015$, $p < 0.001$. When the results of removing outliers is not statistically significant from when the responses are included, the researchers may choose to keep the responses in the analysis (Laerd Statistics, 2023b). The decision was made to not exclude these potential outliers from the regression analysis since the results were not significantly different and it would reduce the number of responses below what is needed to generalize the results to the population. Homoscedasticity was assessed by visual inspection of a plot of the standardized residuals versus the standardized predicted values, and normality was confirmed by visual inspection of a histogram and P-P Plots. These diagrams are shown in

Appendix M: SPSS Output for H13a Regression Analysis. The results of the regression analysis were statistically significant, $F(1, 349) = 15.788$, $p < 0.001$. The equation to calculate project success = .195 * (simplicity) + 4.653. The R^2 value is 0.043 which means that 4.3% of the variance in project success was explained by the agile principle for simplicity. This is slightly more than a smaller than typical effect (Cohen, 1988). The coefficients for the regression analysis are shown in Table 23.

Table 23

Regression Analysis for DV5 and IV10

	Unstandardized Coefficients		Standardized Coefficient		
	B	*SE*	β	*t*	*p*
Constant	4.653	0.262		17.746	< 0.001*
IV10	0.195	0.049	0.208	3.973	< 0.001*

*Note: F(*1,349) = 15.788, $p < 0.001$, adj. $R^2 = 0.043$. Dependent variable: DV10
* Independent variable has $p < 0.05$. Constant and IV10 are significant.

Hypotheses H14o and H14a. The fourteenth hypothesis in the current study is directly related to the eleventh sub-question for research question three (RQ3k). This hypothesis investigated if there is a correlation between deviating from the eleventh agile principle, team environment (IV11), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_s(349) = 0.300$, $p < 0.001$. The rho value is 0.30, which indicates there is a medium or typical association between IV11 and DV5. Since the rho value is positive, the relationship is a positive monotonic relationship, which means that the more closely the project team members adhered to self-organizing teams, the more likely the project was to be successful. To validate the association is statistically meaningful, the p-value is reviewed. A p-value less than 0.05 reflects that less than the associations between the independent and dependent variable occurred by chance (Laerd Statistics, 2023b). The p-value for the Spearman's rho statistic for IV11 and DV5 is less than 0.001, which conveys that the association between the variables is statistically meaningful. The null hypothesis, H14o, can be rejected and the alternative hypothesis, H14a: there is a relationship between deviating from the agile principle self-organizing teams and the success of an agile software development project, is accepted.

The Spearman's correlation statistic demonstrates an association between the agile variable for team environment and project success, but regression analysis is needed to investigate if there is a causation relationship between the two variables (Morgan et al., 2019). After rejecting the null hypothesis, simple regression analysis was run using SPSS to investigate how well team environment predicts project success. There was independence of residuals, as assessed by a Durbin-Watson statistic of 1.649. Linearity was checked using a scatterplot and verified using Pearson's r value. The Pearson's r value is 0.228, which indicates there is a small linear association between team environment and project success (Cohen, 1988). The scatterplot and Model Summary that were generated using SPSS are included in Appendix N: SPSS Output for H14a Regression Analysis. Outliers were checked by visual observation of the scatterplot and through Casewise Diagnostics. The Casewise Diagnostics table, shown in Appendix N: SPSS Output for H14a Regression Analysis, indicates that five responses (cases 269, 276, 306, 332, 333) have a standardized residual value of -3.472, -3.255, -4.587, -3.983, -3.281, respectively. These cases were investigated as possible candidates for outliers since the values exceeded three standard deviations from the mean (Laerd Statistics, 2023b). To compare the results, the variables were also regressed without the five potential outliers. When these cases were excluded, the Pearson's r value decreased from 0. 228 to 0.213 – indicating there is slightly less of a correlation between the variables—and the predictor is slightly less significant, $F(1,344) = 16.385$, $p < 0.001$. When the results of removing outliers is not statistically significant from when the responses are included, the researchers may choose to keep the responses in the analysis (Laerd Statistics, 2023b). The decision was made to not exclude these potential outliers from the regression analysis since the results were not significantly different and it would reduce the number of responses below what is needed to generalize the results to the population.

Homoscedasticity was assessed by visual inspection of a plot of the standardized residuals versus the standardized predicted values, and normality was confirmed by visual inspection of a histogram and P-P Plots. These diagrams are shown in Appendix N: SPSS Output for H14a Regression Analysis. The results of the regression analysis were statistically significant, $F(1, 349) = 19.180$, $p < 0.001$. The equation to calculate project success = .229 * (team environment) + 4.378. The R^2 value is 0.052 which means that 5.2% of the variance in project success was explained by the agile principle for team environment. This is a smaller-than typical-effect (Cohen, 1988). The coefficients for the regression analysis are shown in Table 24.

Table 24

Regression Analysis for DV5 and IV11

	Unstandardized Coefficients		Standardized Coefficient		
	B	*SE*	β	*t*	*p*
Constant	4.378	0.301		14.567	< 0.001*
IV11	0.229	0.052	0.228	4.380	< 0.001*

Note: $F(1,349) = 19.180$, $p < 0.001$, adj. $R^2 = 0.052$. Dependent variable: DV11
* Independent variable has $p < 0.05$. Constant and IV11 are significant.

Hypotheses H15o and H15a. The fifteenth hypothesis in the current study is directly related to the twelfth sub-question for research question three (RQ3L). This hypothesis investigated if there is a correlation between deviating from the twelfth agile principle, reflection on how to become more effective and adjusting behavior accordingly (IV12), and project success for software development projects (DV5). To test the null hypothesis, Spearman's rho statistic was calculated, $r_s(349) = -0.037$, $p = 0.495$. The direction of the correlation is negative, which means that the more closely project team members adhered to the corresponding agile principle the less likely the project was to be successful; however, the Spearman's rho value is less than 0.10. Since the absolute value of the rho is less than 0.10, there is not a meaningful correlation between the variables (Morgan et al., 2019). Furthermore, the p-value exceeds 0.05, which indicates that the statistical probability of the relationship that was calculated using the Spearman's rho correlation statistic occurred by chance more than 5% of the time. The results align with existing research (Aldahmash, 2018; Misra et al., 2009). Another study reported that retrospectives, which align with the twelfth agile principle, were a crucial tool used by one project team to measure success (Tsoy & Staples, 2021); however, the current study concluded that reflection did not have a significant correlation with any dimension of project success. Since no meaningful correlation that is statistically relevant exists between IV12 and DV5, the null hypothesis cannot be rejected and the researcher cannot accept the alternative hypothesis. The null hypothesis, H15o: there is no relationship between deviating from the agile principle regular reflection adjusting behavior accordingly and the success of an agile software development project, is accepted.

Summary of the Hypotheses Testing. Using data collected from the online survey instrument described in Section 2, 15 hypotheses that correspond with the three primary research questions and 12 sub-questions were tested to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. The design originally called to utilize Pearson's correlation analysis to test the null hypotheses and explore if an association exists between the variables. After examining scatter plots of the data, however, I concluded that some of the independent variables lacked a linear relationship with the dependent variable. An alternate statistical test, Spearman's rank-order correlation, was therefore used to test the association. Spearman's rho is an alternative correlational test that can be used for both normal and nonnormal distributed data, can identify linear or nonlinear correlations, and is less sensitive to outliers (Zhang & Wang, 2023). The results of the analysis were to reject the null hypotheses and accept the alternative hypothesis for H1, H2, H3, H8, H9, H13, and H14. Next, regression analysis was used to further test the strength of the relationships between the independent variables and the dependent variable. The results of the hypotheses testing are shown below in Table 25. A check mark (✓) reflects which hypothesis was accepted, null hypothesis or alternative hypothesis, based on there being a significant relationship at the 95% level (p = 0.05).

Table 25

Summary of Hypotheses Findings

	Null Hypothesis	Alternative Hypothesis	Significance
H1		✓	$F(4, 346) = 8.532, p < 0.001$, $Adj.\ R^2 = 0.079$
H2		✓	$F(4, 346) = 8.532, p < 0.001$, $Adj.\ R^2 = 0.079$
H3		✓	$F(4, 346) = 8.532, p < 0.001$, $Adj.\ R^2 = 0.079$
H4	✓		
H5	✓		
H6	✓		

	Null Hypothesis	Alternative Hypothesis	Significance
H7	✓		
H8		✓	$F(1, 349) = 6.031$, $p = 0.015$,. $R^2 = 0.017$
H9		✓	$F(1, 349) = 4.687$, $p = 0.031$, $R^2 = 0.013$
H10	✓		
H11	✓		
H12	✓		
H13		✓	$F(1, 349) = 15.788$, $p < 0.001$, $R^2 = 0.043$
H14		✓	$F(1, 349) = 19.180$, $p < 0.001$, $R^2 = 0.052$
H15	✓		

Relationship of Findings

The purpose of this quantitative correlational study was to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. The study was guided by three primary research questions and 12 sub-questions. Quantitative data was collected using a derivative of the Chow and Cao (2008) survey, and data was analyzed using SPSS to test 15 hypotheses—one corresponding with each research question. The research questions guiding this study and their relationship to the findings are discussed below.

The first research question is, RQ1: How do organizations improve software development project success rates by adhering to agile principles? The null and alternative hypotheses related to this question are, H1o: Organizations can not improve software development project success rates by adhering to agile principles, and H1a: Organizations can improve software development project success rates by adhering to agile principles. The null hypothesis was rejected after Spearman's correlation analysis was computed on the 12 agile principles and project success. Shown in Table 19, four of the 12 agile principles have a positive correlation with project success that is statistically significant at the 95% confidence level. The four agile principles are management commitment (r_s (349) = 0.156, p = 0.003), face-to-face collaboration (r_s (349) = 0.130, p = 0.015) simplicity (r_s (349) = 0.244, p < 0.001), and team environment (r_s (349) = 0.300, p < 0.001). This signifies there is an association between these four agile principles and project success, but it does not indicate that there is a causation relationship (Morgan et al., 2019). To test the alternative hypothesis, project success was regressed on these four agile principles. These principles explain approximately 7.9% of the variance in project success for agile software development projects, $F(4, 346) = 8.532$, $p < 0.001$, adjusted $R^2 = 0.079$, which is between a small and medium effect (Cohen, 1988). This supports accepting the alternative hypothesis, H1a: organizations can improve software development project success rates by adhering to agile principles. The agile principles for simplicity, p = 0.002, and team environment, p < 0.001, significantly predict project success at a 95% confidence level when all four of the variables are included. The study's results for the tenth agile principle, simplicity—the art of maximizing the amount of work not done—is essential, aligning with Chow and Cao (2008) and Aldahmash (2018), but conflicting with other studies (Brown, 2015; Stanberry, 2018; Stankovic, et al., 2013). The results for the eleventh agile principle, the best architectures, requirements, and designs emerge from self-organizing teams, conflict with other research on the topic (Aldahmash, 2018; Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). In response to RQ1, the results of the regression show that organizations improve software development project success rates by adhering to agile principles for simplicity and team environment.

The second research question is, RQ2: To what extent does adhering to the 12 agile principles help organizations improve software development project success rates? The null and alternative hypotheses related to this question are, H2o: There is no relationship between adhering to the 12 agile principles and the success of agile software development projects, and H2a: There is a relationship between adhering to the 12 agile principles and the success of agile software development projects. The correlation analysis and regression analysis discussed with the first research question are also applicable to the second research question. The null hypothesis was rejected after Spearman's correlation analysis was computed on the 12 agile principles and project success. Table 19 shows that four of the 12 agile principles have a positive correlation with project success that is statistically significant at the 95% confidence level – management commitment (r_s (349) = 0.156, p = 0.003), face-to-face collaboration (r_s (349) = 0.130, p = 0.015) simplicity (r_s (349) = 0.244, p < 0.001), and team environment (r_s (349) = 0.300, p < 0.001). Next, project success was regressed on these four agile principles, and it was determined that they explain approximately 7.9% of the variance in project success for agile software development projects, $F(4, 346) = 8.532$, p < 0.001, adjusted $R^2 = 0.079$. This supports accepting the alternative hypothesis, H2a: there is a relationship between adhering to the 12 agile principles and the success of agile software development projects. The principles for simplicity, p = 0.002, and team environment, p < 0.001, significantly predict project success at a 95% confidence level when all four of the variables are included. Research does not agree on the relationship the agile principle for simplicity has with project success, but the results of this study align with Chow and Cao (2008) and Aldahmash (2018). The conclusion that team environment has a small effect on project success differs from related studies (Aldahmash, 2018; Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). In response to RQ2, the results of the regression show that adhering to the 12 agile principles has between a small and medium effect on helping organizations improve software development project success rates.

The third research question is, RQ3: What is the relationship between deviating from the use of the 12 agile principles and the success of a software development project? The null and alternative hypotheses related to this question are, H3o: There is no relationship between deviating from the 12 agile principles and the success of an agile software development project, and H3a: There is a relationship between deviating from the 12 agile principles and the success of an agile software development project. Similarly, the correlation analysis and regression analysis discussed with the first research question are also applicable to the third research question. The Spearman's rank-order correlation statistical test conveys four of the 12 agile principles have a statistically significant positive association with project success. This justified rejecting the null hypothesis. Regression analysis revealed that these four principles explain approximately 7.9% of the variance in project success for agile software development projects, $F(4, 346) = 8.532$, $p < 0.001$, adjusted $R^2 = 0.079$. This is between a small and medium effect (Cohen, 1988). This supports accepting the alternative hypothesis, H3a: there is a relationship between deviating from the 12 agile principles and the success of an agile software development project. The relationship between these findings and related studies is mentioned in the prior two research questions. Two principles, simplicity and team environment, were statistically significantly at predicting project success at a 95% confidence level. In response to RQ3, the positive, monotonic relationship between project success and these principles indicates that deviating away from the agile principles for simplicity and team environment has a small negative effect on project success. Furthermore, deviating from the other 10 agile principles has no statistically significant effect on project success.

The third research question also had 12 sub-questions—one questioning the relationship between each of the 12 agile principles and the success of an agile software development project. The first sub-question under research question three is, RQ3a: What is the relationship between deviating from early and continuous delivery of software and the success of a software development project? The null and alternative hypotheses related to this question are, H4o: There is no relationship between deviating from the agile principle early and continuous delivery of software and the success of an agile software development project, and H4a: There is a relationship between deviating from the agile principle early and continuous delivery of software and the success of an agile software development project. The null hypothesis could not be rejected and was therefore accepted after Spearman's correlation analysis was computed for the agile principle early and continuous delivery of software and project success, $r_s(349) = 0.071$, $p = 0.183$. Other studies investigating the relationship between CSFs and project success associated two CSFs—customer involvement and delivery strategy—with the first agile principle (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013; Tam et al., 2020). The results of the current study align partially with CSF research, indicating that the first agile principle (CSF: customer involvement) has no relationship with project success (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013); however, several of the CSF studies found that delivery strategy, the other CSFs associated with the first agile principle, does have a significant relationship with project success (Chow & Cao, 2008; Brown, 2015; Stanberry, 2018). Recent research on the topic disagreed and concluded that customer involvement, which authors associated with both the first and fourth agile principles, does have a statistically significant relationship with project success (Shakya & Shakya, 2020; Tam et al., 2020; Yousef, 2022). Since the statistical test in the current study supported no correlation between the first agile principle and project success, regression analysis was not performed. Therefore, in response to RQ3a, there is no relationship between deviating from early and continuous delivery of software and the success of a software development project.

The second sub-question under research question three is, RQ3b: What is the relationship between deviating from welcoming requirement changes at any point in the development process and the success of a software development project? The null and alternative hypotheses related to this question are, H5o: There is no relationship between deviating from the agile principle welcoming requirement changes at any point in the development process and the success of an agile software development project, and H5a: There is a relationship between deviating from the agile principle welcoming requirement changes at any point in the development process and the success of an agile software development project. The null hypothesis could not be rejected and was therefore accepted after Spearman's correlation analysis was computed for the agile principle welcoming requirement changes at any point in the development process and project success, $r_s(349) = -0.059$, $p = 0.271$. The results differ from Aldahmash (2018), which associated the success factor organizational culture, including embracing changes, with the second and twelfth agile principles. The difference could be due to Aldahmash measuring project success with a fifth component, addressing organizational needs, in addition to the four used in the current study (quality, scope, time, cost). Yousef (2022) did not specifically address welcoming changes throughout the project but did conclude that managing the scope was a statistically significant factor at determining the outcome of the project. This suggests that allowing changes even late into the project could negatively affect the overall success of the project. Since the statistical test in the current study supported no correlation exists between the second agile principle and project success, regression analysis was not performed. Therefore, in response to RQ3b, there is no relationship between deviating from welcoming requirement changes at any point in the development process and the success of a software development project.

The third sub-question under research question three is, RQ3c: What is the relationship between deviating from delivering working software frequently and the success of a software development project? The null and alternative hypotheses related to this question are, H6o: There is no relationship between deviating from the agile principle delivering working software frequently and the success of an agile software development project, and H6a: There is a relationship between deviating from the agile principle delivering working software frequently and the success of an agile software development project. The null hypothesis could not be rejected and was therefore accepted after Spearman's correlation analysis was computed for the agile principle delivering working software frequently and project success, $r_s(349) = 0.098$, $p = 0.067$. Research does not agree on the relationship between the third agile principle and project success. The results of this study align with some research (Aldahmash, 2018; Stankovic et al., 2013; Tsoy & Staples, 2021), but differ from other studies (Brown, 2015; Chow & Cao, 2008; Misra et al., 2009; Stanberry, 2018). One study investigating the impact on four projects found that delivery strategy—synonymous with the third agile principle—has a moderately strong association with success on one project, but a moderately weak or very weak association with three others (Tsoy & Staples, 2021). When investigating the impact the third principle has on each dimension of project success, the current study found that there is a statistically significant association with the timeliness dimension (r_s (349) = 0.146, $p = 0.006$), but it was not significant at determining the outcome. Since the statistical test in the current study supported no correlation existed between the third agile principle and project success, regression analysis was not performed. Therefore, in response to RQ3c, there is no relationship between deviating from delivering working software frequently and the success of a software development project.

The fourth sub-question under research question three is, RQ3d: What is the relationship between deviating from daily collaboration between the requestor and software developers and the success of a software development project? The null and alternative hypotheses related to this question are, H7o: There is no relationship between deviating from the agile principle daily collaboration between the requestor and software developers and the success of an agile software development project, and H7a: There is a relationship between deviating from the agile principle daily collaboration between the requestor and software developers and the success of an agile software development project. The null hypothesis could not be rejected and was therefore accepted after Spearman's correlation analysis was computed for the agile principle frequent collaboration between the project team members and project success, $r_s(349) = 0.072$, $p = 0.176$. These results align with several other studies on the topic (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013), but conflict with more current research on the topic (Shakya & Shakya, 2020; Tam et al., 2020; Yousef, 2022). However, the current study concluded that the fourth agile principle does have a statistically significant association with the quality dimension of project success (r_s $(349) = 0.221$, $p < 0.001$). There was no substantial association with any other dimension of project success—quality, scope, timeliness—or overall project success. Since the statistical test in the current study supported no correlation exists between the fourth agile principle and project success, regression analysis was not performed.

Therefore, in response to RQ3d, there is no relationship between frequent collaboration between the project team members and the success of a software development project.

The fifth sub-question under research question three is, RQ3e: What is the relationship between deviating from supporting and entrusting the project team to get the job done and the success of a software development project? The null and alternative hypotheses related to this question are, H8o: There is no relationship between deviating from the agile principle supporting and entrusting the project team to get the job done and the success of an agile software development project, and H8a: There is a relationship between deviating from the agile principle supporting and entrusting the project team to get the job done and the success of an agile software development project. The null hypothesis was rejected, and the alternative hypothesis accepted, after Spearman's correlation analysis was computed for the fifth agile principle and project success, $r_s(349) = 0.156$, $p= 0.003$. The correlation is positive and monotonic, meaning there is an association where the more closely a project team adheres to the agile principle, the more successful the project is. Next, regression analysis was done to investigate if deviating from the agile principle supporting and entrusting the project team to get the job done effect project success at the 95% confidence level. The statistical test indicated that the fifth agile principle can explain approximately 1.7% of the variance in project success for agile software development projects, $F(1, 349) = 6.031$, $p = 0.015$, $R^2 = 0.017$, which is a smaller-than-typical effect (Cohen, 1988). The results align with Chow and Cao (2008), which concluded team capability was significantly related to the timeliness and cost aspects of project success, and Misra et al. (2009) which reported the fifth agile principle, described as corporate culture, had a statistically significant association with project success. Similarly, Russo (2021) found evidence to support that top management commitment was the most decisive driving factor for agile transformation, and Meenakshi et al. (2020) reported that executive management support is the second most CSF. Other research associated both management commitment and team capabilities with the fifth agile principle but concluded that only management commitment was statistically significant at effecting project success (Brown, 2015). In response to RQ3e, the results of this study's regression analysis show that organizations can have a smaller-than-typical, positive effect on software development project success rates by adhering to the fifth agile principle, supporting and entrusting the project team to get the job done.

The sixth sub-question under research question three is, RQ3f: What is the relationship between deviating from face-to-face collaboration and the success of a software development project? The null and alternative hypotheses related to this question are, H9o: There is no relationship between deviating from the agile principle face-to-face collaboration and the success of an agile software development project, and H9a: There is a relationship between deviating from the agile principle face-to-face collaboration and the success of an agile software development project. The null hypothesis was rejected and the alternative hypothesis accepted after Spearman's correlation analysis was computed for the sixth agile principle, face-to-face collaboration, and project success, $r_s(349) = 0.130$, $p = 0.015$. The correlation is positive and monotonic, meaning there is an association where the more closely a project team adheres to the agile principle, the more successful the project is. Next, regression analysis was done to investigate if deviating from face-to-face collaboration during a project effects project success at the 95% confidence level. The statistical test indicated that the sixth agile principle can explain approximately 1.3% of the variance in project success for agile software development projects, $F(1, 349) = 4.687$, $p = 0.031$, $R^2 = 0.013$, which is a slightly less than a small effect (Cohen, 1988). Another study found that project management process, which they associate with the sixth agile principle, was significant on the quality aspect of project success but not scope, timeliness, or cost (Chow and Cao, 2008). Other research on the topic aligned with the current study and concluded that the sixth agile principle is statistically significant at determining project success (Aldahmash, 2018; Stanberry, 2018; Stankovic et al., 2013; Yousef, 2022). Participant feedback informed me as the researcher that face-to-face communication was interpreted differently amongst some of the participants. For example, one participant commented, “Communication channels have moved to an online presence. There is not a lot of face to face in software at the current moment unless it is over zoom/teams/etc.” Another said:

> The majority of the team was working remotely at this time so some of the questions about face-to-face communication and working in agile space were not 100% the same as pre-COVID. I answered as if online communication tools, for example Cisco WebEx and Microsoft Teams, were the same as if we were face-to-face.

Increased use of online communication tools has led to varying interpretations of face-to-face communication, which could have impacted the results of this study. Harker Martin and MacDonell (2012) concluded that teleworking has a positive effect on productivity and performance, which supports that online communication tools can be as effective as face-to-face communication. Future studies on this principle should clarify how online collaboration tools should apply to the sixth agile principle, the most efficient and effective method of conveying information to and within a development team is face-to-face conversation. In response to RQ3f, the results of this study’s regression analysis show that organizations can have a smaller-than-typical, positive effect on software development project success rates by adhering to the sixth agile principle, face-to-face collaboration.

The seventh sub-question under research question three is, RQ3g: What is the relationship between deviating from measuring progress through the delivery of working software and the success of a software development project? The null and alternative hypotheses related to this question are, H10o: There is no relationship between deviating from the agile principle measuring progress through the delivery of working software and the success of an agile software development project, and H10a: There is a relationship between deviating from the agile principle measuring progress through the delivery of working software and the success of an agile software development project. The null hypothesis could not be rejected and was therefore accepted after Spearman's correlation analysis was computed for the agile principle measuring progress through working software and project success, $r_s(349) = 0.102$, $p = 0.057$. These results align with Aldahmash (2018), which related delivery strategy to both the third and seventh agile principle and concluded that the CSF was insignificant in determining project success. Since the statistical test in the current study supported no correlation exists between the seventh agile principle and project success, regression analysis was not performed. Therefore, in response to RQ3g, there is no relationship between measuring progress through working software and the success of a software development project.

The eight sub-question under research question three is, RQ3h: What is the relationship between deviating from maintaining a constant pace and the success of a software development project? The null and alternative hypotheses related to this question are, H11o: There is no relationship between deviating from the agile principle maintaining a constant pace and the success of an agile software development project, and H11a: There is a relationship between deviating from the agile principle maintaining a constant pace and the success of an agile software development project. The null hypothesis could not be rejected and was therefore accepted after Spearman's correlation analysis was computed for the agile principle promoting sustainable development so that the project team can maintain a constant pace and project success, $r_s(349) = 0.063$, $p= 0.238$. The results align with Brown (2015) and Chow and Cao (2008) but differ from Stanberry (2018) and Stankovic et al. (2013). More current research on agile software development success did not factor technical excellence (Shakya & Shakya, 2020), but this could be due to how organizations perceive technical excellence. One study identified technical excellence as a mindset that is underpinned by sustainable development, continuous learning, and teamwork. Each of these overlaps other with other agile principles. Since the statistical test in the current study supported no correlation between the eighth agile principle and project success, regression analysis was not performed. Therefore, in response to RQ3h, there is no relationship between promoting sustainable development so that the project team can maintain a constant pace and the success of a software development project.

The ninth sub-question under research question three is, RQ3i: What is the relationship between deviating from continuous attention to technical excellence and good design and the success of a software development project? The null and alternative hypotheses related to this question are, H12o: There is no relationship between deviating from the agile principle continuous attention to technical excellence and good design and the success of an agile software development project, and H12a: There is a relationship between deviating from the agile principle continuous attention to technical excellence and good design and the success of an agile software development project. The null hypothesis could not be rejected and was therefore accepted after Spearman's correlation analysis was computed for the agile principle technical excellence and good design and project success, $r_s(349) = 0.029$, $p = 0.588$. The results align with Brown (2015), Stanberry (2018) and Stankovic et al. (2013), but differ from Aldahmash

(2018) and Chow & Cao (2008). Since the statistical test in the current study supported no correlation exists between the ninth agile principle and project success, regression analysis was not performed. Therefore, in response to RQ3i, there is no relationship between technical excellence and good design and the success of a software development project.

The tenth sub-question under research question three is, RQ3j: What is the relationship between deviating from simplicity and the success of a software development project? The null and alternative hypotheses related to this question are, H13o: There is no relationship between deviating from the agile principle simplicity and the success of an agile software development project, and H13a: There is a relationship between deviating from the agile principle simplicity and the success of an agile software development project. The null hypothesis was rejected and the alternative hypothesis accepted after Spearman's correlation analysis was computed for the tenth agile principle, simplicity, and project success, $r_s(349) = 0.244$, $p < 0.001$. The correlation is positive and monotonic, meaning there is an association where projects are reportedly more successful when a project team more closely adheres to the agile principle for simplicity. Next, regression analysis was done to investigate if deviating from simplicity during a project effects project success at the 95% confidence level. The statistical test indicated that the tenth agile principle can explain approximately 4.3% of the variance in project success for agile software development projects, $F(1, 349) = 15.788$, $p < 0.001$, $R^2 = 0.043$, which is a between a small and medium effect (Cohen, 1988). Similar to many of the agile principles, research does not agree on the significance simplicity has on effecting project success. The results of the study align with Aldahmash (2018) and Chow and Cao (2008), but differ from Brown (2015) and Stanberry (2018). In response to RQ3j, the results of this study's regression analysis show that organizations can have a small positive effect on software development project success rates by adhering to the tenth agile principle, simplicity—the art of maximizing the amount of work not done—is essential.

The eleventh sub-question under research question three is, RQ3k: What is the relationship between deviating from self-organizing teams and the success of a software development project? The null and alternative hypotheses related to this question are, H14o: There is no relationship between deviating from the agile principle self-organizing teams and the success of an agile software development project, and H14a: There is a relationship between deviating from the agile principle self-organizing teams and the success of an agile software development project. The null hypothesis was rejected and the alternative hypothesis accepted after Spearman's correlation analysis was computed for the eleventh agile principle, self-organizing teams, and project success, $r_s(349) = 0.300$, $p < 0.001$. The correlation is positive and monotonic, meaning there is an association where projects are reportedly more successful when a project team more closely adheres to the agile principle for self-organizing teams. Next, regression analysis was done to investigate if deviating from self-organizing teams during a project effects project success at the 95% confidence level. The statistical test indicated that the eleventh agile principle can explain approximately 5.2% of the variance in project success for agile software development projects, $F(1, 349) = 19.180$, $p < 0.001$, $R^2 = 0.052$, which is between a small and medium effect (Cohen, 1988). The results differ from most research on the topic (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013), but align with other more recent studies which concluded there is a statistically significant association between the agile principle and the timeliness and cost dimensions of project success (Yousef, 2022). Similarly, Chow and Cao (2008) reported that team environment affects the quality aspect of project only. The results supported Ahimbisibwe et al.'s (2015) theory that a project's team composition is a CSF. In response to RQ3k, the results of this study's regression analysis show that organizations can have a small effect on software development project success rates by adhering to the eleventh agile principle: the best architectures, requirements, and designs emerge from self-organizing teams.

The twelfth sub-question under research question three is, RQ3L: What is the relationship between deviating from regular reflection adjusting behavior accordingly and the success of a software development project? The null and alternative hypotheses related to this question are, H15o: There is no relationship between deviating from the agile principle regular reflection adjusting behavior accordingly and the success of an agile software development project, and H15a: There is a relationship between deviating from the agile principle regular reflection adjusting behavior accordingly and the success of an agile software development project. The null hypothesis could not be rejected and was therefore accepted after Spearman's correlation analysis was computed for the agile principle reflection on how to become more effective and adjusting behavior accordingly and project success, $r_s(349) = -0.037$, $p = 0.495$. The results align with existing research (Aldahmash, 2018; Misra et al., 2009). Another study reported that retrospectives, which align with the twelfth agile principle, were a crucial tool used by one project team to measure success (Tsoy & Staples, 2021); however, the current study concluded that reflection did not have a significant correlation with any dimension of project success. Since the statistical test in the current study supported no correlation exists between the twelfth agile principle and project success, regression analysis was not performed. Therefore, in response to RQ3L, there is no relationship between reflection on how to become more effective and adjusting behavior accordingly and the success of a software development project.

To cross-reference the results of the current study with existing literature on the topic, correlation analysis and multiple regression analysis were also completed on the 12 agile principles and the four dimensions of overall project success: quality, scope, timeliness, and cost. The results of the Spearman's correlation analysis and multiple regression analysis for quality (DV1), scope (DV2), timeliness (DV3), and cost (DV4) are summarized in Table 26 below and the SPSS output is shown in Appendix O: SPSS Output for Correlation and Regression Analysis of Project Quality, Appendix P: SPSS Output for Correlation and Regression Analysis of Project Scope, Appendix Q: SPSS Output for Correlation and Regression Analysis of Project Timeliness, and Appendix R: SPSS Output for Correlation and Regression Analysis of Project Cost respectively. Six agile principles had a statistically significant correlation with the quality dimension of project success—satisfaction via continuous delivery (r_s (349) = 0.143, $p = 0.007$), frequent collaboration (r_s (349) = 0.221, $p < 0.001$), management commitment (r_s (349) = 0.196, $p < 0.001$), face-to-face collaboration (r_s (349) = 0.119, $p = 0.026$), technical excellence (r_s (349) = 0.125, $p = 0.019$), team environment (r_s (349) = 0.200, $p < 0.001$)—but only frequent collaboration ($p = 0.003$), management commitment ($p = 0.019$), and team environment ($p = 0.008$) significantly predicted the quality dimension of project success at a 95% confidence level when the six variables were present. These principles explain approximately 8.3% of the variance for the quality dimension of project success ($F(6, 344) = 6.307$, $p < 0.001$, adj. $R^2 = 0.083$).

Only two agile principles had a statistically significant correlation with the scope dimension of project success—simplicity (r_s (349) = 0.182, $p < 0.001$) and team environment (r_s (349) = 0.168, $p = 0.002$)—but only simplicity ($p = 0.011$) significantly predicted the scope dimension of project success at a 95% confidence level when both variables were present. These principles explain approximately 2.5% of the variance for the scope dimension of project success ($F(2, 348) = 5.553$, $p = 0.004$, adj. $R^2 = 0.025$).

Three agile principles had a statistically significant correlation with the timeliness dimension of project success—deliver working software frequently ($r_s\,(349) = 0.146$, $p = 0.006$), simplicity ($r_s\,(349) = 0.197$, $p < 0.001$), team environment ($r_s\,(349) = 0.271$, $p < 0.001$)—but only simplicity ($p = 0.011$) and team environment ($p < 0.001$) significantly predicted the quality dimension of project success at a 95% confidence level when the three variables were present. These principles explain approximately 6.2% of the variance for the timeliness dimension of project success ($F(3, 347) = 8.713$, $p < 0.001$, adj. $R^2 = 0.062$).

Finally, five agile principles had a statistically significant correlation with the cost dimension of project success—management commitment ($r_s\,(349) = 0.147$, $p = 0.006$), face-to-face collaboration ($r_s\,(349) = 0.164$, $p = 0.002$), measure progress by work ($r_s\,(349) = 0.222$, $p < 0.001$), simplicity ($r_s\,(349) = 0.278$, $p < 0.001$), team environment ($r_s\,(349) = 0.248$, $p < 0.001$)—but only measuring progress by work ($p = 0.004$), simplicity ($p = 0.005$) and team environment ($p = 0.020$) significantly predicted the quality dimension of project success at a 95% confidence level when the five variables were present. These principles explain approximately 9.9% of the variance for the cost dimension of project success ($F(5, 345) = 8.701$, $p < 0.001$, adj. $R^2 = 0.099$).

Table 26

Spearman's rho for DV1 – DV5 and IV1 – IV12

	DV1 (Quality)		DV2 (Scope)		DV3 (Timeliness)		DV4 (Cost)		DV5 (Overall)	
	$r_s(351)$	p	$r_s(351)$	p	$r_s(351)$	p	$r_s(351)$	p	$r_s(351)$	p
IV1	0.143	0.007	0.097	0.070	0.054	0.313	0.003	0.954	0.071	0.183
IV2	- 0.004	0.939	- 0.052	0.328	- 0.072	0.175	- 0.023	0.665	- 0.059	0.271
IV3	0.084	0.116	0.055	0.308	0.146	0.006	- 0.014	0.790	0.098	0.067
IV4	0.221	<0.001	0.037	0.485	0.055	0.306	0.024	0.651	0.072	0.176
IV5	0.196	<0.001	0.047	0.382	0.085	0.112	0.147	0.006	0.156	0.003
IV6	0.119	0.026	0.087	0.104	0.094	0.077	0.164	0.002	0.130	0.015
IV7	- 0.012	0.828	0.006	0.904	0.012	0.825	0.222	<0.001	0.102	0.057
IV8	- 0.008	0.880	- 0.026	0.629	0.044	0.415	0.069	0.198	0.063	0.238
IV9	0.125	0.019	0.096	0.072	- 0.003	0.954	0.041	0.441	0.029	0.588
IV10	0.096	0.073	0.182	<0.001	0.197	<0.001	0.278	<0.001	0.244	<0.001
IV11	0.200	<0.001	0.168	0.002	0.271	<0.001	0.248	<0.001	0.300	<0.001
IV12	- 0.072	0.180	0.016	0.767	- 0.095	0.075	0.052	0.331	- 0.037	0.495

In Table 27 and Table 28 below, a check mark (✓) reflects that the strength of the relationship between the corresponding IV and DV is small and the relationship is statistically significant at the 95% level (p = .05).

Table 27

Summary of Spearman's rho for DV1 – DV5 and IV1 – IV12

	DV1 (Quality)	DV2 (Scope)	DV3 (Timeliness)	DV4 (Cost)	DV5 (Overall)
IV1: early and continuous delivery of software	✓				
IV2: welcoming requirement changes at any point in the development process					
IV3: delivering working software frequently			✓		
IV4: daily collaboration between the requestor and software developers	✓				
IV5: supporting and entrusting the project team to get the job done	✓			✓	✓
IV6: face-to-face collaboration	✓			✓	✓
IV7: measuring progress through the delivery of working software				✓	
IV8: maintaining a constant pace					
IV9: continuous attention to technical excellence and good design	✓				
IV10: simplicity		✓	✓	✓	✓
IV11: self-organizing teams	✓	✓	✓	✓	✓
IV12: regular reflection adjusting behavior accordingly					

Table 28

Multiple Regression Analysis Results for DV1 – DV5 and IV1 – IV12

	DV1 (Quality)	DV2 (Scope)	DV3 (Timeliness)	DV4 (Cost)	DV5 (Overall)
IV1: early and continuous delivery of software					
IV2: welcoming requirement changes at any point in the development process					
IV3: delivering working software frequently					
IV4: daily collaboration between the requestor and software developers	✓				
IV5: supporting and entrusting the project team to get the job done	✓				
IV6: face-to-face collaboration					
IV7: measuring progress through the delivery of working software				✓	
IV8: maintaining a constant pace					
IV9: continuous attention to technical excellence and good design					
IV10: simplicity		✓	✓	✓	✓
IV11: self-organizing teams	✓		✓	✓	✓
IV12: regular reflection adjusting behavior accordingly					

Summary of the Findings

This quantitative correlational study examined if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. Three primary research questions and 12 sub-questions guided the study, and correlation analysis was run using SPSS to investigate if an association exists between the agile principles and project success. The results concluded that with the full model, only four of the 12 agile principles had a statistically significant correlation. Next, regression analysis was run for the partial model, which only included project success and the four agile principles that had a statistically significant correlation with project success. The analysis concluded that two of these principles—simplicity and team environment—were statistically significant in determining project success. Finally, correlation analysis was run individually on each of the 12 agile principles and project success. Four variables—management commitment, face-to-face collaboration, simplicity, and team environment—were determined to have a significant correlation with project success. Regression analysis was run for these four models, and it was determined that they all have a small positive effect on project success. The research supports that project teams can have a small positive effect on project success when they adhere to the tenth and eleventh agile principle when all principles are represented.

Application to Professional Practice

The purpose of this quantitative correlational study is to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. Existing research on the topic does not agree on which CSFs or agile principles contribute to project success (Brown, 2015; Chow & Cao, 2008; Shakya & Shakya, 2020; Stanberry, 2018; Stankovic et al., 2013; Tam et al., 2020; Yousef, 2022). This research adds to the body of knowledge and offers insight into which agile principles influence the success of software development projects so IT leaders can proactively avoid deviating from principles that have a significant impact on project success. This section provides a detailed discussion on how the results of this study can improve general business practices and potential application strategies that higher education institutions can use to leverage the findings.

Improving General Business Practice

The general problem that was addressed by this study was the failure of organizations adhering to agile principles resulting in unsuccessful software development projects. Successful software implementations are vital for organizations (Arcos-Medina & Mauricio, 2020), yet many businesses struggle to successfully implement software development projects (Standish Group, 2020). The annual cost of unsuccessful software development projects was estimated to be $260 billion in both 2020 and 2022, but the total cost of poor software quality is estimated to have grown from $2.08 trillion to over $2.41 trillion during the same timespan (Consortium for Information & Software Quality, 2020, 2022). Research shows that agile projects are over three times more successful than waterfall projects (Standish Group, 2020). This has some businesses adopting agile practices to improve success rates and reduce financial waste, but institutions that blend both agile and traditional methods need to select the appropriate mix of agile principles with other approaches to be successful (Cram, 2019). This research adds to the body of knowledge and offers insight into which agile principles influence the success of software development projects so IT leaders can proactively avoid deviating from principles that have a significant impact on project success.

The responses to the three primary research questions and 12 sub-questions inform practitioners how organizations can improve general business practice and increase software development project success rates by adhering to agile principles. The results of the study indicate that four agile principles—management commitment, face-to-face collaboration, simplicity, and team environment—have a statistically significant correlation with project success. When these four agile principles are present, simplicity and team environment significantly predict project success. These variables have a positive monotonic relationship with project success, which means institutions can improve their probability of achieving overall project success by adhering to these principles. Conversely, the more institutions deviate away from simplicity and team environment, the more likely they are to not achieve overall project success. This is significant because it supports the foundation of the Agile Manifesto, which indicates that project teams should adhere to agile principles to improve their chance at project success (Beck et al., 2001).

The current study also performed statistical tests on the variables to investigate the relationship between the 12 agile principles and the four dimensions of project success: quality, scope, timeliness, and cost. Table 27 above shows which principles have a statistically significant relationship with each dimension of project success, and **Table 28** shows which of these principles were significant at predicting the outcome of the four dimensions of project success. This is significant because institutions have unique needs that can vary from project to project. For example, cost and timeliness may be more meaningful if a project has a firm deadline, whereas quality and scope may be more important if a project team does not have a strict deadline. The study's results improve general business practice by informing institutions which agile principles have a correlation with each dimension of project success, as well as the principles that are statistically significant at predicting a project's outcome. This research helps organizations striving for success in the dimensions that align with their unique needs by conveying which agile principles should be adhered to.

Potential Application Strategies

As higher education institutions brace to face an anticipated enrollment cliff, many are leveraging IT solutions to improve operational efficiencies and student services (Info-Tech Research Group, 2023). Many colleges and universities are challenged to increase their value to students while maintaining or reducing their cost of attendance (Pathak & Pathak, 2010). Additionally, a growing interest in online education, combined with budgetary constraints, has probed executive leadership to look at using technology and other new methods to respond to evolving demands (Peppard, 2010), but the demand to create a competitive advantage for the organization and provide an environment that prepares graduates for the workforce of today and tomorrow has university IT departments facing increased costs (Sliep & Marnewick, 2020). Some businesses have employed agile practices to improve IT project success rates and reduce financial waste. The specific problem to be addressed is the failure of organizations within the publicly and privately funded North Carolina higher education sector adhering to agile principles resulting in unsuccessful software development projects. The results of the current study can assist North Carolina higher education institutions in improving their overall project success rates, as well as the success rates for the project dimensions that align with their specific needs. The data indicates there is a positive association between a successful project outcome and the fifth, sixth, tenth, and eleventh agile principles. When these principles are present, they explain approximately 7.9% of the variance in project success for agile software development projects, which is a small to medium size effect (Cohen, 1988). Furthermore, adhering to the tenth and eleventh principles can significantly predict project success at the 95% confidence level.

The first step to project success aligns with the fifth agile principle and begins before a project is kicked off. The fifth principle calls for management commitment by building projects around motivated individuals, supporting them, and trusting them to get the job done (Beck et al., 2001). This principle has a positive association with overall project satisfaction ($r_s(349) = 0.156, p= 0.003$) and contributes to explaining approximately 8.3% of the variance for the quality dimension of project success ($F(6, 344) = 6.307, p < 0.001$, adj. $R^2 = 0.083$). This aligns with the finding that executive management support is a leading success factor (Meenakshi et al., 2020), and that good leadership and a committed and motivated team are CSFs (Bogopa & Marnewick, 2022). Similarly, Russo (2021) found evidence to support that top management commitment was the most decisive driving factor for agile transformation. Given adhering to the fifth principle has a positive association with overall project success and contributes to predicting the quality dimension of success, institutions should incorporate building projects around motivated individuals, supporting them, and trusting them to get the job done into their project practices.

The second practice higher education institutions can adopt to improve the outcome of software development projects is to adhere to the sixth agile principle. The sixth principle states that the most effective way to communicate with and within a development team is face-to-face (Beck et al, 2001). This principle had a positive correlation with overall project success ($r_s(349) = 0.130, p = 0.015$), and more specifically had a positive association with the quality ($r_s(349) = 0.119, p = 0.026$) and cost (($r_s(349) = 0.164, p = 0.002$) dimensions of project success. These findings align with other research on the topic, which found that the sixth agile principle is statistically significant at determining project success (Aldahmash, 2018; Stanberry, 2018; Stankovic et al., 2013; Yousef, 2022). Data did not indicate the sixth principle was a significant predictor of project success, but as researcher of this project, I acknowledge that participants interpreting the term face-to-face communication differently could have influenced the results. Participant comments conveyed that the use of online communication tools has led to varying interpretations of face-to-face communication. One participant noted that face-to-face does not occur often, whereas another indicated that they responded as if an online face-to-face communication was comparable to an in-person face-to-face meeting. Although the sixth principle expresses the need for face-to-face communication, the intent is to provide a channel for effective communication. Harker Martin and MacDonell (2012) supported that online communication tools can be as effective as face-to-face communication. Similarly, another study broke-down effective communication into four processes—teams having regular meetings to discuss progress, communication between team members needing to be clear and concise, team members being receptive to feedback, and regular communication with stakeholders (Yousef, 2022). After triangulating the results from the current study with other research on the topic, I suggest higher education institutions adhere to the sixth agile principle to improve the outcome of software development projects.

Next, higher education institutions should adhere to the tenth agile principle to increase their chance at overall project success. The tenth agile principle stresses simplicity and maximizing the amount of work not done on a project. It aligns with the Lean agile practice of developing a minimum viable product (MVP), which tasks development teams to deliver a product quickly by doing the minimum amount of work necessary to meet the user's needs (Agile Alliance, 2024). Kakar (2023) associated this principle with the lean practice of removing waste by eliminating any activity that does not add value to the product. Data supports that adhering to this principle has a positive effect on the project outcome ($F(1, 349) = 15.788$, $p < 0.001$, $R^2 = 0.043$), but participant comments suggest it is important for both the technical and functional users to have a clear understanding of the concept of simplicity. One participant's comments indicated that they utilized the MVP concept, but "[their] customers found the MVP did not include enough of their business processes for them to be successful." They went on to say, "The MVP concept was accepted at the project outset as a concept, but in practice, the customers didn't feel they could run their business on an MVP level of software." A vague understanding of how to implement a simple approach while still meeting business needs may contribute to the differing results amongst researchers. As the researcher of this study, I suggest higher education institutions incorporate the tenth agile principle into agile project practices and clearly communicate the intent of the MVP approach to technical and functional users to increase their chance at overall project success.

Finally, higher education institutions should adhere to the eleventh agile principle to improve their chance at overall project success. The eleventh agile principle emphasizes the importance of the team environment. The principle states, "The best architectures, requirements, and designs emerge from self-organizing teams" (Beck et al., 2001, para. 12). This principle had the strongest correlation ($r_s(349) = 0.300$, $p < 0.001$) with overall project success and was the most influential principle at predicting overall project success ($F(1, 349) = 19.180$, $p < 0.001$, $R^2 = 0.052$) at the 95% confidence level. Although research differs on this significance of this principle, the results aligned with recent research which concluded that there is a statistically significant association between the agile principle and the timeliness and cost dimensions of project success (Yousef, 2022). Based on data from the current study and current research on the topic, I recommend higher education institutions adhere to the eleventh agile principle to maximize their chance at overall project success.

Summary of Application to Professional Practice

The current study examined if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. This section outlined how the study's results can improve general business practices and provided potential application strategies for higher education institutions. The results conveyed that IT leaders in higher education institutions should adhere to management commitment, face-to-face collaboration, simplicity, and team environment to improve the probability of achieving overall project success. Furthermore, the study contributes to the existing body of knowledge on the topic by informing IT leaders how to improve their chance at being successful with specific dimensions of project success for instances when a project has unique needs.

Recommendations for Further Study

After comparing the results of the current study to existing research, I recommend two ideas for further study. First, the results of this study vary from similar studies that investigated the relationships between CSFs which are associated with agile principles and project success (Aldahmash, 2018; Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). The section titled "Relationship of Findings" above (page 183) highlights some of the differences between the studies for each agile principle. Along with the current study, Brown (2015), Stanberry (2018), and Stankovic et al. (2013) all used the Chow and Cao (2008) survey instrument, but the population being investigated differed for each study. Chow and Cao investigated members of the Agile Alliance and its user groups, and responses were received from 25 countries. Stankovic et al. (2013) targeted managers and senior developers from former Yugoslavia IT companies and collected responses from four different countries, and Brown (2015) collected responses from practitioners located in the United States who served professionally in various roles. Lastly, Stanberry (2018) targeted U.S.-based global companies by collecting data from members of the SCRUMstudy LinkedIn group page and the Scrum

Alliance Facebook page. The section titled “Related Studies” (page 72 above) discussed the commonalities between these studies and the current research, but the sampling frames differed between the studies, which may contribute to the variation in the results. Additional research investigating the variation between groups of respondents to determine if the difference between industry or nation explains any of the variance in the results across studies is recommended.

The second area I recommend for further study pertains to the agile methodology being used by study participants. The results of the current study skew towards the hybrid methodology, with 59% of the respondents selecting Hybrid as the methodology that was used for their selected project. Scrum was the next most common methodology used by respondents, representing 34% of the sampling frame, while the remaining five methods that were reported represent between 1% and 3% each. Similar research reported a significant difference in the methodologies that were reportedly used. Chow and Cao (2008) did not explicitly indicate the percentage of hybrid projects represented in their study’s results, but the relative frequency for the top three methods in their study are 53.2% for XP, 21.1% for Scrum, and 19.3% for Other. Stankovic et al. (2013) indicated that XP, Scrum, and Feature Driven Development were the most common methods used, while also acknowledging that some responses indicated a hybrid method was used. Similarly, Brown (2015) reported that XP, Feature Driven Development, and Scrum were the top methods used, respectively, but did not indicate any hybrid methods were reported by respondents. Stanberry (2018) was more equally distributed, with 51.5% of respondents using the Scrum method and 48.5% of respondents using a hybrid method. Some research cautions practitioners from deviating from agile principles (Cram, 2019; Siddique & Hussein, 2016) whereas other research suggests tailoring is acceptable if the business need warrants the change (Akbar, 2019; Xu & Ramesh, 2008). The current research examined if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions, but it did not consider the agile method employed. Additional research investigating the variation between the agile methods used to determine if the difference between agile methods employed explains any of the variance in the results across studies is recommended.

Reflections

Reflection is a practice that overlaps traditional and agile methodologies. Traditional project management practices include conducting lessons learned after major project milestones are complete or at the conclusion of the project (Project Management Institute, 2012). Similarly, the twelfth agile principle calls for team reflection on how to become more effective at regular intervals so team members can adjust behaviors as needed (Beck et al., 2001). Many agile methods such as Scrum include retrospectives which task project teams to reflect and identify ways to increase quality and effectiveness (Scrum, n.d.). This section reflects on the project and discusses how conducting this research has provided for personal and professional growth, and it includes a detailed discussion of how the business functions explored in this study relate to and integrate with a Christian worldview.

Personal & Professional Growth

In the Fall of 2020, the world was still learning how to live with COVID-19, many higher education institutions and public-school systems were cautiously opening their doors for a new academic year, and I was taking my first steps with the current study. At that time, I had to learn new job responsibilities while adjusting to new post-pandemic norms with two young children. Transitioning from an online student to an online researcher proved to be challenging at times, but faith in God and support from family helped keep me motivated. My passion for service, education, and technology is evident, as I have been employed as an IT professional at higher education institutions for over 20 years. I spent the majority of my career developing and implementing software, which led me to examine how to improve software development projects in a North Carolina higher education environment. Like many students, I experienced some life-changing events throughout my doctoral journey, and this section describes how conducting this research project provided for personal and professional growth

First, completing this research helped me personally by strengthening my faith in God. I am enrolled in an online program, so the face-to-face accountability and in-class support network did not exist. My university has alternative channels of support, and I believe the most effective efforts center around how God and His message are infused into the curriculum. The weekly devotional and motivational messages were meaningful, but I still became overwhelmed at times and the project got off pace several semesters. Despite the challenging moments, turning to God always helped me regain focus and get the project back on track. Psalm 86 is a prayer for help from David. As he pleads for help, David says “Listen, LORD, to my prayer; hear my cries for help. I call to you in times of trouble, because you answer my prayers” (*Good News Bible*, 2001, Psalm 86: 6-7). Similarly, I would ask God for help with various challenges throughout the research and God would always answer the call. Reflecting back on the experience, the longest gaps without significant progress always occurred when I failed to look to God for help. “God is our shelter and strength, always ready to help in times of trouble” (Psalms 46:1). Acknowledging that we need to turn to God for help and trusting Him to get us through difficult times helped me grow personally during this project.

In 2020, my job duties changed, and I assumed more responsibility at work while trying to initiate this research project. There were many parallels between my new role and this project, in that there was no longer a guided curriculum or director guiding my next steps. I had help on all fronts, from family and co-workers, but the direction and pace of progress were in my hands. It took some time, but the combination of this project and new job duties helped me realize there is a difference between having plans and having a plan of action. Both are necessary for success. The research project differed significantly from online coursework in the doctoral journey. To complete the coursework, I needed to be scheduled and allocate time weekly to complete assignments, but the curriculum and syllabi provided a guided path. The research project consisted of different tasks, but many seemed overwhelming and open-ended at times. Once I divided the tasks into granular milestones, I started to make significant measurable progress. The Bible states, “You may make your plans, but God directs your actions” (*Good News Bible*, 2001, Proverbs, 16:9). Asking God for help and breaking tasks into measurable milestones helped me work with purpose and make progress on this research. Professionally, I applied this by setting more granular goals to accomplish tasks weekly, while ensuring tasks still aligned with a long-term vision. This helped me make significant progress towards overarching goals over time.

Biblical Perspective

This research sought out to further advance the benefits reaped from agile methodologies by exploring if a relationship exists between deviating from agile principles and project success. Through Spearman’s rank-order correlation analysis, this study identified relationships exist between how closely a project team adheres to the agile principles for management commitment, face-to-face collaboration, simplicity, and team environment and the overall success of the agile software development project. Furthermore, through multiple regression analysis, it was determined that adhering to the agile principles for simplicity and team environment has a small, positive effect on project success when the four aforementioned principles are present. Extending on the existing body of knowledge on the subject of agile software development and project success aligns with God's will to advance His creations. Genesis 2:15 confirms God's desire for mankind to cultivate and build upon what He has provided (*Good News Bible*, 2001).

Although related studies exist, this research is unique in that it investigates how deviating from agile principles impacts the success of agile software development projects. The results show that deviating from the agile principles for simplicity and team environment can have an effect on project success. A positive, monotonic relationship between the agile principle for teamwork and project success aligns with the biblical view that two are better off than one (*Good News Bible*, 2001, Ecclesiastes 4:9-12). This principle states, "The best architectures, requirements, and designs emerge from self-organizing teams" (Beck et al., 2001, para. 12). This principle highlights the need for less bureaucracy so that team members can contribute to areas they have experience and expertise in. Additionally, it conveys the need for project team members to distribute responsibilities and independently determine the best approach to resolving problems or meeting business needs (Alsaqqa et al., 2020). Proverbs 27:17 states that "people learn from one another, just as iron sharpens iron." A team environment provides a structure where team members can learn from each other, and supports working collaboratively towards a common goal.

This study also concluded that the agile principle for simplicity also had a positive, monotonic relationship with the success of an agile software development project. This principle states, "Simplicity--the art of maximizing the amount of work not done--is essential" (Beck et al., 2001, para. 11). The tenth principle supports creating simple processes and simple designs. It charges project teams with creating simple designs that meet the needs at hand while still being dynamic enough to handle future changes (Alsaqqa et al., 2020). Although the Bible does not speak to simplistic project designs, it does include two ideas which are closely related to the tenth agile principle—greed and trust. There are numerous examples within the Bible that warn mankind to not exhibit greedy tendencies by worshiping money or possessions (*Good News Bible*, 2001, Ecclesiastes 5:10-12; Matthew 6:24), and Luke 12:15 does a good job of generalizing this idea by communicating that one should "watch out and guard yourselves from every kind of greed." This Scripture supports that people should not worry about what they cannot control, but put faith and trust into God to provide what they need. This relates to simple project designs because users should not be concerned about unnecessary features. Agile practices support the concept of an MVP, which aims to produce a product that meets the minimum business need with the least amount of effort, so that the development team can learn more about the need and improve the product with future releases (Agile Alliance, 2024). The tenth principle, simplicity, is the foundation of an MVP, and aligns closely with the biblical idea that people should be simplistic and not greedy and trust that what is needed will be delivered.

Finally, the last biblical message that was reinforced throughout the process of working on this study was to always trust in and obey the Lord. Discussed in the prior section, there were many distractions throughout the process of conducting research, but whenever I looked towards God for help, the call was always answered. Romans 8:28 reinforces that "God works for the good of those who love him, who have been called according to his purpose" (*Good News Bible*, 2001). When I reset and asked the Lord for help, God helped realign priorities and I was able to make progress on this study. Conversely, when I did not focus on the research and did not seek God's help, there were big gaps in time where little progress was made. Similarly, the Lord rejected Saul when he did not do as he asked (1 Samuel 15). I was gifted with the opportunity to pursue a terminal degree and conduct research on a topic meaningful to my professional calling. When I deviated from the Lord's plan, I was not rewarded with progress and time lapsed without any significant progress being made on the research. I am thankful for the biblical messaging embedded throughout my university's curriculum, which reminds students that God has a purpose for us all and that we need to keep our faith in Him as He guides us throughout our journey. This messaging and God's guidance helped refocus me when it was needed most, and the results reflect that throughout this study.

Summary of Reflections

Andriyani et al.(2017) found that reflection occurs when a project team embodies three levels of reflection— reporting and responding, relating and reasoning, and reconstructing. Similarly, this section included a reflection which discussed how conducting this research provided for personal and professional growth, and how the business functions explored in this study relate to and integrate with a Christian worldview. The data from the study did not support that the twelfth principle, reflection, had a correlation with project success; however, the intent of reflection is to make changes to future iterations or subsequent projects. It is unknown if lessons learned during a study participant's reflection contributed to the success of subsequent projects. As the researcher of this study, however, I do believe that my personal experience reflecting and refactoring throughout the process contributed to completing the study and contributed to the spiritual and professional growth discussed above.

Summary of Section 3

The purpose of this quantitative correlational study was to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. Section 3 presented the study's findings and discussed the practical application of the information learned by conducting the research. The section began with an overview of the study where I affirmed that a derivative of the Chow and Cao (2008) survey instrument was used to collect ordinal data using a secure online survey platform. After inviting 1,872 people from the sampling frame to complete the online survey, data was collected from 351 respondents and used to calculate the independent and dependent variables for this study. The "Presentation of the Findings" heading within *Section 3* included the detailed process for how the variables were computed using SPSS. This section also included descriptive statistics that talked about the institutions and agile projects represented in the sample and outline characteristics of the variables. These variables were then used to test the 15 hypotheses that guided the study.

Section 3 also chronicled the hypotheses testing with a detailed discussion covering the process and outcomes of testing each of the 15 hypotheses. Although the study's original design included using Pearson's correlation analysis to test the null hypotheses and explore if an association exists between the variables, I pivoted to using Spearman's rank-order correlation to test the association after examining scatter plots of the data and concluding that some of the independent variables lacked a linear relationship with the dependent variable. Spearman's rho is an alternative correlational test that can be used for both normal and nonnormal distributed data, can identify linear or nonlinear correlations, and is less sensitive to outliers (Zhang & Wang, 2023). The results of the analysis were to reject the null hypotheses and accept the alternative hypothesis for H1, H2, H3, H8, H9, H13, and H14. For these hypotheses, regression analysis was used to further test the strength of the relationships between the independent variables and the dependent variable. Table 25 shows the results of the hypotheses testing.

Section 3 also included a discussion on how the findings related to existing research on the topic of success factors for agile software development projects, and it provides recommendations for practitioners to leverage the knowledge gained by conducting the research. Many existing studies failed to agree on the significance the 12 agile principles have on determining a successful project outcome, so naturally the results of the current study aligned with some scholarly research while conflicting with others. For example, this study's findings on the significance of the tenth agile principle, simplicity, is essential, align with Chow and Cao (2008) and Aldahmash (2018), but conflict with other studies (Brown, 2015; Stanberry, 2018; Stankovic, et al., 2013). Similarly, the results for the eleventh agile principle, the best architectures, requirements, and designs emerge from self-organizing teams, conflicted with existing research on the topic (Aldahmash, 2018; Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). I discussed some of the commonalities and differences between these studies and the current research and recommended additional research investigating the variation between groups of respondents to determine if the difference between industry or nation explains any of the variance in the results across studies.

In Section 3, I also recommended further study on the agile methodology being used by study participants. The results of the current study skewed towards the hybrid (59%) and Scrum (34%) methodologies. Similar research reported a significant difference in the methodologies that were used. In addition to the Scrum method, XP, and Feature Driven Development were common methodologies represented in other studies (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). In the current study, XP was only used by 1% of participants, and no participants indicated Feature Driven Development was used. Since the current study did not consider the agile method employed, I recommend additional research investigating the variation between groups of respondents to determine if the difference between agile methods employed explains any of the variance in the results across studies.

Finally, Section 3 closes with reflections by me as the researcher and author of this study. The reflections include two sub-sections, one on my personal and professional growth throughout the experience and another on my biblical perspective about the research. I confessed that despite the challenging moments throughout his multi-year journey to complete this research, turning to God always helped me regain focus and get the project back on track. The experience also resulted in me gaining skills which benefit me professionally. Highlighting some challenges I faced transitioning from online student to online researcher, I began to make more measurable progress after I found strength in God and my family. Although Section 3 documented several biblical messages that were learned or reinforced by conducting this research, the most significant lesson is to always trust and obey the Lord. Romans 8:28 reinforces that "God works for the good of those who love Him, who have been called according to His purpose" (*Good News Bible*, 2001). There were many distractions throughout the process of conducting this research, but whenever I looked to God for help, the call was always answered.

Summary and Study Conclusions

For over 30 years, software development projects have been plagued with low success rates. In 1994, researchers estimated that 84% of IT projects failed or were unsuccessful at meeting the timeline, budget, and scope of the request (Standish Group, 1994). After 26 years, IT projects still fall short of being on time, on budget, and ending with satisfactory results 69% of the time (Standish Group, 2020). Despite some progress, the problem of low project success rates persists; one factor that contributed to the improved success rate is the birth of the Agile

Manifesto (Henriksen & Pedersen, 2017). Created in 2001, the Agile Manifesto is a collection of four values and 12 principles created by a group of 17 skilled practitioners representing different software development methodologies (Beck et al., 2001; Cram, 2019). These practitioners pulled common best practices from their respective methodologies with the goal of improving project success (Hohl et al., 2018). Although the Agile Manifesto is not an agile software development methodology itself, its principles and core values have shaped many agile software development methods. The results show that agile-managed (42%) software development projects are over three-times more successful than waterfall-managed (13%) software development projects, but 69% of all projects continue to be challenged or fail (Standish Group, 2020). This is important because low IT project success rates can have significant financial repercussions for businesses and higher education institutions. There are many studies that investigate CSFs for software development projects, but researchers often come to different conclusions about which factors help projects succeed (Ahimbisibwe et al., 2015; Aleem et al., 2016; Brown, 2015; Chiyangwa & Mnkandla, 2017; Chow & Cao, 2008; Garousi et al., 2019; Shakya & Shakya, 2020; Stanberry, 2018; Tam et al., 2020; Yousef, 2022). Given agile software development projects have a higher success rate than waterfall projects, there is a need to explore if a relationship exists between deviating from agile principles and the perceived level of project success. The specific problem to be addressed by this research is the failure of organizations within the publicly and privately funded North Carolina higher education sector adhering to agile principles resulting in unsuccessful software development projects.

The purpose of this quantitative correlational study was to examine if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions. This research was conducted in response to the calls for additional studies on hybrid agile methods and the relationship between deviating from agile methods and project success (Eloranta et al., 2016; Serrador & Pinto, 2015). The study utilized an altered version of the Chow and Cao (2008) framework, which was based on Rockart's (1979) CSF theory. The framework was altered so each agile principle was represented as an isolated independent variable. More information on how the model was altered is available in the section titled "Theoretical Framework." The altered model was used to collect nominal data about participants and the projects, and ordinal data on the independent and dependent variables. Data was collected anonymously and securely through an online survey tool. The population consisted of IT professionals and IT project managers employed in publicly or privately funded, not-for-profit, degree-granting higher education institutions located in North Carolina. The sampling frame for the study is the subset of the population whose directory information is available online through their college's or university's website. For institutions that did not have a directory publicly available online, I contacted the corresponding chief information officer or equivalent position, and requested the contact information of qualifying individuals. Based on an estimated population of 3,957, the sample size was calculated using the formula published NEA (1960). The NEA formula applied to the current study (shown in Figure 6 on page 36), determined that at least 350 respondents were necessary to generalize the results to the population.

Between June 26, 2023 and October 15, 2023, I was able to collect 351 complete responses from eligible participants using the aforementioned online survey tool. The data was import into the SPSS Statistical Package software for correlation analysis and multiple regression analysis. These statistical tests were used to test the 15 hypotheses that correspond with the research questions. The original project design called for Pearson's correlation analysis to test the null hypotheses, but I pivoted to using Spearman's rank-order correlation to test the association after examining scatter plots of the data and concluding that some of the independent variables lacked a linear relationship with the dependent variable. The results of the correlation analysis were to reject the null hypotheses and accept the alternative hypothesis for H1, H2, H3, H8, H9, H13, and H14. For these hypotheses, regression analysis was also used to further test the strength of the relationships between the independent variables and the dependent variable. Table 25 (page 182) shows the results of the hypotheses testing.

This research adds to the body of knowledge and offers insight into which agile principles influence the success of software development projects so IT leaders can proactively avoid deviating from principles that have a significant impact on project success. The responses to the three primary research questions and 12 sub-questions inform practitioners how organizations can improve general business practice and increase software development project success rates by adhering to agile principles. The results of the study indicate that four agile principles—management commitment (r_s (349) = 0.156, p = 0.003), face-to-face collaboration (r_s (349) = 0.130, p = 0.015) simplicity (r_s (349) = 0.244, $p < 0.001$), and team environment (r_s (349) = 0.300, $p < 0.001$)—have a statistically significant correlation with project success. When these four agile principles are present, simplicity and team environment significantly predict project success ($F($4, 346) = 8.532, $p < 0.001$, adjusted $R^2 = 0.079$) and can explain approximately 7.9% of the variance. This is between a smaller than typical to medium effect (Cohen, 1988). These variables have a positive, monotonic relationship with project success which means institutions can improve their probability of achieving overall project success by adhering to these principles. Conversely, the more institutions deviate away from simplicity and team environment, the more likely they are to not achieve overall project success. This is significant because it supports the foundation of the Agile Manifesto which indicates that project teams should adhere to agile principles to improve their chance at project success (Beck et al., 2001).

When God placed man on Earth, He challenged Adam to cultivate His creation (*Good News Bible*, 2001, Genesis 2:15). With the guidance and support of God, I was able, as researcher of this study, to add to the existing body of knowledge on the topic by investigating the relationship between the 12 agile principles and the success of agile software development projects. Similarly, I also encourage other scholars to further explore the topic by offering two recommendations for additional research. First, the results of this study contradicted similar studies which investigate the relationships between CSFs and project success (Aldahmash, 2018; Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013). Although some of these studies utilize the same instrument (Brown, 2015; Chow & Cao, 2008; Stanberry, 2018; Stankovic et al., 2013), the population and sampling frames differ for each study. As such, I call for further research investigating the variation between groups of respondents to determine if the difference between industry or nation explains any of the variance in the results across studies. Next, the results of the current study skew towards the hybrid methodology (59%) and Scrum (34%). Existing research on the topic reported a significant difference in the methodologies that were reportedly used. Some research cautions practitioners from deviating from agile principles (Cram, 2019; Siddique & Hussein, 2016), whereas other research suggests tailoring is acceptable if the business need warrants the change (Akbar, 2019; Xu & Ramesh, 2008). The current research examined if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects within North Carolina higher education institutions, but it did not consider the agile method employed. As such, I also call for further study investigating the variation between the agile methods employed to determine if the difference between agile methods used helps explain any of the variance in the results across studies is recommended.

The results of the current study support some research while challenging others. Most of the existing research on the topic investigates various CSFs for project success and then relates those factors to agile principles. Although researchers agree that adhering to agile principles can improve project success rates, a significant percent of IT projects continue to fail or are challenged (Cram, 2019; Serrador & Pinto, 2015). The current study brought a fresh perspective to the topic by investigating if a relationship exists between deviating from the 12 agile principles outlined in the Agile Manifesto, and the perceived level of success for agile software development projects. Through correlation analysis and multiple regression analysis, the project was successful at closing the gap in literature and identifying which agile principles have a statistically significant association with project success. Furthermore, I identified additional avenues for research so future scholars can continue to build on this work.

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Appendix A: North Carolina Degree-Granting, Not-for-Profit, Public or Privately Funded Higher Education Institutions

Unit Id	Institution Name	State	Control of Institution	Degree-granting Status
199786	Alamance Community College	North Carolina	Public	Degree-granting
197869	Appalachian State University	North Carolina	Public	Degree-granting
197887	Asheville-Buncombe Technical Community College	North Carolina	Public	Degree-granting
197911	Barton College	North Carolina	Private not-for-profit	Degree-granting
197966	Beaufort County Community College	North Carolina	Public	Degree-granting
197984	Belmont Abbey College	North Carolina	Private not-for-profit	Degree-granting
197993	Bennett College	North Carolina	Private not-for-profit	Degree-granting
198011	Bladen Community College	North Carolina	Public	Degree-granting
198039	Blue Ridge Community College	North Carolina	Public	Degree-granting
198066	Brevard College	North Carolina	Private not-for-profit	Degree-granting
198084	Brunswick Community College	North Carolina	Public	Degree-granting
198109	Cabarrus College of Health Sciences	North Carolina	Private not-for-profit	Degree-granting
198118	Caldwell Community College and Technical Institute	North Carolina	Public	Degree-granting
198136	Campbell University	North Carolina	Private not-for-profit	Degree-granting
198154	Cape Fear Community College	North Carolina	Public	Degree-granting
199971	Carolina Christian College	North Carolina	Private not-for-profit	Degree-granting
461032	Carolina College of Biblical Studies	North Carolina	Private not-for-profit	Degree-granting
489937	Carolina University	North Carolina	Private not-for-profit	Degree-granting
433174	Carolinas College of Health Sciences	North Carolina	Public	Degree-granting

198206	Carteret Community College	North Carolina	Public	Degree-granting
198215	Catawba College	North Carolina	Private not-for-profit	Degree-granting
198233	Catawba Valley Community College	North Carolina	Public	Degree-granting
198251	Central Carolina Community College	North Carolina	Public	Degree-granting
198260	Central Piedmont Community College	North Carolina	Public	Degree-granting
444778	Charlotte Christian College and Theological Seminary	North Carolina	Private not-for-profit	Degree-granting
198303	Chowan University	North Carolina	Private not-for-profit	Degree-granting
198321	Cleveland Community College	North Carolina	Public	Degree-granting
198330	Coastal Carolina Community College	North Carolina	Public	Degree-granting
197814	College of the Albemarle	North Carolina	Public	Degree-granting
198367	Craven Community College	North Carolina	Public	Degree-granting
198385	Davidson College	North Carolina	Private not-for-profit	Degree-granting
198376	Davidson County Community College	North Carolina	Public	Degree-granting
198419	Duke University	North Carolina	Private not-for-profit	Degree-granting
198455	Durham Technical Community College	North Carolina	Public	Degree-granting
198464	East Carolina University	North Carolina	Public	Degree-granting
198491	Edgecombe Community College	North Carolina	Public	Degree-granting
198507	Elizabeth City State University	North Carolina	Public	Degree-granting
198516	Elon University	North Carolina	Private not-for-profit	Degree-granting
198543	Fayetteville State University	North Carolina	Public	Degree-granting
198534	Fayetteville Technical Community College	North Carolina	Public	Degree-granting
198552	Forsyth Technical Community College	North Carolina	Public	Degree-granting
198561	Gardner-Webb University	North Carolina	Private not-for-profit	Degree-granting

198570	Gaston College	North Carolina	Public	Degree-granting
461528	Grace College of Divinity	North Carolina	Private not-for-profit	Degree-granting
198598	Greensboro College	North Carolina	Private not-for-profit	Degree-granting
198613	Guilford College	North Carolina	Private not-for-profit	Degree-granting
198622	Guilford Technical Community College	North Carolina	Public	Degree-granting
198640	Halifax Community College	North Carolina	Public	Degree-granting
198668	Haywood Community College	North Carolina	Public	Degree-granting
198677	Heritage Bible College	North Carolina	Private not-for-profit	Degree-granting
198695	High Point University	North Carolina	Private not-for-profit	Degree-granting
443076	Hood Theological Seminary	North Carolina	Private not-for-profit	Degree-granting
198710	Isothermal Community College	North Carolina	Public	Degree-granting
198729	James Sprunt Community College	North Carolina	Public	Degree-granting
445708	Johnson & Wales University-Charlotte	North Carolina	Private not-for-profit	Degree-granting
198756	Johnson C Smith University	North Carolina	Private not-for-profit	Degree-granting
198774	Johnston Community College	North Carolina	Public	Degree-granting
461139	Jung Tao School of Classical Chinese Medicine	North Carolina	Private not-for-profit	Degree-granting
198808	Lees-McRae College	North Carolina	Private not-for-profit	Degree-granting
198817	Lenoir Community College	North Carolina	Public	Degree-granting
198835	Lenoir-Rhyne University	North Carolina	Private not-for-profit	Degree-granting
198862	Livingstone College	North Carolina	Private not-for-profit	Degree-granting
198871	Louisburg College	North Carolina	Private not-for-profit	Degree-granting
198899	Mars Hill University	North Carolina	Private not-for-profit	Degree-granting

198905	Martin Community College	North Carolina	Public	Degree-granting
198914	Mayland Community College	North Carolina	Public	Degree-granting
198923	McDowell Technical Community College	North Carolina	Public	Degree-granting
198950	Meredith College	North Carolina	Private not-for-profit	Degree-granting
198969	Methodist University	North Carolina	Private not-for-profit	Degree-granting
199458	Mid-Atlantic Christian University	North Carolina	Private not-for-profit	Degree-granting
198987	Mitchell Community College	North Carolina	Public	Degree-granting
199023	Montgomery Community College	North Carolina	Public	Degree-granting
199032	Montreat College	North Carolina	Private not-for-profit	Degree-granting
199087	Nash Community College	North Carolina	Public	Degree-granting
199102	North Carolina A & T State University	North Carolina	Public	Degree-granting
199157	North Carolina Central University	North Carolina	Public	Degree-granting
199193	North Carolina State University at Raleigh	North Carolina	Public	Degree-granting
199209	North Carolina Wesleyan College	North Carolina	Private not-for-profit	Degree-granting
199263	Pamlico Community College	North Carolina	Public	Degree-granting
199306	Pfeiffer University	North Carolina	Private not-for-profit	Degree-granting
199324	Piedmont Community College	North Carolina	Public	Degree-granting
199333	Pitt Community College	North Carolina	Public	Degree-granting
199412	Queens University of Charlotte	North Carolina	Private not-for-profit	Degree-granting
199421	Randolph Community College	North Carolina	Public	Degree-granting
199449	Richmond Community College	North Carolina	Public	Degree-granting
199467	Roanoke-Chowan Community College	North Carolina	Public	Degree-granting
199476	Robeson Community College	North Carolina	Public	Degree-granting

199485	Rockingham Community College	North Carolina	Public	Degree-granting
199494	Rowan-Cabarrus Community College	North Carolina	Public	Degree-granting
199582	Saint Augustine's University	North Carolina	Private not-for-profit	Degree-granting
199607	Salem College	North Carolina	Private not-for-profit	Degree-granting
199625	Sampson Community College	North Carolina	Public	Degree-granting
199634	Sandhills Community College	North Carolina	Public	Degree-granting
199643	Shaw University	North Carolina	Private not-for-profit	Degree-granting
461485	Shepherds Theological Seminary	North Carolina	Private not-for-profit	Degree-granting
197850	South Piedmont Community College	North Carolina	Public	Degree-granting
199759	Southeastern Baptist Theological Seminary	North Carolina	Private not-for-profit	Degree-granting
199722	Southeastern Community College	North Carolina	Public	Degree-granting
233602	Southeastern Free Will Baptist Bible College	North Carolina	Private not-for-profit	Degree-granting
199731	Southwestern Community College	North Carolina	Public	Degree-granting
199698	St. Andrews University	North Carolina	Private not-for-profit	Degree-granting
199740	Stanly Community College	North Carolina	Public	Degree-granting
199768	Surry Community College	North Carolina	Public	Degree-granting
199795	Tri-County Community College	North Carolina	Public	Degree-granting
199069	University of Mount Olive	North Carolina	Private not-for-profit	Degree-granting
199111	University of North Carolina at Asheville	North Carolina	Public	Degree-granting
199120	University of North Carolina at Chapel Hill	North Carolina	Public	Degree-granting
199139	University of North Carolina at Charlotte	North Carolina	Public	Degree-granting
199148	University of North Carolina at Greensboro	North Carolina	Public	Degree-granting
199281	University of North Carolina at Pembroke	North Carolina	Public	Degree-granting

199184	University of North Carolina School of the Arts	North Carolina	Public	Degree-granting
199218	University of North Carolina Wilmington	North Carolina	Public	Degree-granting
199838	Vance-Granville Community College	North Carolina	Public	Degree-granting
199847	Wake Forest University	North Carolina	Private not-for-profit	Degree-granting
199856	Wake Technical Community College	North Carolina	Public	Degree-granting
199865	Warren Wilson College	North Carolina	Private not-for-profit	Degree-granting
199892	Wayne Community College	North Carolina	Public	Degree-granting
200004	Western Carolina University	North Carolina	Public	Degree-granting
199908	Western Piedmont Community College	North Carolina	Public	Degree-granting
199926	Wilkes Community College	North Carolina	Public	Degree-granting
199272	William Peace University	North Carolina	Private not-for-profit	Degree-granting
199953	Wilson Community College	North Carolina	Public	Degree-granting
199962	Wingate University	North Carolina	Private not-for-profit	Degree-granting
199999	Winston-Salem State University	North Carolina	Public	Degree-granting

Appendix B: IT Professional and IT Project Manager Count by Qualifying Institution

Institutional Name	Count
Alamance Community College	6
Appalachian State University	163
Asheville-Buncombe Technical Community College[1]	1
Barton College[1]	1
Beaufort County Community College	6
Belmont Abbey College[1]	1
Bennett College	2
Bladen Community College	4
Blue Ridge Community College	15
Brevard College	4
Brunswick Community College[1]	1
Cabarrus College of Health Sciences[2]	1
Caldwell Community College and Technical Institute	21
Campbell University	39
Cape Fear Community College	15
Carolina Christian College[1]	1
Carolina College of Biblical Studies[2]	1
Carolina University	2
Carolinas College of Health Sciences[1]	1
Carteret Community College	5
Catawba College	16
Catawba Valley Community College	11
Central Carolina Community College	13
Central Piedmont Community College[1]	1
Charlotte Christian College and Theological Seminary[2]	1
Chowan University	4
Cleveland Community College	12
Coastal Carolina Community College	10
College of the Albemarle	2
Craven Community College	12
Davidson College	36
Davidson County Community College	4
Duke University[1]	1
Durham Technical Community College	14
East Carolina University	284
Edgecombe Community College	6
Elizabeth City State University	14

[1] Only the Chief Information Officer's (or equivalent position) contact information was available online.

[2] Contact information for IT professionals and IT project management staff not found on public website.

Elon University	50
Fayetteville State University	26
Fayetteville Technical Community College	37
Forsyth Technical Community College	34
Gardner-Webb University	8
Gaston College	14
~~Grace College of Divinity~~ Manna University[2]	1
Greensboro College	3
Guilford College	12
Guilford Technical Community College	30
Halifax Community College	5
Haywood Community College[1]	1
Heritage Bible College[2]	1
High Point University	28
Hood Theological Seminary[2]	1
Isothermal Community College	8
James Sprunt Community College	5
Johnson & Wales University-Charlotte	24
Johnson C Smith University[1]	1
Johnston Community College	15
Jung Tao School of Classical Chinese Medicine[2]	1
Lees-McRae College	3
Lenoir Community College	11
Lenoir-Rhyne University	7
Livingstone College	5
Louisburg College	3
Mars Hill University	5
Martin Community College[1]	1
Mayland Community College	4
McDowell Technical Community College	4
Meredith College	26
Methodist University	10
Mid-Atlantic Christian University[1]	1
Mitchell Community College	9
Montgomery Community College	5
Montreat College	5
Nash Community College	6
North Carolina A & T State University	78
North Carolina Central University	69
North Carolina State University at Raleigh	654
North Carolina Wesleyan College	8
Pamlico Community College	3
Pfeiffer University	4
Piedmont Community College	6
Pitt Community College[1]	1

Queens University of Charlotte	14
Randolph Community College	9
Richmond Community College	3
Roanoke-Chowan Community College	2
Robeson Community College	7
Rockingham Community College	10
Rowan-Cabarrus Community College	30
Saint Augustine's University	6
Salem College	3
Sampson Community College	5
Sandhills Community College	13
Shaw University	6
Shepherds Theological Seminary	13
South Piedmont Community College	6
Southeastern Baptist Theological Seminary[1]	1
Southeastern Community College	6
Southeastern Free Will Baptist Bible College[2]	1
Southwestern Community College	11
St. Andrews University[1]	1
Stanly Community College	10
Surry Community College	7
Tri-County Community College	4
University of Mount Olive	7
University of North Carolina at Asheville	31
University of North Carolina at Chapel Hill	932
University of North Carolina at Charlotte	228
University of North Carolina at Greensboro	184
University of North Carolina at Pembroke	44
University of North Carolina School of the Arts	26
University of North Carolina Wilmington	140
Vance-Granville Community College	5
Wake Forest University[1]	1
Wake Technical Community College	52
Warren Wilson College[2]	1
Wayne Community College	5
Western Carolina University	92
Western Piedmont Community College	8
Wilkes Community College	12
William Peace University	2
Wilson Community College	4
Wingate University	14
Winston-Salem State University	37

Appendix C: Chow and Cao (2008) Survey Instrument

Agile Software Development Project Survey

Section 1 – Demographics

Thank you very much for agreeing to spend a few minutes of your time to complete this survey. If you have been involved with more than one agile project, please pick one (either successful or failed) that was most relevant or most telling with regard to critical success factors of such a project.

Section 1.1

For questions 1–5 please provide some basic information regarding the agile project.

1. Project description (i.e. what the software was about):
2. Agile method used:
3. Size of the project (number of project team members):
4. Length of the project (in months):
5. Location of the project (country):

Section 1.2

For questions 6–13 please provide some basic information regarding your organization and yourself (all information provided will be kept completely confidential):

6. Company name (optional):
7. Company size (ranges of number of employees):
8. Company revenues (ranges of annual sales dollar amounts):
9. Company industry (selection of pre-determined industries):
10. Your job responsibility in the project (project manager, team lead, team member, customer, organization management, other):

11. Your level of experience with agile projects (in years):

12. Number of agile project you have been involved with:

13. Please provide your name, address, phone and email information, should we need to get some clarification regarding your response to this survey (optional):

Section 2 – Success factors of the agile project

This section includes all the possible success factors of software development projects using agile methods, which had been compiled and consolidated from the academic and professional literature. Responses to each of the following statements range from 1 to 7 as follows:

1)	Strongly disagree	2)	Disagree
3)	Somewhat disagree	4)	Neither disagree or agree
5)	Somewhat agree	6)	Agree
7)	Strongly agree	N/A)	Not applicable/Don't know

Section 2.1 – Organizational dimension

14. The project received strong executive support. "Executive" may mean the whole Board of Directors or the CEO, CFO, CIO, etc. who influenced the decision-making:

15. The project had a committed sponsor or a committed organization manager. An example of a committed sponsor/manager would be one who would stand up to critics and vouch for the agile method in a non-agile organizational environment:

16. The organization had a cooperative culture instead of hierarchal. A cooperative culture is one that fosters ad-hoc teams driven by the needs of the job at hand (e.g. start-up organizations) while a hierarchal culture is one that has clear divisions of responsibility and authority (e.g. established, large organizations):

17. The organization had an oral culture placing high value on fluid, face-to-face communication style:

18. Agile methodology was universally accepted in the organization:

19. The organization had a reward system that was appropriate for agile behavior. An example of such a reward system would be one that recognizes both individual and team contributions, and that rewards results of the agile pilot projects:
20. The project team was collocated, i.e. all team members worked in the same location for ease of communication and casual, constant contact:
21. The project team worked in a facility with proper agile-style work environment, e.g. a dedicated office with pair programming workstations, communal area, ample wall spaces for postings, no separate cubicles or offices, etc.:

Section 2.2 – People dimension

22. The selected project team members had high technical competence and expertise (problem solving, programming, subject matter):
23. Project team members had great motivation and were committed to the project success:
24. Project management was knowledgeable in agile principles and processes:
25. Project management had light-touch and/or adaptive management style, e.g. encouraging creative, flexible working environment while taking advantage of mutual interactions among the project's various parts and steering them toward continuous learning and adaptation:
26. The project team worked in a coherent, self-organizing teamwork manner, i.e. relying on the collective ability of an autonomous team to solve problems and adapt to changing conditions:
27. Project management had a good relationship with the customer:

Section 2.3 – Process dimension

28. The project scope and objectives were well-defined:

29. The project followed agile-oriented requirement process, e.g. specifying initial requirements at a very high level, leaving much room for interpretation and adaptation as the project progressed:
30. The project followed agile project management style, e.g. plans generally not being documented in great detail, and deviations and changes being readily accepted and incorporated into the project plan:
31. The project followed agile-oriented configuration management process, e.g. employing good version control or source code management to accommodate the refactoring efforts and frequent builds:
32. The project manager followed an agile-friendly progress tracking mechanism, e.g. using flexible time-boxing or rapid-pace progress measurement techniques instead of document milestones or work breakdown structure:
33. The project had strong communication focus and rigorous communication schedule, i.e. face-to-face and instant communication channels (between team members, between team and management, and between team and customers), daily standup meetings, build cycle meetings, etc.:
34. The project honored regular working schedule, i.e. 40-hour work week, no overtime:
35. The project had strong customer commitment and presence, i.e. having at least one customer representative on site working hard and full-time as a member of the project team:
36. The customer representative on the project had full authority and knowledge to make decisions on-site, such as approving, disapproving, and prioritizing project requirements and changes:

Section 2.4 – Technical dimension

37. The project imposed a well-defined coding standards up front:
38. The project pursued simple design, e.g. programmers used the simplest possible design for each module to avoid waste and to facilitate cooperative work:
39. The project pursued vigorous refactoring activities to ensure the results are optimal and to accommodate well all changes in requirements:
40. The project maintained right amount of documentation for agile purpose, i.e. not too focused on producing elaborate documentation as milestones but not ignoring documentation altogether either:
41. The project followed continuous and rigorous unit and integration testing strategy for each and every iteration:
42. The project delivered working software regularly within short periods of time:
43. The project delivered most important features first:
44. The project employed proper platforms, technologies, and tools suitable for agile practice, e.g. object-oriented development techniques, tools supporting rapid iterative development, processes supporting refactoring, etc.:
45. The project provided appropriate technical training to team, including training on subject matter and agile processes:

Section 2.5 – Project dimension

46. The project nature was a non-life-critical software project, although it could be a business mission-critical software. (Examples of life-critical projects are certain advanced weapons programs or air traffic control programs):
47. The project type was of variable scope with emergent requirements:

48. The project had a dynamic, accelerated schedule:

49. The project had a small team size (20 members or less):

50. The project had no multiple, independent teams working together:

51. The project had up-front, detailed cost evaluation done and approved:

52. The project had up-front risk analysis done and evaluated for using agile method:

Section 3 – Perception of success of the agile project

This section includes aspects of your perceived level of success of the agile software development project at hand. Responses each of the following statements range from 1 to 7 as follows:

1) Very unsuccessful
2) Unsuccessful
3) Somewhat unsuccessful
4) Neutral
5) Somewhat successful
6) Successful
7) Very successful

53. The project was successful in terms of quality of the project outcome or of the resulting software product:

54. The project was successful in terms of scope and requirements of the project being met:

55. The project was successful in terms of timeliness of project completion:

56. The project was successful in terms of costs and efforts being under budget or within estimates:

Section 4 – Additional comments

This section includes one free-form text area where you invited to enter any additional comments on any matter which has not been covered in the survey. Your input may be used follow-up for clarification or for further exploration if necessary:

57. Please enter any additional comments or thoughts here:

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Date: Tuesday, November 22, 2022 at 5:24:30 AM Eastern Standard Time
From: Permissions Helpdesk <permissionshelpdesk@elsevier.com>
To: Stanley, Douglas <dstanley6@liberty.edu>

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Dear Doug

Yes, you can use the survey instrument too.

Kind regards,

Roopa Lingayath
Senior Copyrights Coordinator
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From: Doug Stanley
Date: Monday, November 21, 2022 02:33 AM GMT

Roopa,

Thank you for this information. I am also seeking permission to utilize the survey instrument. The license reflects I am able to use the requested figures, tables, and illustrations, but does not include the survey. Will you clarify, does the license also include use of the survey instrument?

Thank you,

Doug Stanley

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From: Roopa Lingayath
Date: Monday, November 14, 2022 03:17 PM GMT

Dear Doug

Thank you for getting back to us.

I am attaching the .pdf copy of the article for tables and image copy of Figure 1. I hope this will be helpful.

Kind regards,

Roopa Lingayath
Senior Copyrights Coordinator
ELSEVIER | HCM - Health Content Management

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From: Doug Stanley
Date: Saturday, November 12, 2022 04:37 PM GMT

Thank you Roopa for your help. I have obtained a license – see attached for reference. If you are able, can you please send me a copy of the following tables, figures, and survey instrument?

- survey instrument
- Figure 1 (p. 964)
- Table 1 (p. 963)
- Table 2 (p. 963)
- Table 3 (p. 963)
- Table 9 (p. 967)

Thank you,

Doug Stanley

From: Roopa Lingayath
Date: Monday, November 07, 2022 06:36 AM GMT

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From: Doug Stanley
Date: Sunday, November 06, 2022 06:01 PM GMT

I am a doctoral student at Liberty University completing a dissertation for my Doctor of Business Administration with a cognate in Information Systems. I am writing to ask written permission to use the survey instrument developed by the authors and used in Chow and Cao (2008 -- doi: 10.1016/j.jss.2007.08.020) in my research study. My proposed study examines if a relationship exists between deviating from the 12 agile principles outlined in the Manifesto for Agile Software Development (Beck et al., 2001) and the perceived level of success for agile software development projects within North Carolina higher education institutions. My research is being supervised by my professor, Dr. Mike Kipreos, Associate Professor and Doctoral Research Chair with the Liberty University School of Business'

Computer Science Department.

The survey instrument in Chow and Cao (2008) collected data on participants' feedback on their work as it related to critical success factors for agile projects and project success. As noted within the article, these critical success factors closely relate to the 12 agile principles. The authors' work closely aligns with my proposed research which seeks to contribute to the existing body of knowledge on agile software development and project success.

If approved, I would appreciate receiving a copy of the survey questions and survey instructions that were employed in the Chow and Cao (2008) study. If this is not feasible, can you advise me on how I can obtain a copy of this? Additionally, I also ask your permission to reproduce they survey in my dissertation appendix.
I would like to use your survey instrument under the following conditions:
• I will use the survey only for my research study and will not sell or use it for any other purposes.
• I will include a statement of attribution and copyright on all copies of the instrument. If you have a specific statement of attribution that you would like for me to include, please provide it in your response.
• At your request, I will send a copy of my completed research study to you upon completion of the study and/or provide a hyperlink to the final manuscript.

If you do not control the copyright for these materials, I would appreciate any information you can provide concerning the proper person or organization I should contact.

If these are acceptable terms and conditions, please indicate so by replying to me through e-mail at dstanley6@liberty.edu.

Sincerely,
Doug Stanley
Doctoral Student
Liberty University

Appendix E: Change Log for the Modified Survey

This appendix describes the changes that were made to the original survey instrument shown in Appendix C: Chow and Cao (2008) Survey Instrument to derive at the survey instrument to be employed, Appendix F: Survey Instrument.

Original Survey Location	Modified Survey Location	Description of Change
N/A	Pre-Survey	The modified survey adds an attestation statement describing the requirements to contribute to the study as described in the Delimitations section of this document.
Section 1	Section 1	The modified survey updates the language of the introductory paragraph for Section 1, Demographics, to eliminate a redundant message from the attestation and to remove the reference to critical success factors.
Question 2	Question 2	The modified survey adds examples of agile methods to reduce the risk of including responses on non-agile software development projects in the survey results – as described in the Participants section of this document.
Question 5	N/A	The modified survey eliminates the question, *Location of the project (country)*, since this will be the same for all participants as described in the Delimitations and Participants sections of this document.
Section 1.2	Section 1.2	The modified survey updates the language of the introductory paragraph for Section 1.2 to reflect responses are submitted anonymously.
Question 6	Question 5	The modified survey updates the question language to reflect the population is academic.
Question 7	Question 6	The modified survey updates the question language to reflect the population is academic.
Question 8	N/A	The modified survey removes this question since it is not relevant to the population.
Question 9	N/A	The modified survey removes this question since it is not relevant to the population.
N/A	Question 7	The modified survey adds this question to allow the researcher to be more descriptive of the survey respondents.
N/A	Question 8	The modified survey adds this question to allow the researcher to be more descriptive of the survey respondents.

N/A	Question 9	The modified survey adds this question to allow the researcher to be more descriptive of the survey respondents.
13	N/A	The modified survey removes the question asking for the respondent's name, address, phone, and email information since responses are submitted anonymously.
Question 14	Question 13	The modified survey updates the question language to reflect the population is academic.
Question 28	N/A	This question was removed as it corresponds with the Project Definition Process critical success factor from Chow and Cao (2008), which does not correlate to an agile principle and was identified as not being significant.
Question 46	N/A	This question was removed as it corresponds with the Project Nature critical success factor from Chow and Cao (2008), which does not correlate to an agile principle and was identified as not being significant.
Question 47	N/A	This question was removed as it corresponds with the Project Type critical success factor from Chow and Cao (2008), which does not correlate to an agile principle and was identified as not being significant.
Question 48	N/A	This question was removed as it corresponds with the Project Schedule critical success factor from Chow and Cao (2008), which does not correlate to an agile principle and was identified as not being significant.
Question 51	N/A	This question was removed as it corresponds with the Project Definition Process critical success factor from Chow and Cao (2008), which does not correlate to an agile principle and was identified as not being significant.
Question 52	N/A	This question was removed as it corresponds with the Project Definition Process critical success factor from Chow and Cao (2008), which does not correlate to an agile principle and was identified as not being significant.

Appendix F: Survey Instrument

Attestation

Thank you very much for agreeing to spend a few minutes of your time to complete this survey. The purpose of this study is to examine if a relationship exists between deviating from the 12 agile principles outlined in the Manifesto for Agile Software Development (Beck et al., 2001) and the perceived level of success for agile software development projects within North Carolina higher education institutions (HEI). This study will focus on HEI because many institutions are challenged to increase their value to students while maintaining or reducing cost. This research seeks to add to the body of knowledge and offer insight into which agile principles influence the success of software development projects so future IT leaders can proactively avoid deviating from principles that have a significant impact on project success.

This survey should take approximately 15 minutes to complete. To be eligible to contribute to this study, participants must be an IT professional or IT project manager currently employed at a North Carolina degree-granting, not-for-profit, public or privately funded higher education institution and have completed an IT project using an agile methodology. Participants must also be at least 19 years of age, possess the ability to complete an online survey autonomously, and be willing to voluntarily complete a survey without receiving any compensation. Survey responses will be collected anonymous and data will be managed securely. The results of the survey findings are available upon requests by emailing dstanley6@liberty.edu. By proceeding, you agree that you meet the criteria outlined above to participate.

Options: Agree (*advances to survey*), Disagree (*ends survey*)

Agile Software Development Project Survey

Section 1 – Demographics

Please choose one agile project (either successful or failed) to base your responses from.

Section 1.1

For questions 1–4 please provide some basic information regarding the agile project.

1. Project description (i.e. what the project was about):
2. Agile method used (e.g. Scrum, eXtreme Programming, hybrid method…):
3. Size of the project (number of project team members):
4. Length of the project (in months):

Section 1.2

For questions 5–12 please provide some basic information regarding your academic institution and yourself (all information provided is submitted anonymously):

5. College or University name (optional):
6. College or University employment size (ranges of number of employees):
7. College or University student body size (ranges of number of students):
8. Control of institution (public, private not-for-profit):
9. Sector of institution (2-year, 4-year or above):
10. Your job responsibility in the project (project manager, team lead, team member, customer, organization management, other):
11. Your level of experience with agile projects (in years):
12. Number of agile projects you have been involved with (including the selected project):

Section 2 – Success factors of the agile project

This section includes possible success factors of software development projects using agile methods, which had been compiled and consolidated from the academic and professional literature. Responses to each of the following statements range from 1 to 7 as follows:

1	Strongly disagree
2	Disagree
3	Somewhat disagree
4	Neither disagree or agree
5	Somewhat agree
6	Agree
7	Strongly agree
N/A	Not applicable/Don't know

Section 2.1 – Organizational dimension

13. The project received strong executive support. "Executive" may mean the President/Chancellor, Chief Financial Officer, Chief Information Officer, etc. who influenced the decision-making: (Principle #5)
14. The project had a committed sponsor or a committed organization manager. An example of a committed sponsor/manager would be one who would stand up to critics and vouch for the agile method in a non-agile organizational environment: (Principle #5)
15. The organization had a cooperative culture instead of hierarchal. A cooperative culture is one that fosters ad-hoc teams driven by the needs of the job at hand (e.g. start-up organizations) while a hierarchal culture is one that has clear divisions of responsibility and authority (e.g. established, large organizations): (Principle #11)
16. The organization had an oral culture placing high value on fluid, face-to-face communication style: (Principle #6)
17. Agile methodology was universally accepted in the organization: (Principle #2)

18. The organization had a reward system that was appropriate for agile behavior. An example of such a reward system would be one that recognizes both individual and team contributions, and that rewards results of the agile pilot projects: (Principle #12)
19. The project team was collocated, i.e. all team members worked in the same location for ease of communication and casual, constant contact: (Principle #6)
20. The project team worked in a facility with proper agile-style work environment, e.g. a dedicated office with pair programming workstations, communal area, ample wall spaces for postings, no separate cubicles or offices, etc.: (Principle #5)

Section 2.2 – People dimension

21. The selected project team members had high technical competence and expertise (problem solving, programming, subject matter): (Principle #5)
22. Project team members had great motivation and were committed to the project success: (Principle #5)
23. Project management was knowledgeable in agile principles and processes: (Principle #5)
24. Project management had light-touch and/or adaptive management style, e.g. encouraging creative, flexible working environment while taking advantage of mutual interactions among the project's various parts and steering them toward continuous learning and adaptation: (Principle #5)
25. The project team worked in a coherent, self-organizing teamwork manner, i.e. relying on the collective ability of an autonomous team to solve problems and adapt to changing conditions: (Principle #11)
26. Project management had a good relationship with the customer: (Principle #1, #4)

Section 2.3 – Process dimension

27. The project followed agile-oriented requirement process, e.g. specifying initial requirements at a very high level, leaving much room for interpretation and adaptation as the project progressed: (Principle #2)
28. The project followed agile project management style, e.g. plans generally not being documented in great detail, and deviations and changes being readily accepted and incorporated into the project plan: (Principle #2)
29. The project followed agile-oriented configuration management process, e.g. employing good version control or source code management to accommodate the refactoring efforts and frequent builds: (Principle #8, #9)
30. The project manager followed an agile-friendly progress tracking mechanism, e.g. using flexible time-boxing or rapid-pace progress measurement techniques instead of document milestones or work breakdown structure: (Principle #8)
31. The project had strong communication focus and rigorous communication schedule, i.e. face-to-face and instant communication channels (between team members, between team and management, and between team and customers), daily standup meetings, build cycle meetings, etc.: (Principle #6)
32. The project honored regular working schedule, i.e. 40-hour work week, no overtime: (Principle #8)
33. The project had strong customer commitment and presence, i.e. having at least one customer representative on site working hard and full-time as a member of the project team: (Principle #4)

34. The customer representative on the project had full authority and knowledge to make decisions on-site, such as approving, disapproving, and prioritizing project requirements and changes: (Principle #1, #4)

Section 2.4 – Technical dimension

35. The project imposed a well-defined coding standards up front: (Principle #9)
36. The project pursued simple design, e.g. programmers used the simplest possible design for each module to avoid waste and to facilitate cooperative work: (Principle #10)
37. The project pursued vigorous refactoring activities to ensure the results are optimal and to accommodate well all changes in requirements: (Principle #9)
38. The project maintained right amount of documentation for agile purpose, i.e. not too focused on producing elaborate documentation as milestones but not ignoring documentation altogether either: (Principle #10)
39. The project followed continuous and rigorous unit and integration testing strategy for each and every iteration: (Principle #9)
40. The project delivered working software regularly within short periods of time: (Principle #3, #7)
41. The project delivered most important features first: (Principle #1)
42. The project employed proper platforms, technologies, and tools suitable for agile practice, e.g. object-oriented development techniques, tools supporting rapid iterative development, processes supporting refactoring, etc.: (Principle #5)
43. The project provided appropriate technical training to team, including training on subject matter and agile processes: (Principle #5)

Section 2.5 – Project dimension

44. The project had a small team size (20 members or less): (Principle #11)

45. The project had no multiple, independent teams working together: (Principle #11)

Section 3 – Perception of success of the agile project

This section includes aspects of your perceived level of success of the agile software development project at hand. Responses each of the following statements range from 1 to 7 as follows:

1	Very unsuccessful
2	Unsuccessful
3	Somewhat unsuccessful
4	Neutral
5	Somewhat successful
6	Successful
7	Very successful

46. The project was successful in terms of quality of the project outcome or of the resulting software product:

47. The project was successful in terms of scope and requirements of the project being met:

48. The project was successful in terms of timeliness of project completion:

49. The project was successful in terms of costs and efforts being under budget or within estimates:

Section 4 – Additional comments

This section includes one free-form text area where you invited to enter any additional comments on any matter which has not been covered in the survey. Your input may be used follow-up for clarification or for further exploration if necessary:

50. Please enter any additional comments or thoughts here:

Appendix G: Frequency and Frequency Distribution of Survey Questions 13-45

The frequency and frequency distribution of questions 13-45 are shown below. The table was generated using SPSS version 29.0.1 for Windows operating systems.

		Strongly Disagree	Disagree	Somewhat Disagree	Neither Disagree or Agree	Somewhat Agree	Agree	Strongly Agree	Not Applicable/ Do Not Know	Total
Q13	Count	0	24	22	19	101	103	81	1	351
	N %	0.0%	6.8%	6.3%	5.4%	28.8%	29.3%	23.1%	0.3%	100.0%
Q14	Count	0	4	25	26	101	122	69	4	351
	N %	0.0%	1.1%	7.1%	7.4%	28.8%	34.8%	19.7%	1.1%	100.0%
Q15	Count	1	6	26	3	67	147	101	0	351
	N %	0.3%	1.7%	7.4%	0.9%	19.1%	41.9%	28.8%	0.0%	100.0%
Q16	Count	1	14	28	22	100	133	52	1	351
	N %	0.3%	4.0%	8.0%	6.3%	28.5%	37.9%	14.8%	0.3%	100.0%
Q17	Count	1	12	35	37	140	108	18	0	351
	N %	0.3%	3.4%	10.0%	10.5%	39.9%	30.8%	5.1%	0.0%	100.0%
Q18	Count	0	46	82	46	113	47	13	4	351
	N %	0.0%	13.1%	23.4%	13.1%	32.2%	13.4%	3.7%	1.1%	100.0%
Q19	Count	3	43	51	4	136	83	30	1	351
	N %	0.9%	12.3%	14.5%	1.1%	38.7%	23.6%	8.5%	0.3%	100.0%
Q20	Count	6	94	91	9	95	38	15	3	351
	N %	1.7%	26.8%	25.9%	2.6%	27.1%	10.8%	4.3%	0.9%	100.0%
Q21	Count	0	2	14	1	58	185	91	0	351
	N %	0.0%	0.6%	4.0%	0.3%	16.5%	52.7%	25.9%	0.0%	100.0%
Q22	Count	0	1	10	1	70	155	114	0	351
	N %	0.0%	0.3%	2.8%	0.3%	19.9%	44.2%	32.5%	0.0%	100.0%
Q23	Count	0	6	50	7	155	100	33	0	351
	N %	0.0%	1.7%	14.2%	2.0%	44.2%	28.5%	9.4%	0.0%	100.0%
Q24	Count	0	5	32	11	107	135	61	0	351
	N %	0.0%	1.4%	9.1%	3.1%	30.5%	38.5%	17.4%	0.0%	100.0%
Q25	Count	0	2	24	2	70	151	102	0	351
	N %	0.0%	0.6%	6.8%	0.6%	19.9%	43.0%	29.1%	0.0%	100.0%
Q26	Count	0	2	15	6	41	150	136	1	351
	N %	0.0%	0.6%	4.3%	1.7%	11.7%	42.7%	38.7%	0.3%	100.0%
Q27	Count	0	5	40	14	91	142	59	0	351
	N %	0.0%	1.4%	11.4%	4.0%	25.9%	40.5%	16.8%	0.0%	100.0%
Q28	Count	4	5	41	22	93	120	66	0	351
	N %	1.1%	1.4%	11.7%	6.3%	26.5%	34.2%	18.8%	0.0%	100.0%
Q29	Count	0	1	25	22	81	129	92	1	351
	N %	0.0%	0.3%	7.1%	6.3%	23.1%	36.8%	26.2%	0.3%	100.0%
Q30	Count	0	13	45	13	112	115	53	0	351
	N %	0.0%	3.7%	12.8%	3.7%	31.9%	32.8%	15.1%	0.0%	100.0%
Q31	Count	0	9	32	13	116	126	55	0	351
	N %	0.0%	2.6%	9.1%	3.7%	33.0%	35.9%	15.7%	0.0%	100.0%
Q32	Count	11	17	36	15	102	133	37	0	351
	N %	3.1%	4.8%	10.3%	4.3%	29.1%	37.9%	10.5%	0.0%	100.0%
Q33	Count	1	15	39	23	106	81	83	3	351
	N %	0.3%	4.3%	11.1%	6.6%	30.2%	23.1%	23.6%	0.9%	100.0%

		Strongly Disagree	Disagree	Somewhat Disagree	Neither Disagree or Agree	Somewhat Agree	Agree	Strongly Agree	Not Applicable/ Do Not Know	Total
Q34	Count	1	9	36	26	92	148	36	3	351
	N %	0.3%	2.6%	10.3%	7.4%	26.2%	42.2%	10.3%	0.9%	100.0%
Q35	Count	0	11	32	34	107	112	44	11	351
	N %	0.0%	3.1%	9.1%	9.7%	30.5%	31.9%	12.5%	3.1%	100.0%
Q36	Count	0	5	33	18	91	133	60	11	351
	N %	0.0%	1.4%	9.4%	5.1%	25.9%	37.9%	17.1%	3.1%	100.0%
Q37	Count	0	6	28	17	105	143	48	4	351
	N %	0.0%	1.7%	8.0%	4.8%	29.9%	40.7%	13.7%	1.1%	100.0%
Q38	Count	0	8	49	21	121	129	23	0	351
	N %	0.0%	2.3%	14.0%	6.0%	34.5%	36.8%	6.6%	0.0%	100.0%
Q39	Count	1	15	36	15	89	136	58	1	351
	N %	0.3%	4.3%	10.3%	4.3%	25.4%	38.7%	16.5%	0.3%	100.0%
Q40	Count	1	6	43	12	96	149	34	10	351
	N %	0.3%	1.7%	12.3%	3.4%	27.4%	42.5%	9.7%	2.8%	100.0%
Q41	Count	1	7	21	18	52	152	98	2	351
	N %	0.3%	2.0%	6.0%	5.1%	14.8%	43.3%	27.9%	0.6%	100.0%
Q42	Count	0	4	44	23	104	130	45	1	351
	N %	0.0%	1.1%	12.5%	6.6%	29.6%	37.0%	12.8%	0.3%	100.0%
Q43	Count	0	8	40	33	117	127	24	2	351
	N %	0.0%	2.3%	11.4%	9.4%	33.3%	36.2%	6.8%	0.6%	100.0%
Q44	Count	8	20	13	0	15	233	62	0	351
	N %	2.3%	5.7%	3.7%	0.0%	4.3%	66.4%	17.7%	0.0%	100.0%
Q45	Count	8	10	35	3	61	185	47	2	351
	N %	2.3%	2.8%	10.0%	0.9%	17.4%	52.7%	13.4%	0.6%	100.0%

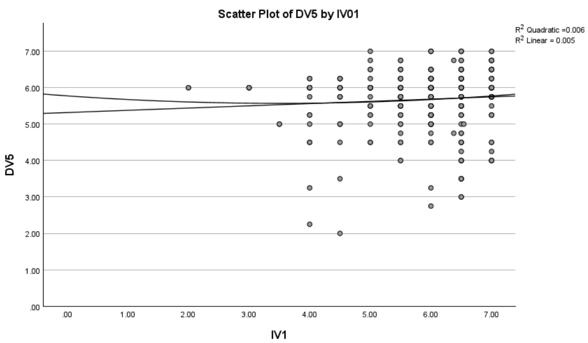
Appendix H: Frequency and Frequency Distribution of Survey Questions 46-49

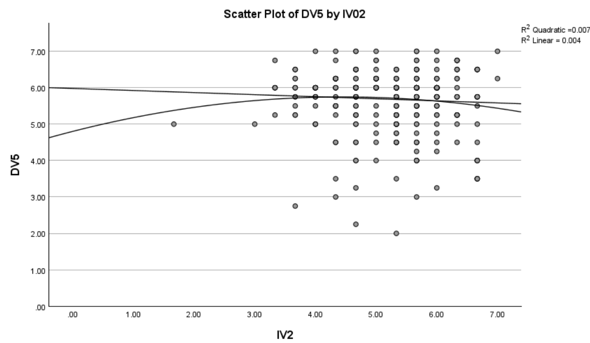
The frequency and frequency distribution of questions 46-49 are shown below. These questions represent dependent variables 1-4 (DV1 – DV4) in the study. The table was generated using SPSS version 29.0.1 for Windows operating systems.

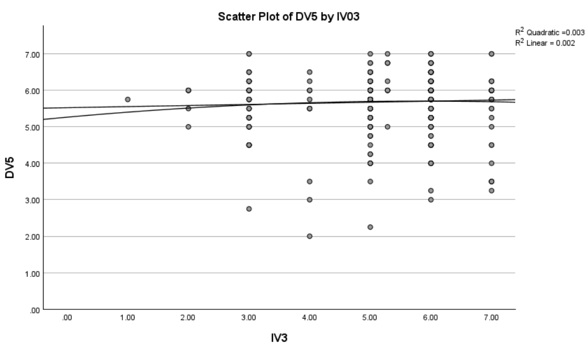
		Very Unsuccessful	Unsuccessful	Somewhat Unsuccessful	Neutral	Somewhat Successful	Successful	Very Successful	Total
Q46	Count	2	1	2	3	48	219	76	351
	N %	1%	0%	1%	1%	14%	62%	22%	100%
Q47	Count	0	2	8	6	41	255	39	351
	N %	0%	1%	2%	2%	12%	73%	11%	100%
Q48	Count	4	11	29	18	66	170	53	351
	N %	1%	3%	8%	5%	19%	48%	15%	100%
Q49	Count	3	4	23	45	44	201	31	351
	N %	1%	1%	7%	13%	13%	57%	9%	100%

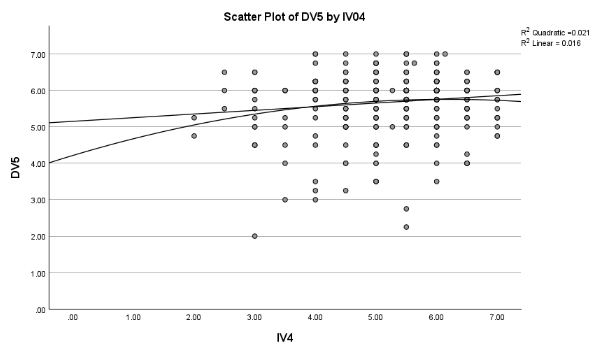
Appendix I: Scatterplots for Independent and Dependent Variables

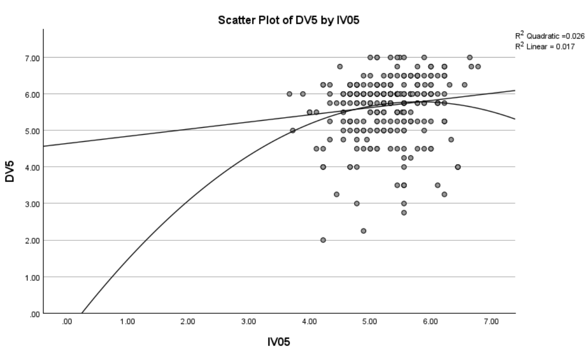
This appendix shows the scatterplot graphs for the relationships between independent and dependent variables.

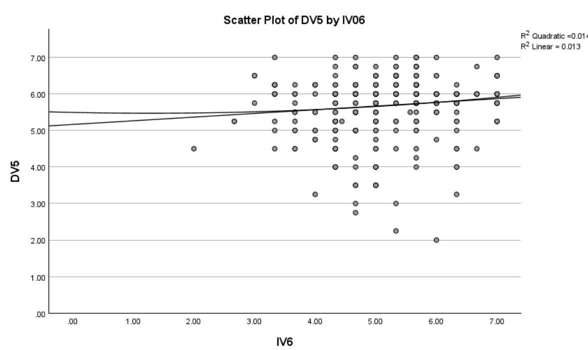


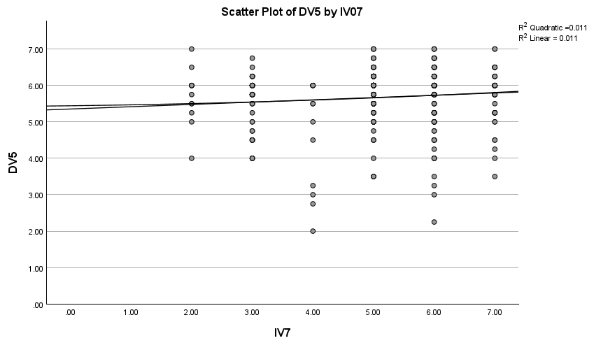


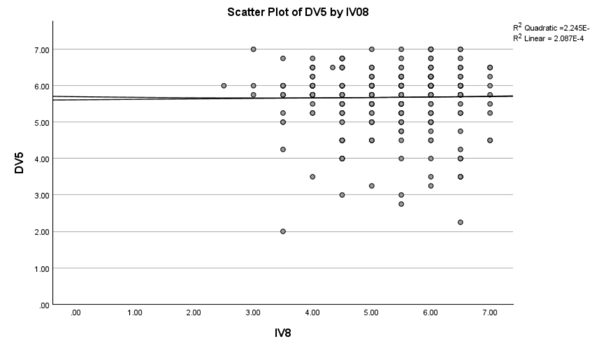


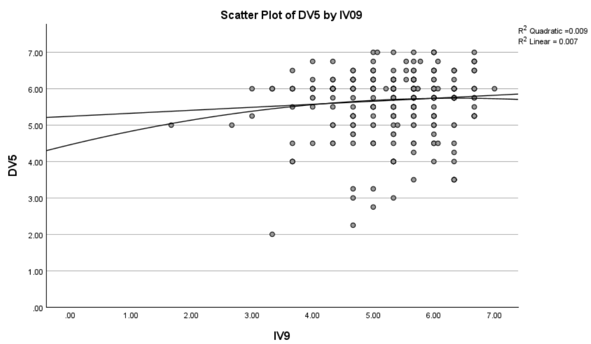


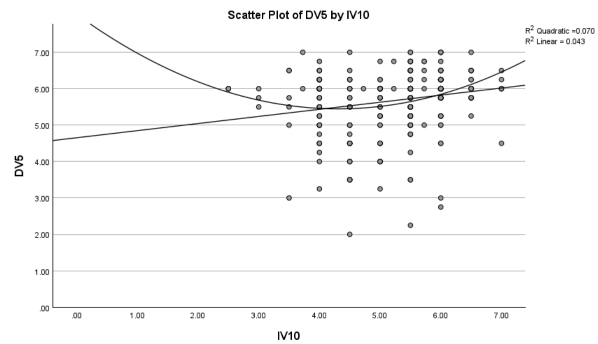


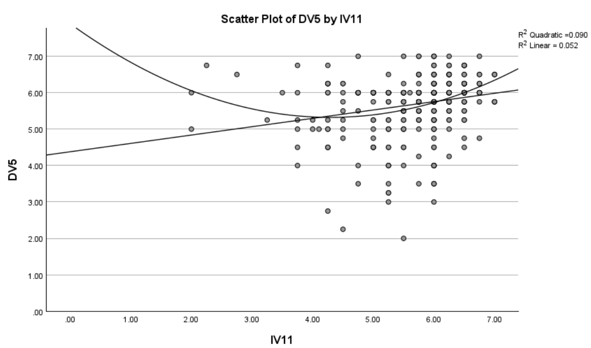


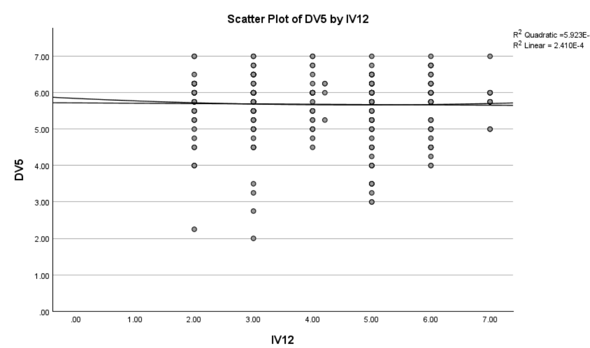

Scatter Plot of DV5 by IV07
R2 Quadratic =0.011
R2 Linear = 0.011
DV5
IV7

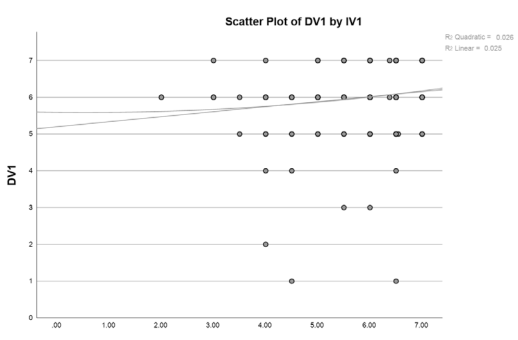

Scatter Plot of DV5 by IV08
R2 Quadratic =2.245E-4
R2 Linear = 2.087E-4
DV5
IV8

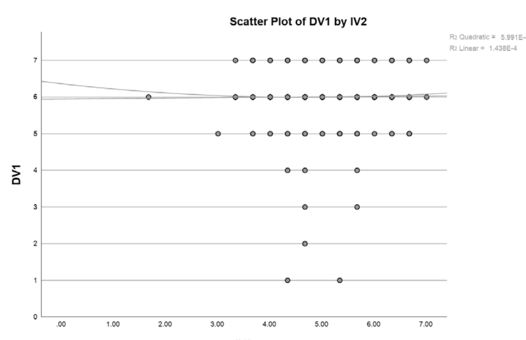

Scatter Plot of DV5 by IV09
R2 Quadratic =0.009
R2 Linear = 0.007
DV5
IV9

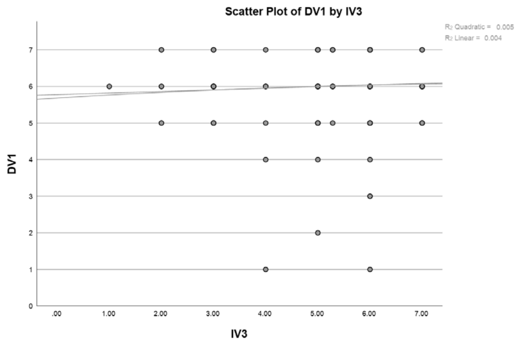

Scatter Plot of DV5 by IV10
R2 Quadratic =0.070
R2 Linear = 0.043
DV5
IV10

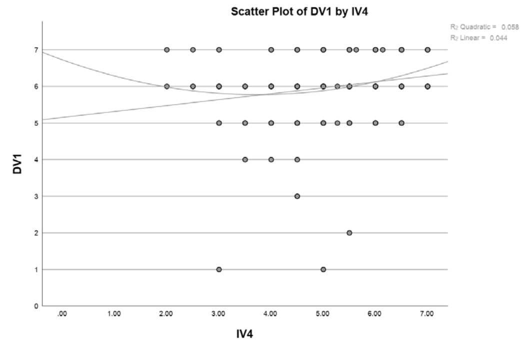

Scatter Plot of DV5 by IV11
R2 Quadratic =0.090
R2 Linear = 0.052
DV5
IV11

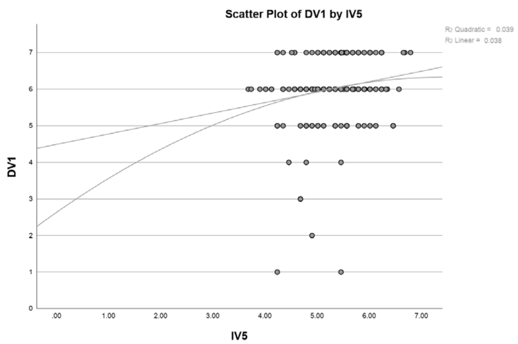

Scatter Plot of DV5 by IV12
R2 Quadratic =5.923E-4
R2 Linear = 2.410E-4
DV5
IV12

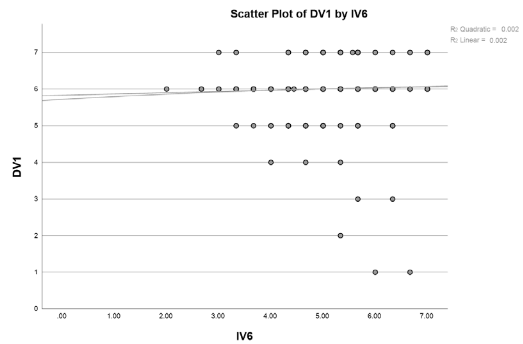

Scatter Plot of DV1 by IV1
R2 Quadratic = 0.026
R2 Linear = 0.025
DV1
IV1

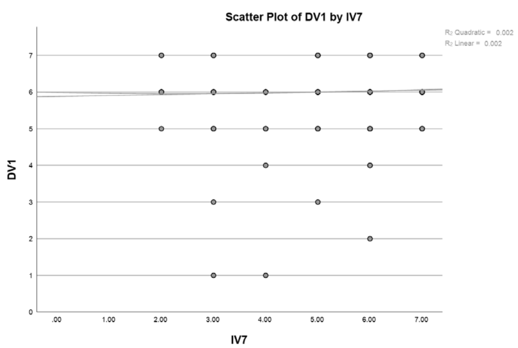

Scatter Plot of DV1 by IV2
R2 Quadratic = 5.991E-4
R2 Linear = 1.438E-4
DV1
IV2

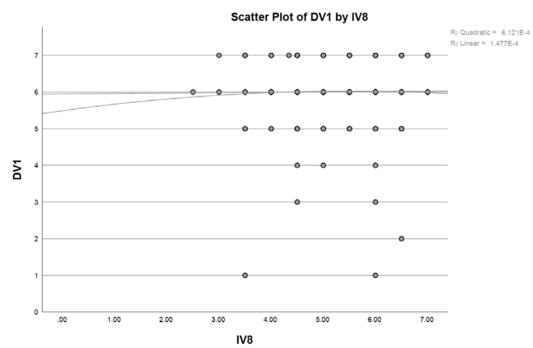

Scatter Plot of DV1 by IV3
R² Quadratic = 0.005
R² Linear = 0.004
DV1
IV3

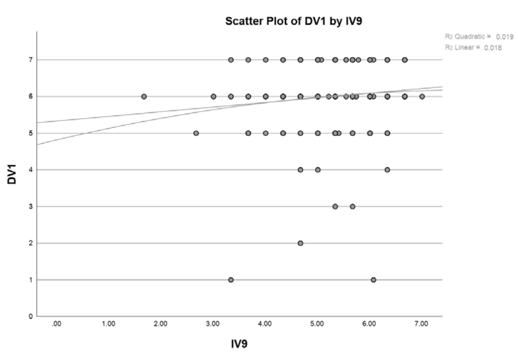

Scatter Plot of DV1 by IV4
R² Quadratic = 0.058
R² Linear = 0.044
DV1
IV4

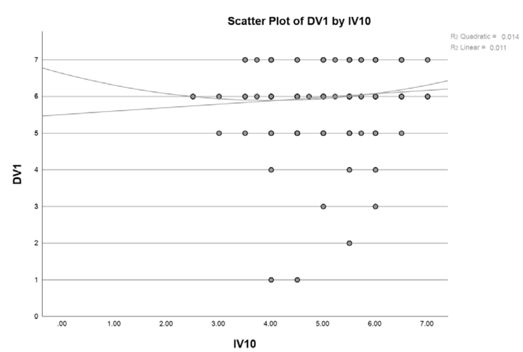

Scatter Plot of DV1 by IV5
R² Quadratic = 0.039
R² Linear = 0.038
DV1
IV5

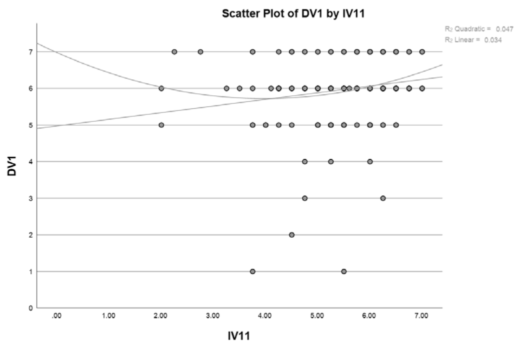

Scatter Plot of DV1 by IV6
R² Quadratic = 0.002
R² Linear = 0.002
DV1
IV6

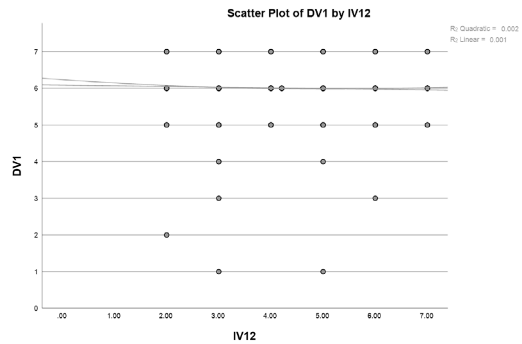

Scatter Plot of DV1 by IV7
R² Quadratic = 0.002
R² Linear = 0.002
DV1
IV7

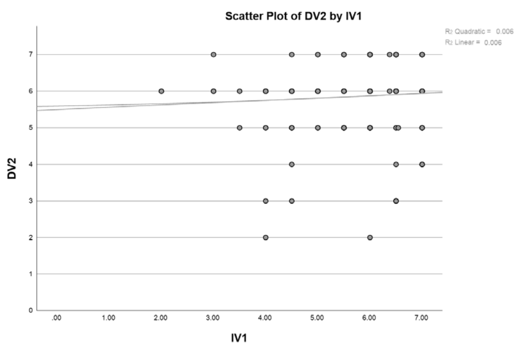

Scatter Plot of DV1 by IV8
R² Quadratic = 6.121E-4
R² Linear = 1.477E-4
DV1
IV8

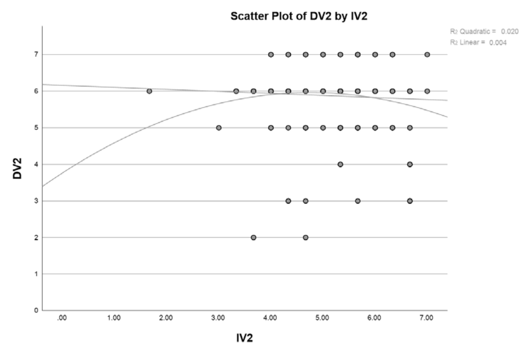

Scatter Plot of DV1 by IV9
R² Quadratic = 0.019
R² Linear = 0.018
DV1
IV9

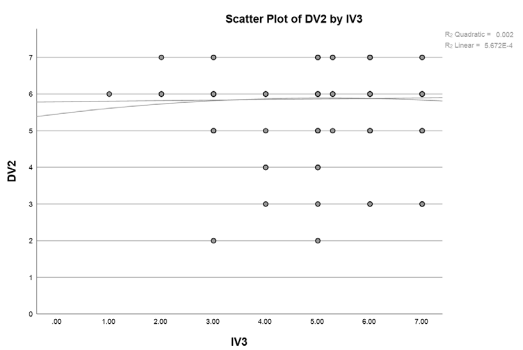

Scatter Plot of DV1 by IV10
R² Quadratic = 0.014
R² Linear = 0.011
DV1
IV10

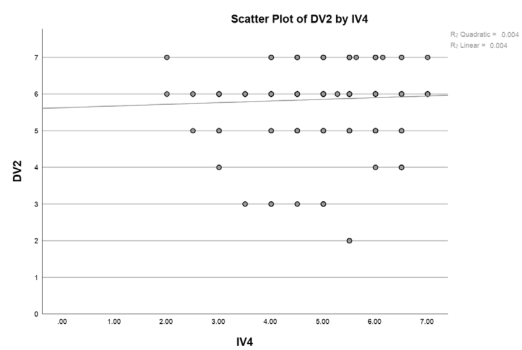

Scatter Plot of DV1 by IV11
R² Quadratic = 0.047
R² Linear = 0.034
DV1
IV11

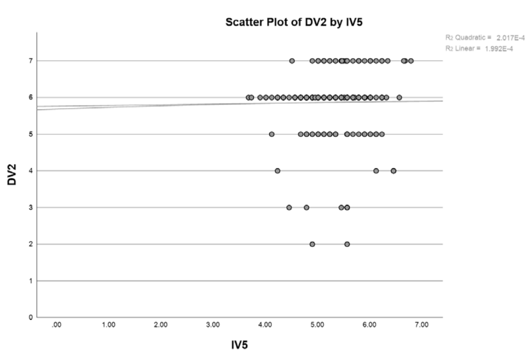

Scatter Plot of DV1 by IV12
R² Quadratic = 0.002
R² Linear = 0.001
DV1
IV12

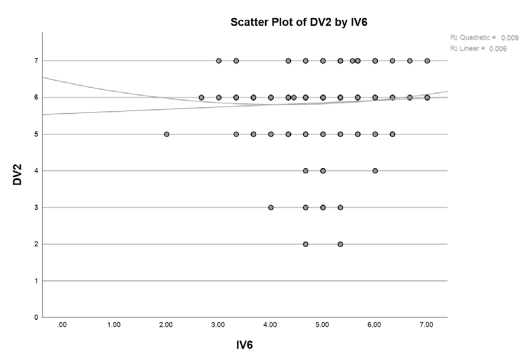

Scatter Plot of DV2 by IV1
R² Quadratic = 0.006
R² Linear = 0.006
DV2
IV1

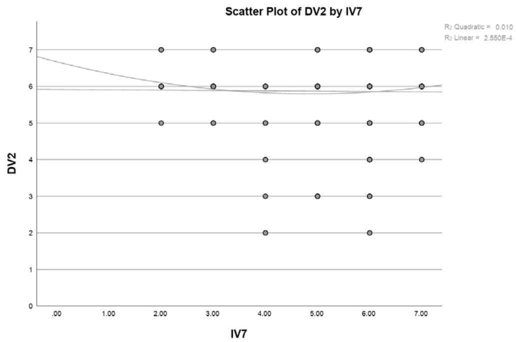

Scatter Plot of DV2 by IV2
R² Quadratic = 0.020
R² Linear = 0.004
DV2
IV2

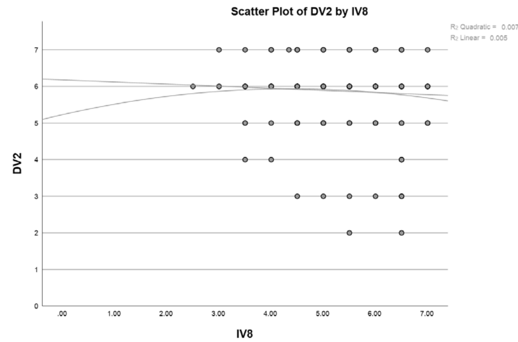

Scatter Plot of DV2 by IV3
R² Quadratic = 0.002
R² Linear = 5.672E-4
DV2
IV3

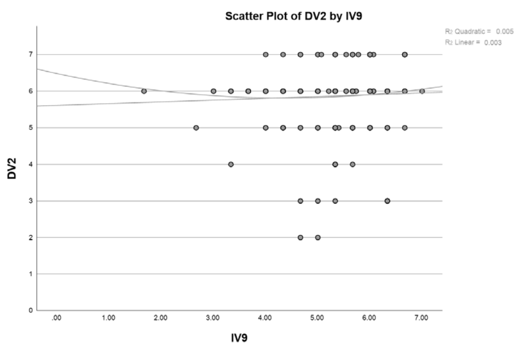

Scatter Plot of DV2 by IV4
R² Quadratic = 0.004
R² Linear = 0.004
DV2
IV4

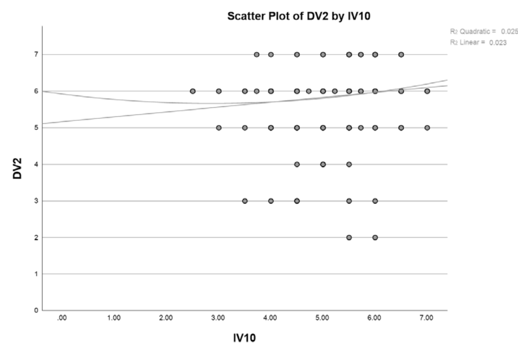

Scatter Plot of DV2 by IV5
R² Quadratic = 2.017E-4
R² Linear = 1.992E-4
DV2
IV5

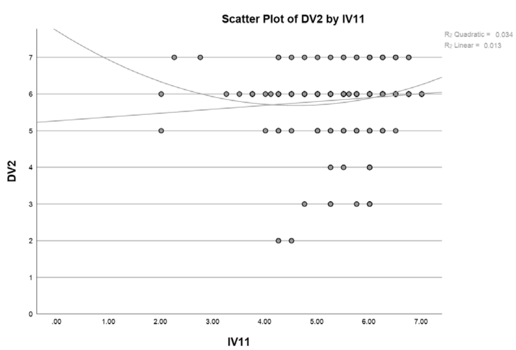

Scatter Plot of DV2 by IV6
R² Quadratic = 0.009
R² Linear = 0.006
DV2
IV6

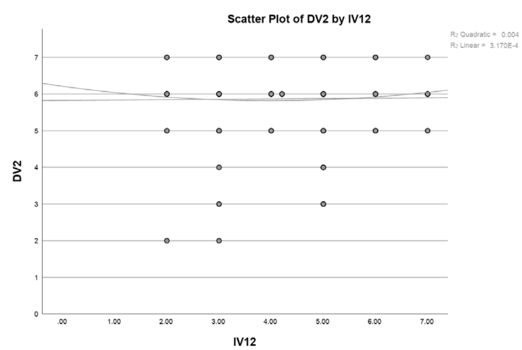

Scatter Plot of DV2 by IV7
R2 Quadratic = 0.010
R2 Linear = 2.550E-4
DV2
IV7

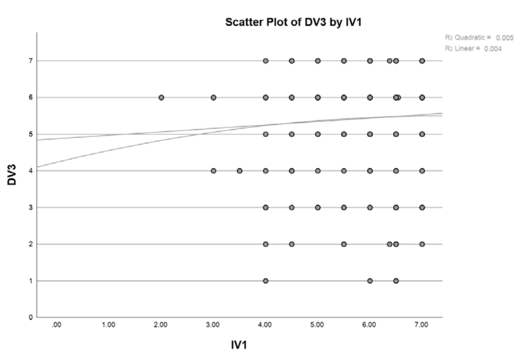

Scatter Plot of DV2 by IV8
R2 Quadratic = 0.007
R2 Linear = 0.005
DV2
IV8

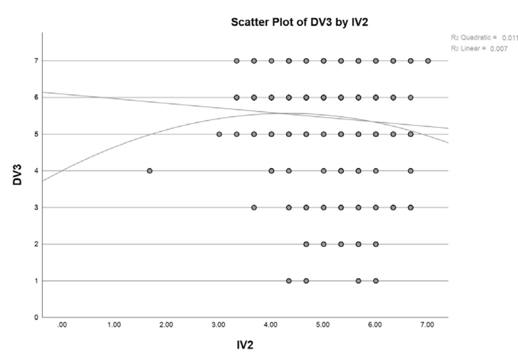

Scatter Plot of DV2 by IV9
R2 Quadratic = 0.005
R2 Linear = 0.003
DV2
IV9

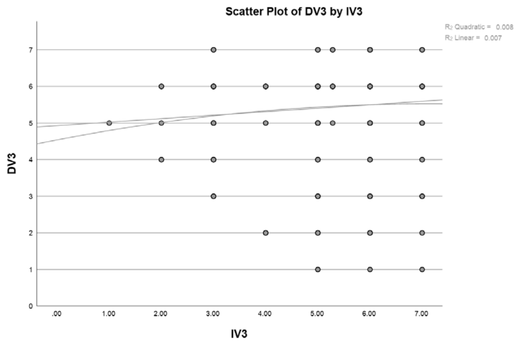

Scatter Plot of DV2 by IV10
R2 Quadratic = 0.025
R2 Linear = 0.023
DV2
IV10

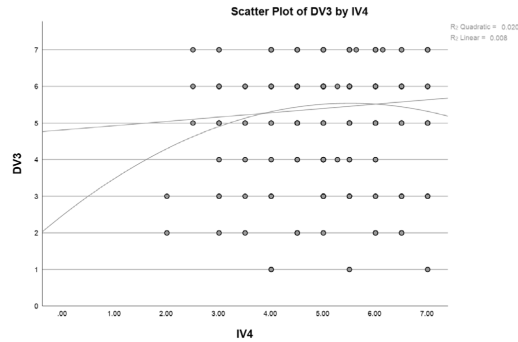

Scatter Plot of DV2 by IV11
R2 Quadratic = 0.034
R2 Linear = 0.013
DV2
IV11

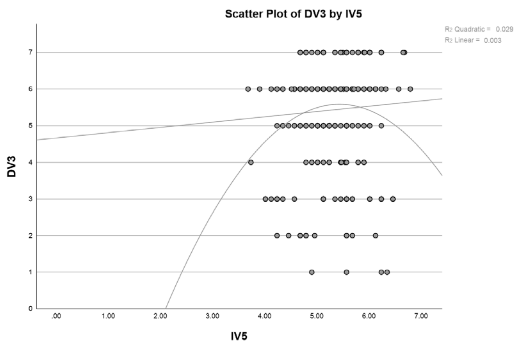

Scatter Plot of DV2 by IV12
R2 Quadratic = 0.004
R2 Linear = 3.170E-4
DV2
IV12

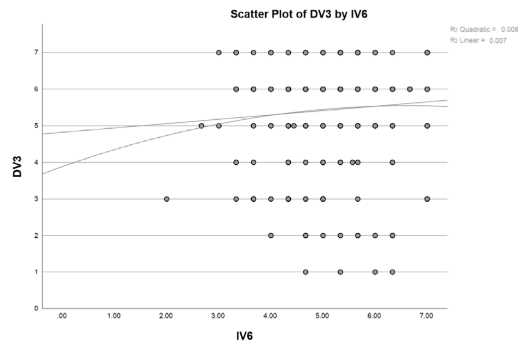

Scatter Plot of DV3 by IV1
R2 Quadratic = 0.005
R2 Linear = 0.004
DV3
IV1

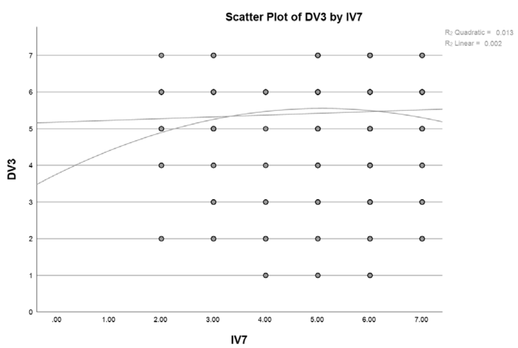

Scatter Plot of DV3 by IV2
R2 Quadratic = 0.011
R2 Linear = 0.007
DV3
IV2

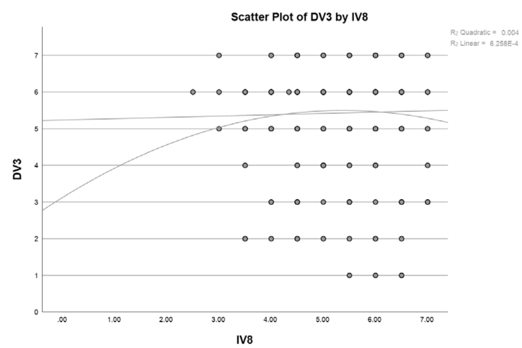

Scatter Plot of DV3 by IV3
DV3
IV3

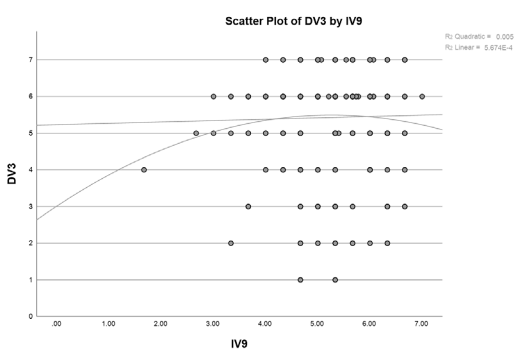

Scatter Plot of DV3 by IV4
DV3
IV4

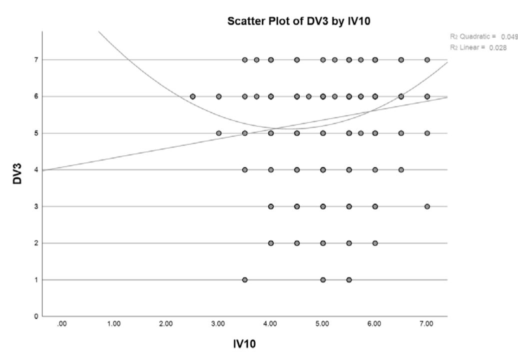

Scatter Plot of DV3 by IV5
DV3
IV5

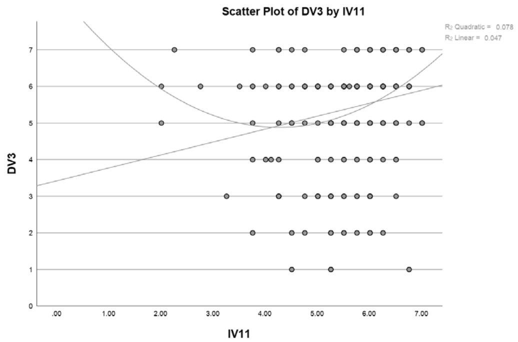

Scatter Plot of DV3 by IV6
DV3
IV6

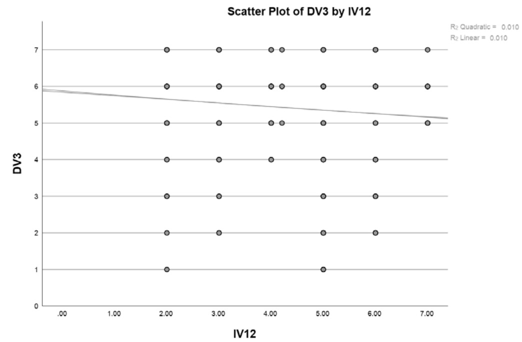

Scatter Plot of DV3 by IV7
DV3
IV7

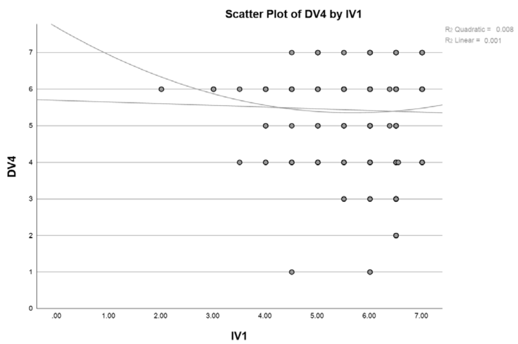

Scatter Plot of DV3 by IV8
DV3
IV8

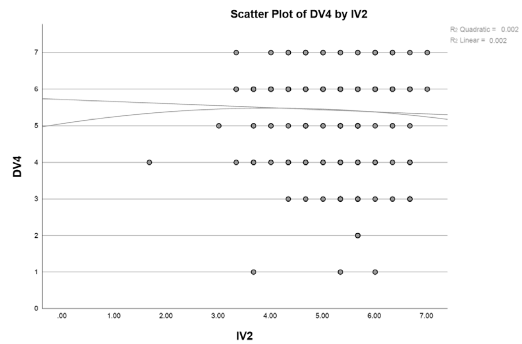

Scatter Plot of DV3 by IV9
DV3
IV9

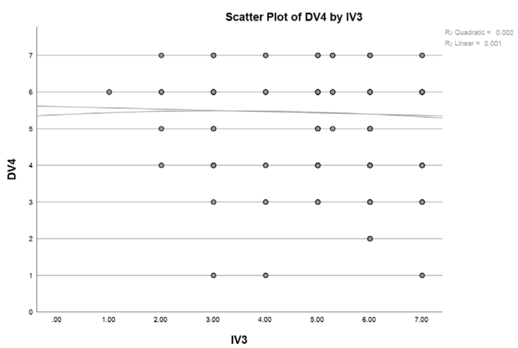

Scatter Plot of DV3 by IV10
DV3
IV10

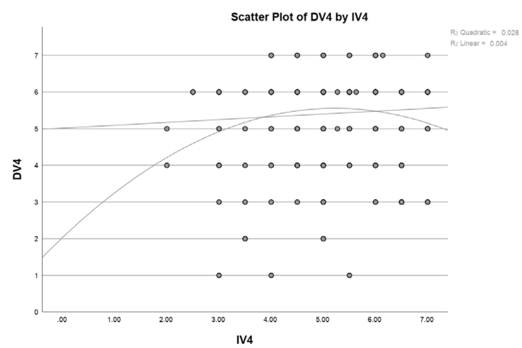

Scatter Plot of DV3 by IV11
R2 Quadratic = 0.078
R2 Linear = 0.047
DV3
IV11

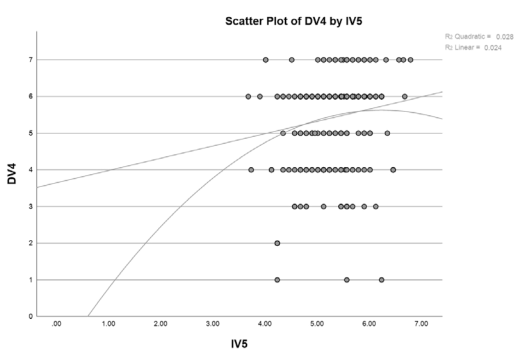

Scatter Plot of DV3 by IV12
R2 Quadratic = 0.010
R2 Linear = 0.010
DV3
IV12

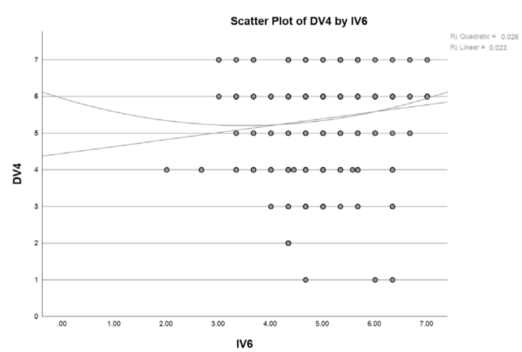

Scatter Plot of DV4 by IV1
R2 Quadratic = 0.008
R2 Linear = 0.001
DV4
IV1

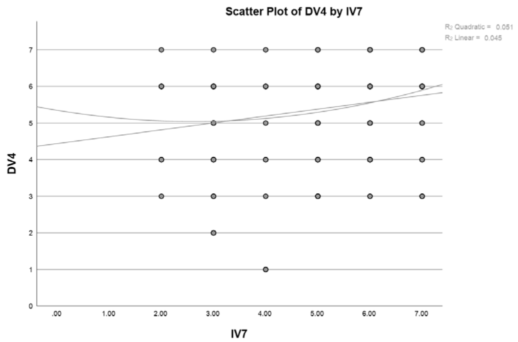

Scatter Plot of DV4 by IV2
R2 Quadratic = 0.002
R2 Linear = 0.002
DV4
IV2

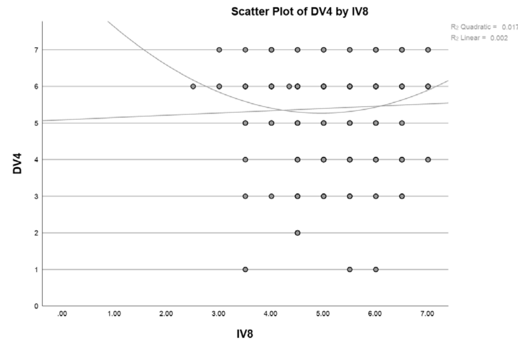

Scatter Plot of DV4 by IV3
R2 Quadratic = 0.002
R2 Linear = 0.001
DV4
IV3

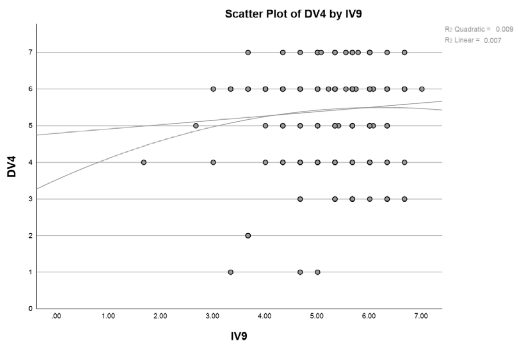

Scatter Plot of DV4 by IV4
R2 Quadratic = 0.028
R2 Linear = 0.004
DV4
IV4

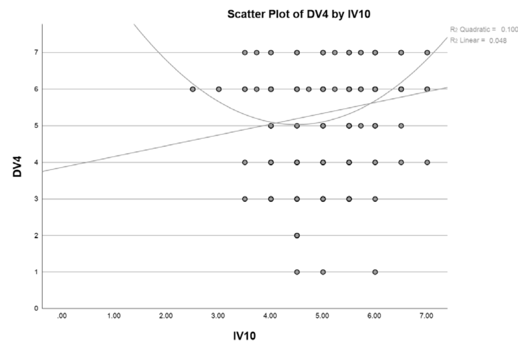

Scatter Plot of DV4 by IV5
R2 Quadratic = 0.028
R2 Linear = 0.024
DV4
IV5

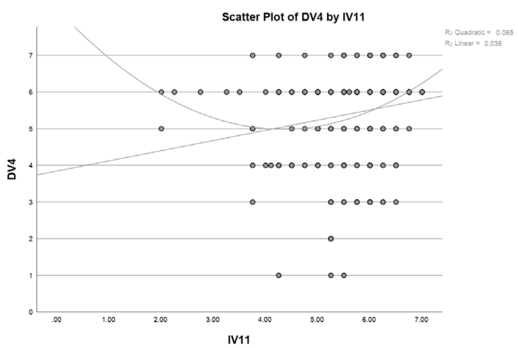

Scatter Plot of DV4 by IV6
R2 Quadratic = 0.026
R2 Linear = 0.023
DV4
IV6

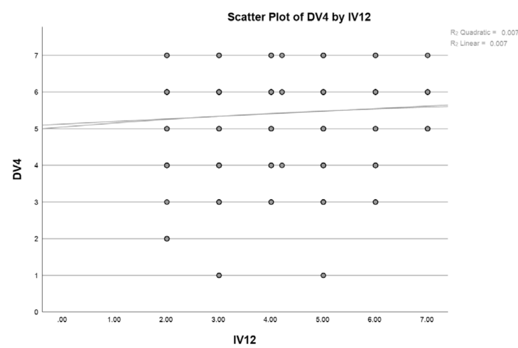

Scatter Plot of DV4 by IV7
R2 Quadratic = 0.051
R2 Linear = 0.045
DV4
IV7


Scatter Plot of DV4 by IV8
R2 Quadratic = 0.017
R2 Linear = 0.002
DV4
IV8


Scatter Plot of DV4 by IV9
R2 Quadratic = 0.009
R2 Linear = 0.007
DV4
IV9


Scatter Plot of DV4 by IV10
R2 Quadratic = 0.100
R2 Linear = 0.048
DV4
IV10


Scatter Plot of DV4 by IV11
R2 Quadratic = 0.065
R2 Linear = 0.036
DV4
IV11


Scatter Plot of DV4 by IV12
R2 Quadratic = 0.007
R2 Linear = 0.007
DV4
IV12

Appendix J: SPSS Output for Multiple Regression Analysis

This appendix contains the SPSS output for the multiple regression analysis used to test the alternative hypotheses H1a, H2a, and H3a. The dependent variable for project success (DV5) was regressed against the four independent variables: management commitment (IV5), face-to-face collaboration (IV6), simplicity (IV10), and team environment (IV11).

Model Summary

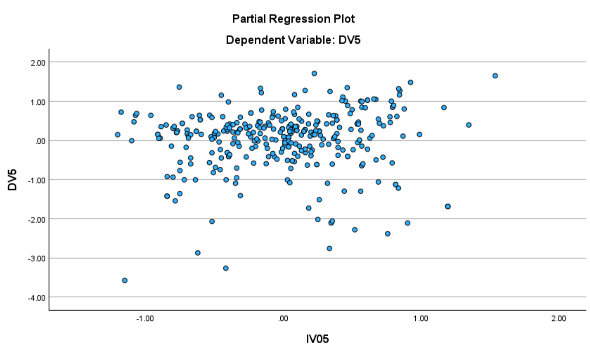
Model Summary[b]

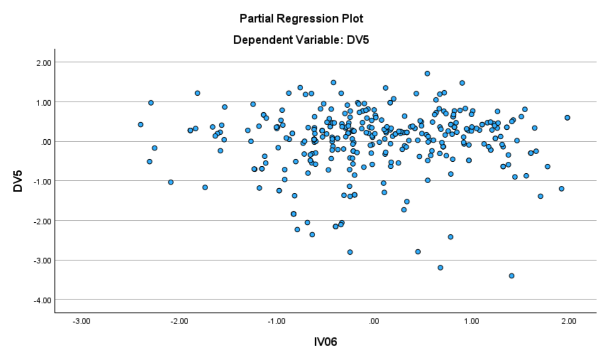
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.300[a]	.090	.079	.78099	1.686

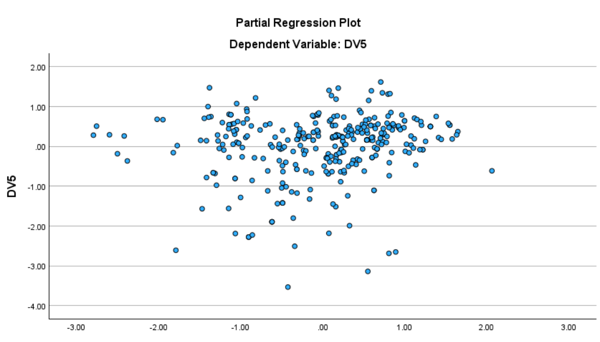
a. Predictors: (Constant), IV11, IV05, IV10, IV06

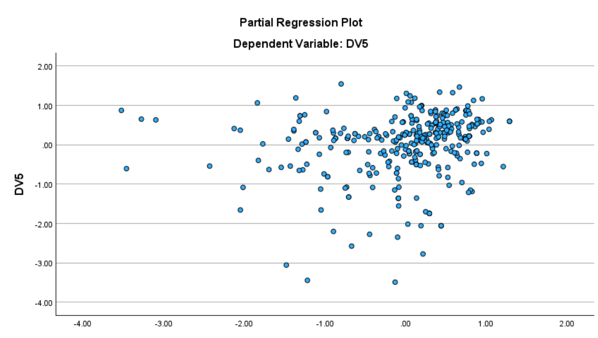
b. Dependent Variable: DV5

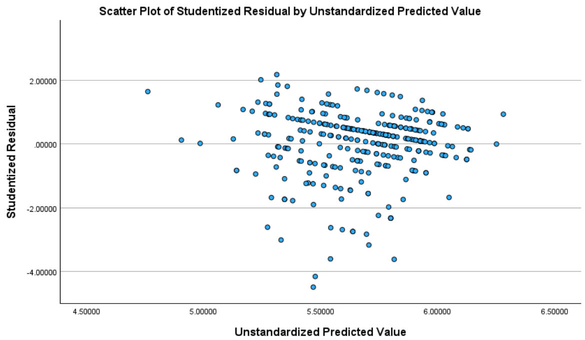
Scatterplots











Correlations

Correlations

		DV5	IV05	IV06	IV10	IV11
Pearson Correlation	DV5	1.000	.130	.115	.208	.228
	IV05	.130	1.000	.321	.152	.141
	IV06	.115	.321	1.000	.014	.220
	IV10	.208	.152	.014	1.000	.174
	IV11	.228	.141	.220	.174	1.000
Sig. (1-tailed)	DV5	.	.007	.016	<.001	<.001
	IV05	.007	.	.000	.002	.004
	IV06	.016	.000	.	.394	.000
	IV10	.000	.002	.394	.	.001
	IV11	.000	.004	.000	.001	.
N	DV5	351	351	351	351	351
	IV05	351	351	351	351	351
	IV06	351	351	351	351	351
	IV10	351	351	351	351	351
	IV11	351	351	351	351	351

Coefficients

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	3.099	.505		6.135	<.001	2.106	4.093					
	IV05	.094	.083	.063	1.141	.254	-.068	.257	.130	.061	.059	.873	1.146
	IV06	.047	.048	.053	.965	.335	-.048	.142	.115	.052	.050	.862	1.160
	IV10	.156	.049	.167	3.166	.002	.059	.253	.208	.168	.162	.949	1.054
	IV11	.180	.054	.179	3.343	<.001	.074	.285	.228	.177	.171	.920	1.087

a. Dependent Variable: DV5

Casewise Diagnostics

Casewise Diagnostics[a]

Case Number	Std. Residual	DV5	Predicted Value	Residual
269	-3.603	3.00	5.8142	-2.81416
306	-4.441	2.00	5.4686	-3.46861
332	-4.132	2.25	5.4770	-3.22701
333	-3.575	2.75	5.5420	-2.79201
339	-3.145	3.25	5.7060	-2.45601

a. Dependent Variable: DV5

High Leverage Points

High leverage points sorted descending

	PRE_1	SRE_1	SDR_1	COO_1	LEV_1
1	5.24474	2.01589	2.02490	.07637	.08304
2	4.76185	1.64642	1.65052	.04257	.06995
3	4.98551	.01921	.01919	.00001	.06503
4	5.43767	-1.23749	-1.23845	.01910	.05587
5	5.31327	1.56345	1.56674	.02868	.05256
6	5.30334	.91161	.91139	.00738	.03968
7	5.06216	1.22708	1.22798	.01331	.03948
8	4.90533	.12371	.12354	.00013	.03710
9	5.26435	.96084	.96074	.00749	.03611
10	5.96638	.69668	.69616	.00385	.03528
11	5.35728	-.14001	-.13981	.00015	.03454
12	5.22244	-.94223	-.94208	.00667	.03334
13	5.28982	-1.68143	-1.68590	.02067	.03242
14	5.28306	.93448	.93431	.00633	.03214
15	5.16877	1.08341	1.08369	.00849	.03206

High leverage points sorted ascending

	PRE_1	SRE_1	SDR_1	COO_1	LEV_1
1	5.75398	.31553	.31512	.00007	.00044
2	5.75398	.31553	.31512	.00007	.00044
3	5.73843	-.30581	-.30541	.00006	.00056
4	5.73843	-.30581	-.30541	.00006	.00056
5	5.73843	.33550	.33507	.00008	.00056
6	5.73843	.33550	.33507	.00008	.00056
7	5.58393	-.10765	-.10750	.00001	.00056
8	5.58393	-.74896	-.74849	.00038	.00056
9	5.78841	.27139	.27103	.00005	.00061
10	5.77286	-.02932	-.02928	.00000	.00073
11	5.76238	.94618	.94603	.00065	.00077
12	5.66028	-.52632	-.52577	.00021	.00089
13	5.78334	.27795	.27758	.00006	.00097
14	5.78334	.27795	.27758	.00006	.00097
15	5.78334	.27795	.27758	.00006	.00097
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Cook's Distance Values

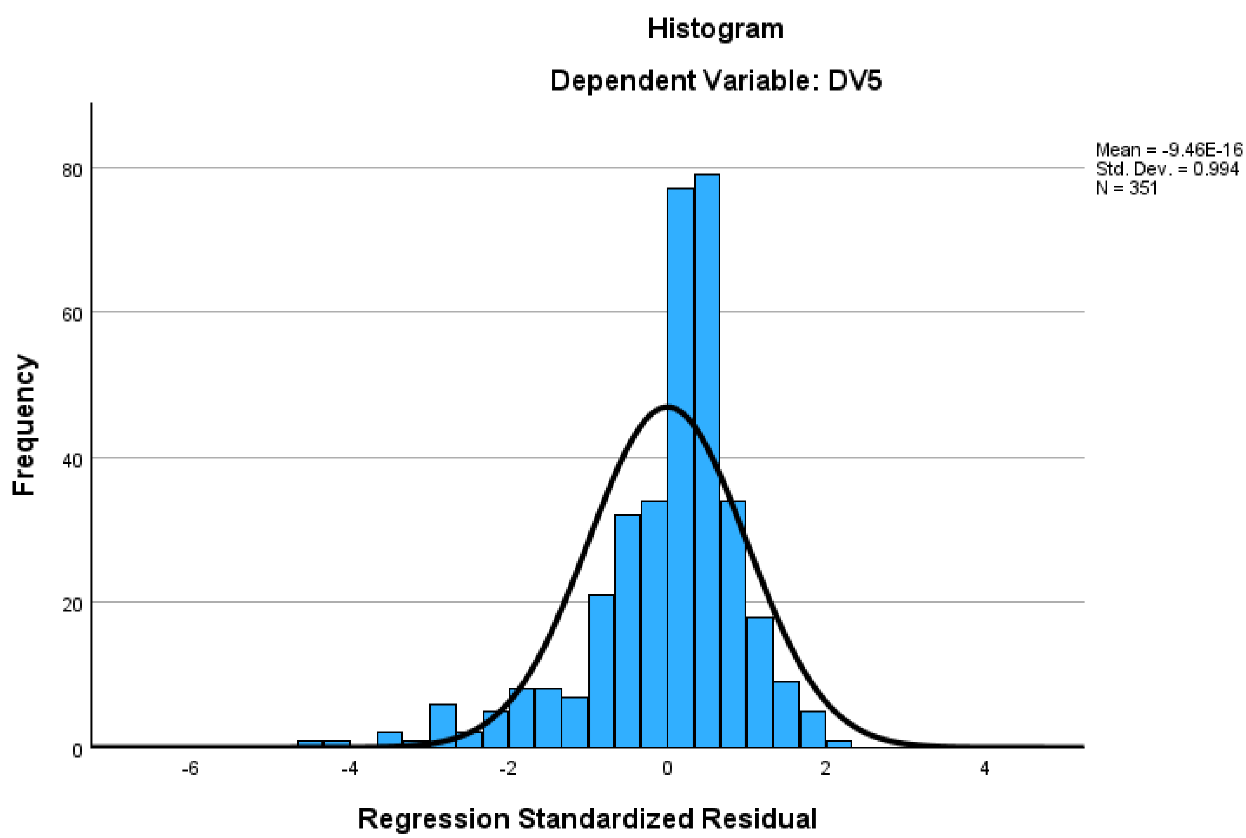
Cook's D value sorted descending

	PRE_1	SRE_1	SDR_1	COO_1	LEV_1
1	5.46861	-4.49238	-4.62273	.09339	.01977
2	5.24474	2.01589	2.02490	.07637	.08304
3	5.54201	-3.60559	-3.66998	.04474	.01407
4	5.47701	-4.15806	-4.25984	.04385	.00967
5	4.76185	1.64642	1.65052	.04257	.06995
6	5.33096	-3.01251	-3.04840	.03408	.01558
7	5.70601	-3.17038	-3.21281	.03293	.01327
8	5.31327	1.56345	1.56674	.02868	.05256
9	5.81416	-3.62034	-3.68558	.02483	.00653
10	5.27322	-2.61162	-2.63393	.02225	.01320
11	5.69592	-2.83098	-2.86021	.02205	.01072
12	5.79951	-2.32737	-2.34241	.02196	.01702
13	5.79951	-2.32737	-2.34241	.02196	.01702
14	5.79951	-2.32737	-2.34241	.02196	.01702
15	5.79951	-2.32737	-2.34241	.02196	.01702

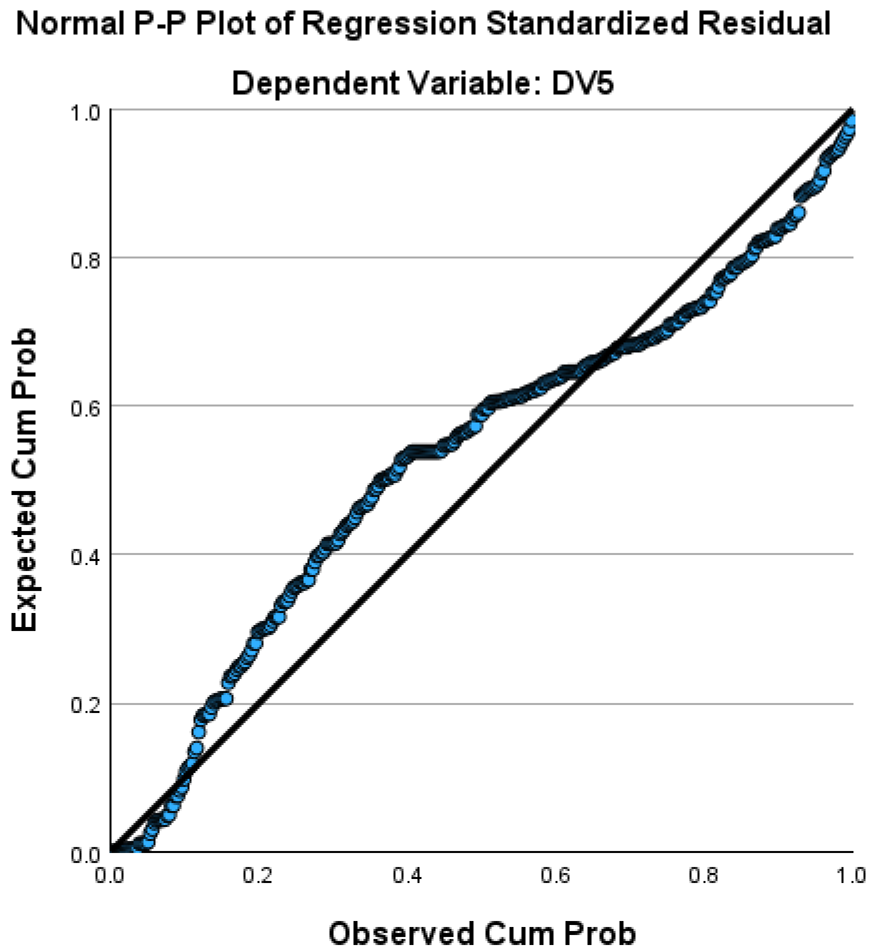
Cook's D value sorted ascending

	PRE_1	SRE_1	SDR_1	COO_1	LEV_1
1	5.74857	.00184	.00184	.00000	.00151
2	6.25118	-.00153	-.00153	.00000	.02076
3	5.74650	.00450	.00449	.00000	.00302
4	5.74355	.00829	.00828	.00000	.00472
5	5.49468	.00691	.00690	.00000	.02597
6	5.76451	-.01864	-.01862	.00000	.00424
7	5.77286	-.02932	-.02928	.00000	.00073
8	5.77465	-.03166	-.03161	.00000	.00328
9	5.98563	.01857	.01854	.00000	.01606
10	5.98563	.01857	.01854	.00000	.01606
11	5.72316	.03457	.03452	.00000	.00889
12	4.98551	.01921	.01919	.00001	.06503
13	5.96570	.04428	.04422	.00001	.01383
14	5.94590	.06953	.06943	.00001	.00463
15	5.58393	-.10765	-.10750	.00001	.00056

Standardized Residual Histogram



P-P Plot of Regression Standardized Residual



ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20.817	4	5.204	8.532	<.001[b]
	Residual	211.042	346	.610		
	Total	231.859	350			

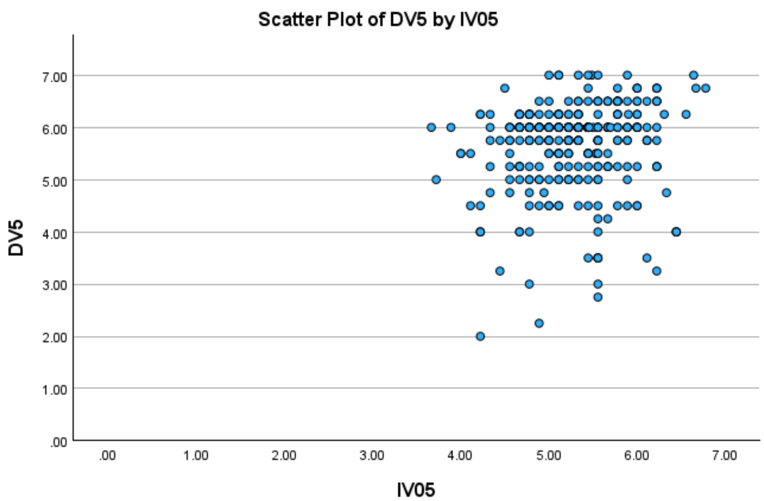
a. Dependent Variable: DV5

b. Predictors: (Constant), IV11, IV05, IV10, IV06

Appendix K: SPSS Output for H8a Regression Analysis

This appendix contains the SPSS output for the linear regression analysis used to test the alternative hypotheses H8a. The dependent variable for project success (DV5) was regressed against the independent variable management commitment (IV5).

Scatterplot



Correlations

Correlations where $N = 351$

Correlations

		IV05	DV5
IV05	Pearson Correlation	1	.130*
	Sig. (2-tailed)		.015
	N	351	351
DV5	Pearson Correlation	.130*	1
	Sig. (2-tailed)	.015	
	N	351	351

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations where $N = 345$ after excluding the six potential outliers to determine if they should be excluded from the regression analysis.

Correlations

		IV05	DV5
IV05	Pearson Correlation	1	.129*
	Sig. (2-tailed)		.016
	N	345	345
DV5	Pearson Correlation	.129*	1
	Sig. (2-tailed)	.016	
	N	345	345

*. Correlation is significant at the 0.05 level (2-tailed).

Model Summary

Model Summary where $N = 351$

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.130[a]	.017	.014	.80812	1.696

a. Predictors: (Constant), IV05

b. Dependent Variable: DV5

Model Summary where $N = 345$

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.129[a]	.017	.014	.71174	1.645

a. Predictors: (Constant), IV05

b. Dependent Variable: DV5

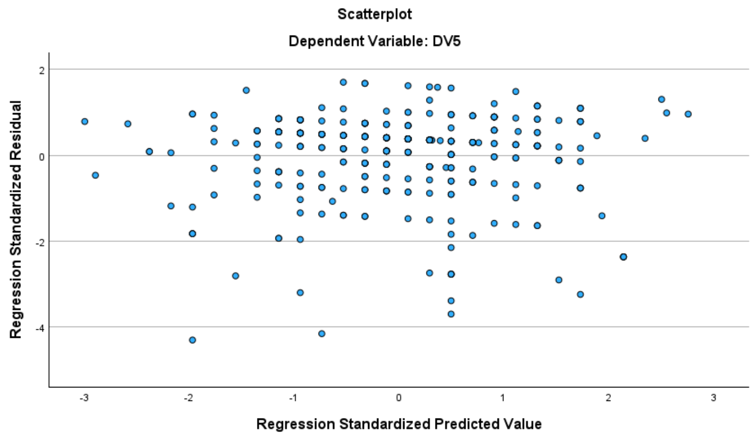
Casewise Diagnostics

Casewise Diagnostics[a]

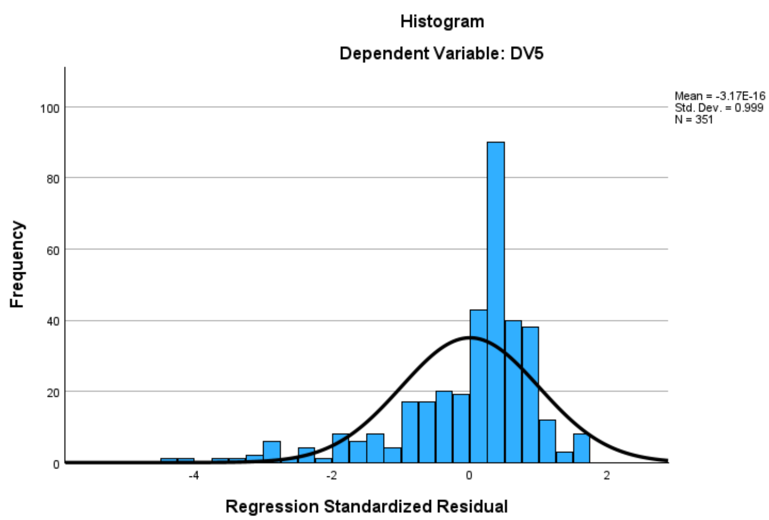
Case Number	Std. Residual	DV5	Predicted Value	Residual
269	-3.195	3.00	5.5818	-2.58177
276	-3.384	3.00	5.7343	-2.73433
306	-4.297	2.00	5.4728	-3.47279
332	-4.150	2.25	5.6036	-3.35356
333	-3.693	2.75	5.7343	-2.98433
339	-3.236	3.25	5.8651	-2.61510

a. Dependent Variable: DV5

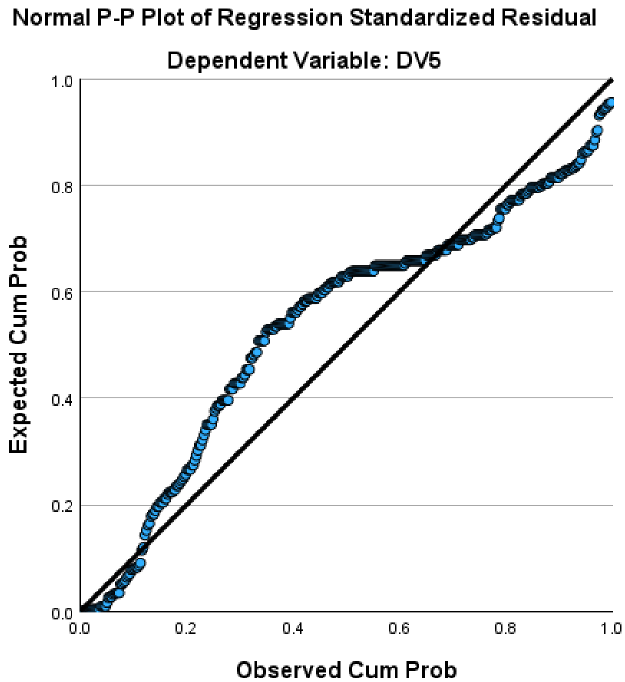
Scatterplot to test Homoscedasticity



Standardized Residual Histogram



P-P Plot of Regression Standardized Residual



ANOVA

ANOVA where *N* = 351

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.939	1	3.939	6.031	.015[b]
	Residual	227.920	349	.653		
	Total	231.859	350			

a. Dependent Variable: DV5

b. Predictors: (Constant), IV05

ANOVA where *N* = 345

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.960	1	2.960	5.843	.016[b]
	Residual	173.757	343	.507		
	Total	176.717	344			

a. Dependent Variable: DV5

b. Predictors: (Constant), IV05

Coefficients

Coefficients[a]

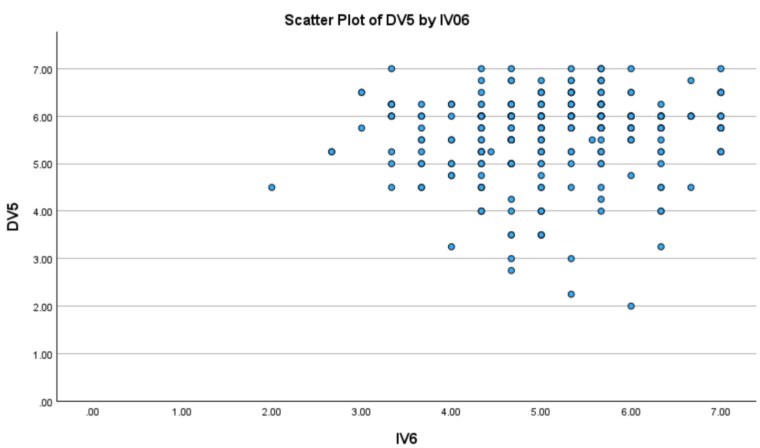
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	4.645	.424		10.942	<.001	3.810	5.479
	IV05	.196	.080	.130	2.456	.015	.039	.353

a. Dependent Variable: DV5

Appendix L: SPSS Output for H9a Regression Analysis

This appendix contains the SPSS output for the linear regression analysis used to test the alternative hypotheses H9a. The dependent variable for project success (DV5) was regressed against the independent variable face-to-face collaboration (IV6).

Scatterplot



Correlations

Correlations where $N = 351$

Correlations

		DV5	IV06
DV5	Pearson Correlation	1	.115*
	Sig. (2-tailed)		.031
	N	351	351
IV06	Pearson Correlation	.115*	1
	Sig. (2-tailed)	.031	
	N	351	351

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations where $N = 345$ after excluding the six potential outliers to determine if they should be excluded from the regression analysis.

Correlations

		DV5	IV06
DV5	Pearson Correlation	1	.153**
	Sig. (2-tailed)		.004
	N	345	345
IV06	Pearson Correlation	.153**	1
	Sig. (2-tailed)	.004	
	N	345	345

**. Correlation is significant at the 0.01 level (2-tailed).

Model Summary

Model Summary where $N = 351$

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.115[a]	.013	.010	.80966	1.698

a. Predictors: (Constant), IV06

b. Dependent Variable: DV5

Model Summary where $N = 345$

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.153[a]	.023	.021	.70931	1.646

a. Predictors: (Constant), IV06

b. Dependent Variable: DV5

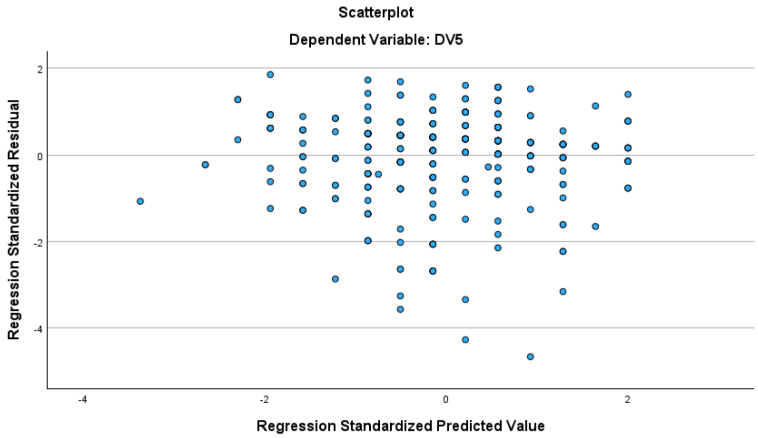
Casewise Diagnostics

Casewise Diagnostics[a]

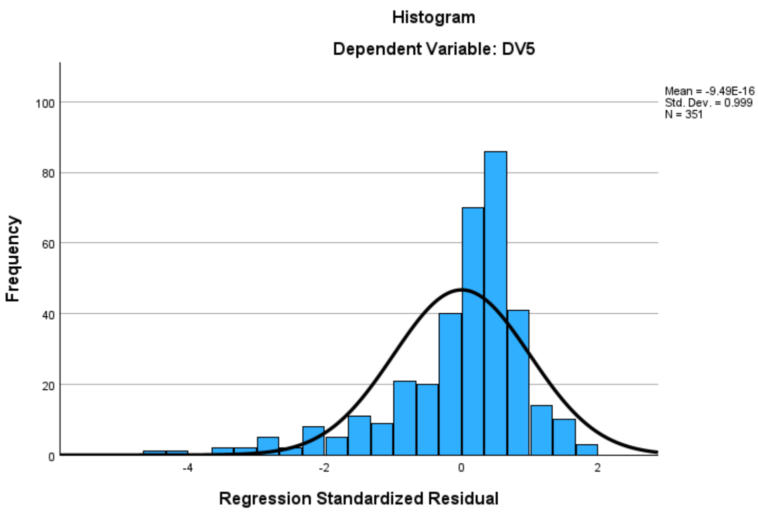
Case Number	Std. Residual	DV5	Predicted Value	Residual
269	-3.337	3.00	5.7017	-2.70170
276	-3.254	3.00	5.6346	-2.63458
306	-4.655	2.00	5.7688	-3.76882
332	-4.263	2.25	5.7017	-3.45170
333	-3.563	2.75	5.6346	-2.88458
339	-3.152	3.25	5.8024	-2.55238

a. Dependent Variable: DV5

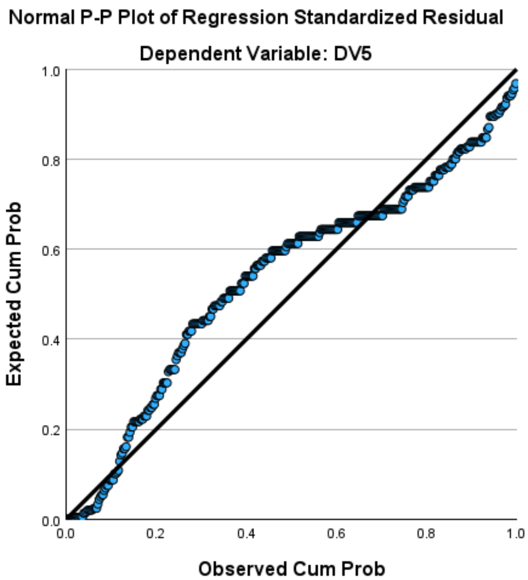
Scatterplot to test Homoscedasticity



Standardized Residual Histogram



P-P Plot of Regression Standardized Residual



ANOVA

ANOVA where $N = 351$

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.073	1	3.073	4.687	.031[b]
	Residual	228.786	349	.656		
	Total	231.859	350			

a. Dependent Variable: DV5

b. Predictors: (Constant), IV06

ANOVA where $N = 345$

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.148	1	4.148	8.244	.004[b]
	Residual	172.569	343	.503		
	Total	176.717	344			

a. Dependent Variable: DV5

b. Predictors: (Constant), IV06

Coefficients

Coefficients[a]

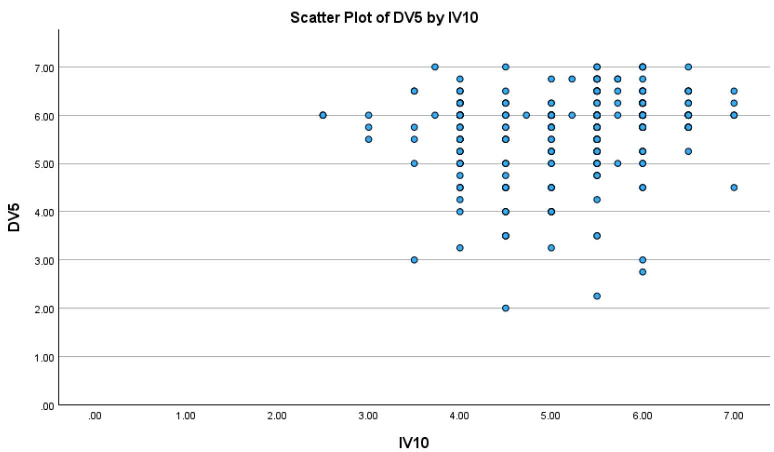
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	5.165	.243		21.286	<.001	4.688	5.642
	IV06	.101	.047	.115	2.165	.031	.009	.192

a. Dependent Variable: DV5

Appendix M: SPSS Output for H13a Regression Analysis

This appendix contains the SPSS output for the linear regression analysis used to test the alternative hypotheses H13a. The dependent variable for project success (DV5) was regressed against the independent variable simplicity (IV10).

Scatterplot



Correlations

Correlations where $N = 351$

Correlations

		DV5	IV10
DV5	Pearson Correlation	1	.208**
	Sig. (2-tailed)		<.001
	N	351	351
IV10	Pearson Correlation	.208**	1
	Sig. (2-tailed)	<.001	
	N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations where $N = 347$ after excluding the four potential outliers to determine if they should be excluded from the regression analysis.

Correlations

		DV5	IV10
DV5	Pearson Correlation	1	.240**
	Sig. (2-tailed)		<.001
	N	347	347
IV10	Pearson Correlation	.240**	1
	Sig. (2-tailed)	<.001	
	N	347	347

**. Correlation is significant at the 0.01 level (2-tailed).

Model Summary

Model Summary where *N* = 351

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.208[a]	.043	.041	.79724	1.713

a. Predictors: (Constant), IV10

b. Dependent Variable: DV5

Model Summary where *N* = 347

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.240[a]	.057	.055	.72101	1.671

a. Predictors: (Constant), IV10

b. Dependent Variable: DV5

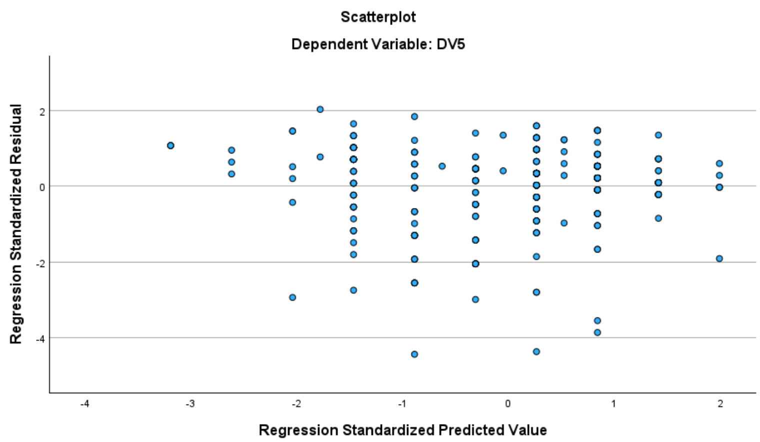
Casewise Diagnostics

Casewise Diagnostics[a]

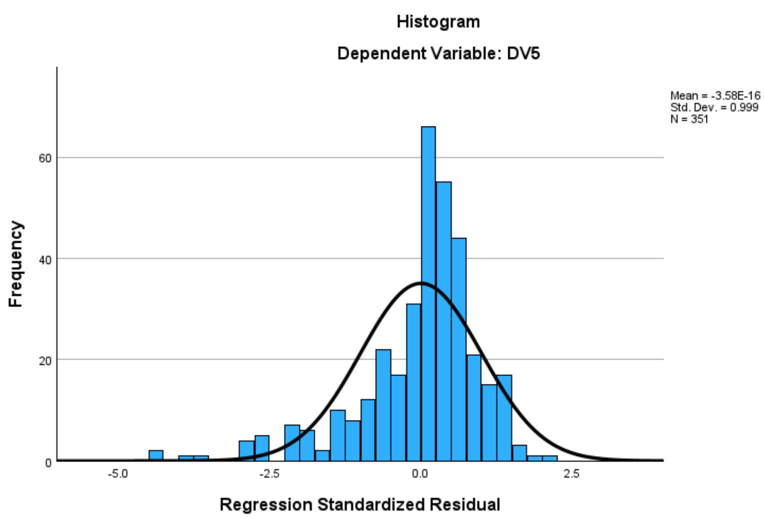
Case Number	Std. Residual	DV5	Predicted Value	Residual
269	-3.542	3.00	5.8236	-2.82358
306	-4.429	2.00	5.5311	-3.53106
332	-4.360	2.25	5.7261	-3.47608
333	-3.855	2.75	5.8236	-3.07358

a. Dependent Variable: DV5

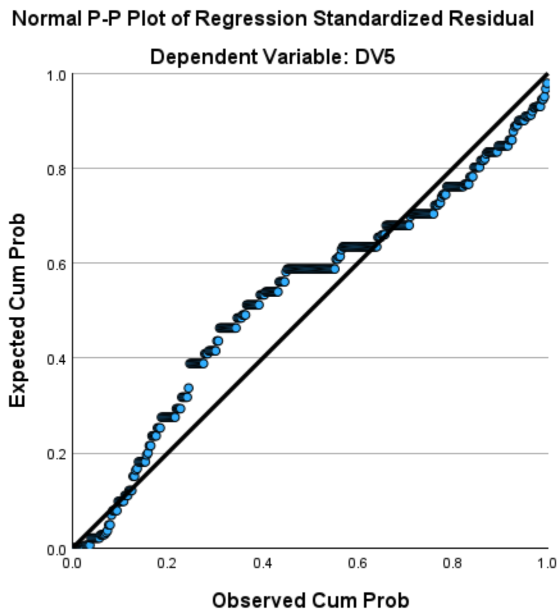
Scatterplot to test Homoscedasticity



Standardized Residual Histogram



P-P Plot of Regression Standardized Residual



ANOVA

ANOVA where $N = 351$

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.035	1	10.035	15.788	<.001[b]
	Residual	221.824	349	.636		
	Total	231.859	350			

a. Dependent Variable: DV5

b. Predictors: (Constant), IV10

ANOVA where $N = 347$

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.925	1	10.925	21.015	<.001[b]
	Residual	179.351	345	.520		
	Total	190.276	346			

a. Dependent Variable: DV5

b. Predictors: (Constant), IV10

Coefficients

Coefficients[a]

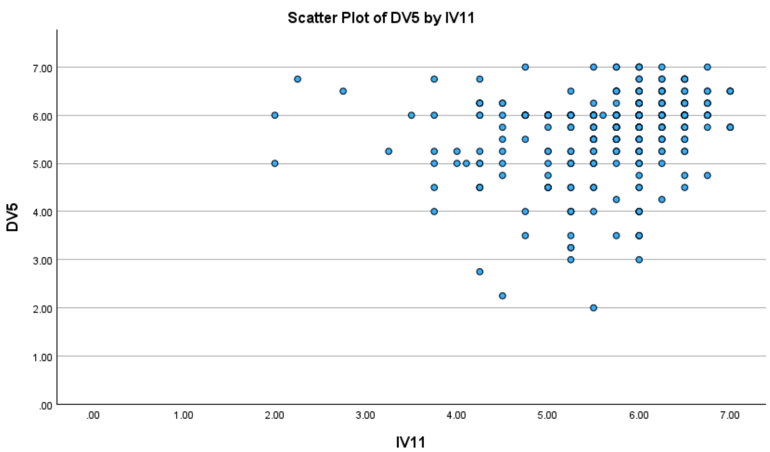
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	4.653	.262		17.746	<.001	4.138	5.169
	IV10	.195	.049	.208	3.973	<.001	.098	.292

a. Dependent Variable: DV5

Appendix N: SPSS Output for H14a Regression Analysis

This appendix contains the SPSS output for the linear regression analysis used to test the alternative hypotheses H14a. The dependent variable for project success (DV5) was regressed against the independent variable team environment (IV11).

Scatterplot



Correlations

Correlations where $N = 351$

Correlations

		DV5	IV11
DV5	Pearson Correlation	1	.228**
	Sig. (2-tailed)		<.001
	N	351	351
IV11	Pearson Correlation	.228**	1
	Sig. (2-tailed)	<.001	
	N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations where $N = 346$ after excluding the five potential outliers to determine if they should be excluded from the regression analysis.

Correlations

		DV5	IV11
DV5	Pearson Correlation	1	.213**
	Sig. (2-tailed)		<.001
	N	346	346
IV11	Pearson Correlation	.213**	1
	Sig. (2-tailed)	<.001	
	N	346	346

**. Correlation is significant at the 0.01 level (2-tailed).

Model Summary

Model Summary where *N* = 351

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.228[a]	.052	.049	.79356	1.649

a. Predictors: (Constant), IV11

b. Dependent Variable: DV5

Model Summary where *N* = 346

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.213[a]	.045	.043	.71233	1.573

a. Predictors: (Constant), IV11

b. Dependent Variable: DV5

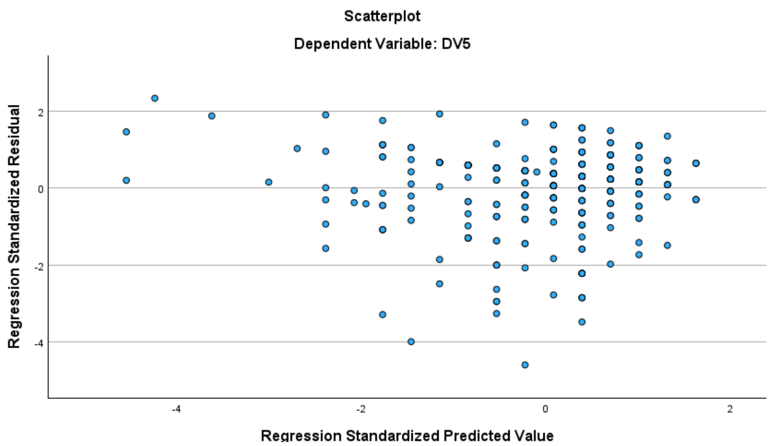
Casewise Diagnostics

Casewise Diagnostics[a]

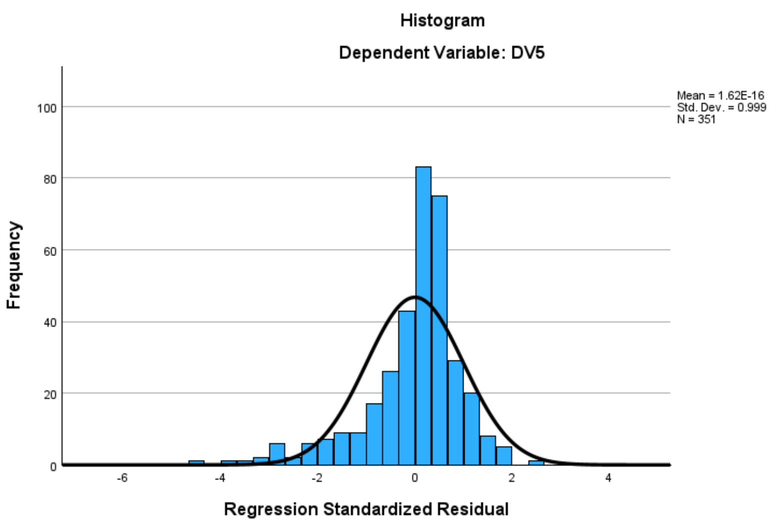
Case Number	Std. Residual	DV5	Predicted Value	Residual
269	-3.472	3.00	5.7550	-2.75503
276	-3.255	3.00	5.5829	-2.58295
306	-4.587	2.00	5.6403	-3.64031
332	-3.983	2.25	5.4109	-3.16087
333	-3.281	2.75	5.3535	-2.60351

a. Dependent Variable: DV5

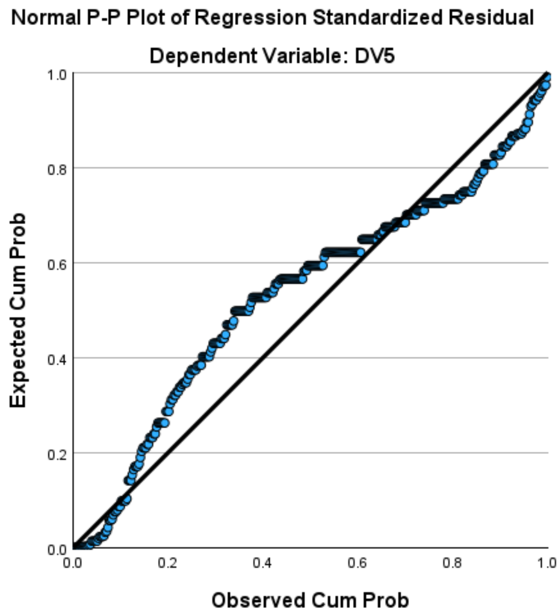
Scatterplot to test Homoscedasticity



Standardized Residual Histogram



P-P Plot of Regression Standardized Residual



ANOVA

ANOVA where $N = 351$

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.079	1	12.079	19.180	<.001[b]
	Residual	219.780	349	.630		
	Total	231.859	350			

a. Dependent Variable: DV5

b. Predictors: (Constant), IV11

ANOVA where $N = 346$

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.314	1	8.314	16.385	<.001[b]
	Residual	174.552	344	.507		
	Total	182.866	345			

a. Dependent Variable: DV5

b. Predictors: (Constant), IV11

Coefficients

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	4.378	.301		14.567	<.001	3.787	4.970
	IV11	.229	.052	.228	4.380	<.001	.126	.332

a. Dependent Variable: DV5

Appendix O: SPSS Output for Correlation and Regression Analysis of Project Quality

This appendix contains the SPSS output for the Spearman's Rho correlation analysis and the linear regression analysis used to investigate the relationship between the independent variables and the cost component of project success. The Spearman's Rho test revealed that six independent variables had a statistically significant correlation with the dependent variable, project quality (DV1). The results of the correlation analysis are shown below. Next, the dependent variable for project quality (DV1) was regressed against the six independent variables that the correlation analysis revealed it has a statistically significant relationship with – satisfying the customer through early and continuous delivery of valuable software (IV1), frequent collaboration between the project team members (IV4), management commitment (IV5), face-to-face collaboration (IV6), technical excellence and good design (IV9), team environment (IV11). The results of the regression analysis are shown below.

Spearman's Rho

Correlations

			DV1	IV01
Spearman's rho	DV1	Correlation Coefficient	1.000	.143**
		Sig. (2-tailed)	.	.007
		N	351	351
	IV01	Correlation Coefficient	.143**	1.000
		Sig. (2-tailed)	.007	.
		N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			DV1	IV02
Spearman's rho	DV1	Correlation Coefficient	1.000	-.004
		Sig. (2-tailed)	.	.939
		N	351	351
	IV02	Correlation Coefficient	-.004	1.000
		Sig. (2-tailed)	.939	.
		N	351	351

Correlations

			DV1	IV03
Spearman's rho	DV1	Correlation Coefficient	1.000	.084
		Sig. (2-tailed)	.	.116
		N	351	351
	IV03	Correlation Coefficient	.084	1.000
		Sig. (2-tailed)	.116	.
		N	351	351

Correlations

			DV1	IV04
Spearman's rho	DV1	Correlation Coefficient	1.000	.221**
		Sig. (2-tailed)	.	<.001
		N	351	351
	IV04	Correlation Coefficient	.221**	1.000
		Sig. (2-tailed)	<.001	.
		N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			DV1	IV05
Spearman's rho	DV1	Correlation Coefficient	1.000	.196**
		Sig. (2-tailed)	.	<.001
		N	351	351
	IV05	Correlation Coefficient	.196**	1.000
		Sig. (2-tailed)	<.001	.
		N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			DV1	IV06
Spearman's rho	DV1	Correlation Coefficient	1.000	.119*
		Sig. (2-tailed)	.	.026
		N	351	351
	IV06	Correlation Coefficient	.119*	1.000
		Sig. (2-tailed)	.026	.
		N	351	351

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			DV1	IV07
Spearman's rho	DV1	Correlation Coefficient	1.000	-.012
		Sig. (2-tailed)	.	.828
		N	351	351
	IV07	Correlation Coefficient	-.012	1.000
		Sig. (2-tailed)	.828	.
		N	351	351

Correlations

			DV1	IV08
Spearman's rho	DV1	Correlation Coefficient	1.000	-.008
		Sig. (2-tailed)	.	.880
		N	351	351
	IV08	Correlation Coefficient	-.008	1.000
		Sig. (2-tailed)	.880	.
		N	351	351

Correlations

			DV1	IV09
Spearman's rho	DV1	Correlation Coefficient	1.000	.125*
		Sig. (2-tailed)	.	.019
		N	351	351
	IV09	Correlation Coefficient	.125*	1.000
		Sig. (2-tailed)	.019	.
		N	351	351

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			DV1	IV10
Spearman's rho	DV1	Correlation Coefficient	1.000	.096
		Sig. (2-tailed)	.	.073
		N	351	351
	IV10	Correlation Coefficient	.096	1.000
		Sig. (2-tailed)	.073	.
		N	351	351

Correlations

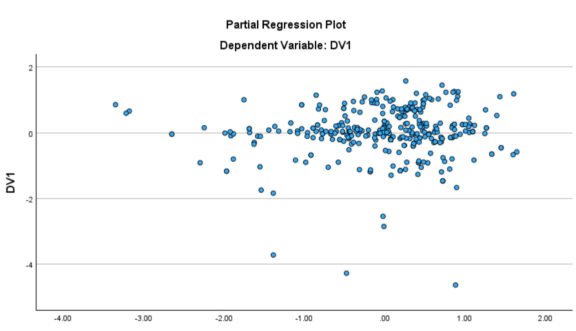
			DV1	IV11
Spearman's rho	DV1	Correlation Coefficient	1.000	.200**
		Sig. (2-tailed)	.	<.001
		N	351	351
	IV11	Correlation Coefficient	.200**	1.000
		Sig. (2-tailed)	<.001	.
		N	351	351

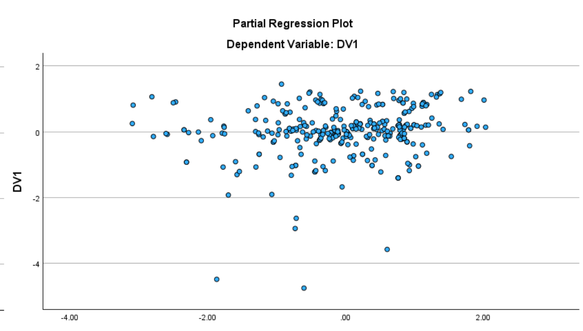
**. Correlation is significant at the 0.01 level (2-tailed).

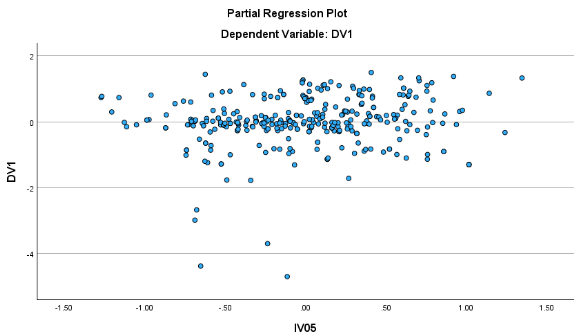
Correlations

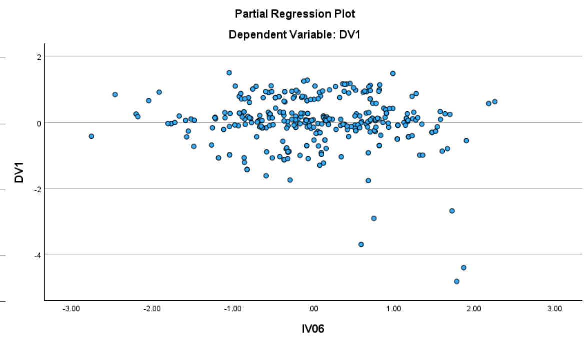
			DV1	IV12
Spearman's rho	DV1	Correlation Coefficient	1.000	-.072
		Sig. (2-tailed)	.	.180
		N	351	351
	IV12	Correlation Coefficient	-.072	1.000
		Sig. (2-tailed)	.180	.
		N	351	351

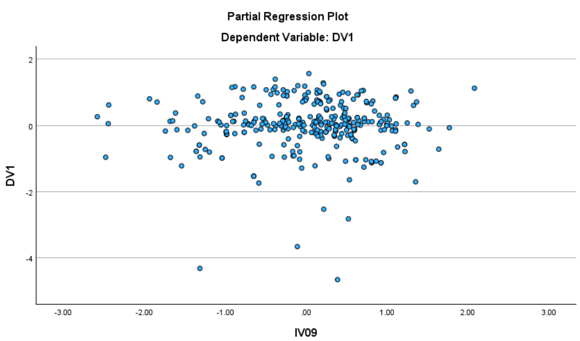
Scatterplot

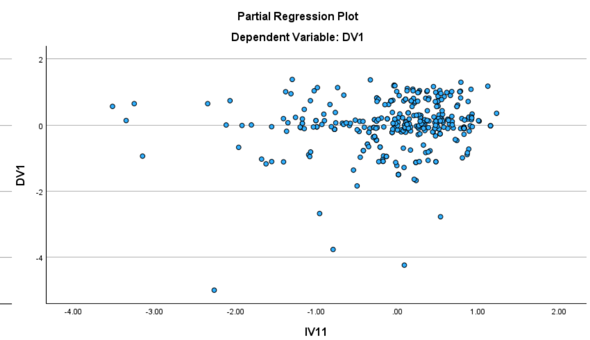


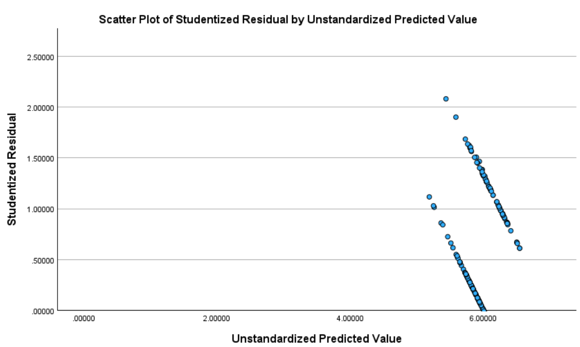












Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.315[a]	.099	.083	.759	1.847

a. Predictors: (Constant), IV11, IV09, IV04, IV06, IV01, IV05

b. Dependent Variable: DV1

Correlations

Correlations

		DV1	IV01	IV04	IV05	IV06	IV09	IV11
Pearson Correlation	DV1	1.000	.158	.209	.195	.040	.135	.185
	IV01	.158	1.000	.179	.221	.150	.322	.281
	IV04	.209	.179	1.000	.259	.260	.156	.134
	IV05	.195	.221	.259	1.000	.321	.312	.141
	IV06	.040	.150	.260	.321	1.000	.212	.220
	IV09	.135	.322	.156	.312	.212	1.000	.110
	IV11	.185	.281	.134	.141	.220	.110	1.000
Sig. (1-tailed)	DV1	.	.001	<.001	<.001	.228	.006	<.001
	IV01	.001	.	.000	.000	.002	.000	.000
	IV04	.000	.000	.	.000	.000	.002	.006
	IV05	.000	.000	.000	.	.000	.000	.004
	IV06	.228	.002	.000	.000	.	.000	.000
	IV09	.006	.000	.002	.000	.000	.	.019
	IV11	.000	.000	.006	.004	.000	.019	.
N	DV1	351	351	351	351	351	351	351
	IV01	351	351	351	351	351	351	351
	IV04	351	351	351	351	351	351	351
	IV05	351	351	351	351	351	351	351
	IV06	351	351	351	351	351	351	351
	IV09	351	351	351	351	351	351	351
	IV11	351	351	351	351	351	351	351

Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	3.369	.492		6.851	<.001	2.402	4.336					
	IV01	.048	.049	.056	.994	.321	-.047	.144	.158	.054	.051	.819	1.221
	IV04	.125	.042	.162	2.969	.003	.042	.208	.209	.158	.152	.884	1.131
	IV05	.197	.084	.135	2.357	.019	.033	.362	.195	.126	.121	.802	1.247
	IV06	-.083	.048	-.097	-1.726	.085	-.177	.012	.040	-.093	-.088	.830	1.205
	IV09	.051	.053	.054	.962	.337	-.053	.155	.135	.052	.049	.826	1.211
	IV11	.141	.053	.144	2.651	.008	.036	.246	.185	.142	.136	.886	1.128

a. Dependent Variable: DV1

Casewise Diagnostics

Casewise Diagnostics[a]

Case Number	Std. Residual	DV1	Predicted Value	Residual
49	-6.153	1	5.67	-4.670
89	-3.748	3	5.84	-2.845
214	-3.342	3	5.54	-2.537
306	-5.593	1	5.25	-4.245
332	-4.805	2	5.65	-3.647

a. Dependent Variable: DV1

High Leverage Points

High leverage points sorted descending

	PRE_1_DV1	SRE_1_DV1	SDR_1_DV1	COO_1_DV1	LEV_1_DV1
1	5.93774	1.46554	1.46800	.02964	.08525
2	5.38875	.84147	.84112	.00929	.08126
3	5.18631	1.11632	1.11672	.01502	.07496
4	5.24884	1.02854	1.02862	.01212	.07138
5	5.25909	1.01407	1.01411	.01164	.07058
6	5.49321	-.67306	-.67253	.00472	.06510
7	5.89325	1.50772	1.51052	.02247	.06186
8	5.98138	1.38640	1.38826	.01847	.06016
9	5.60476	.53517	.53462	.00230	.05047
10	5.51024	.66120	.66066	.00313	.04483
11	5.79825	-1.07685	-1.07710	.00803	.04337
12	5.24513	-5.72648	-6.01187	.22655	.04328
13	5.46318	.72376	.72326	.00354	.04227
14	6.64907	-.87476	-.87446	.00508	.04153
15	5.36248	.85919	.85887	.00490	.04152

High leverage points sorted ascending

	PRE_1_DV1	SRE_1_DV1	SDR_1_DV1	COO_1_DV1	LEV_1_DV1
1	5.99799	.00265	.00265	.00000	.00109
2	5.99739	1.32380	1.32526	.00109	.00151
3	6.01515	-1.34038	-1.34194	.00113	.00155
4	6.05268	-.06957	-.06947	.00000	.00200
5	6.14622	-.19316	-.19289	.00003	.00250
6	6.04125	1.26653	1.26765	.00124	.00252
7	5.98525	.01949	.01946	.00000	.00253
8	6.03122	-.04125	-.04119	.00000	.00275
9	6.23770	1.00727	1.00729	.00086	.00302
10	6.07849	-.10373	-.10358	.00001	.00337
11	6.08488	1.20949	1.21030	.00133	.00349
12	6.06450	-.08526	-.08513	.00001	.00359
13	5.90724	-1.19916	-1.19992	.00134	.00365
14	6.18599	-.24590	-.24556	.00006	.00411
15	5.93885	.08084	.08073	.00001	.00412

Cook's Distance Values

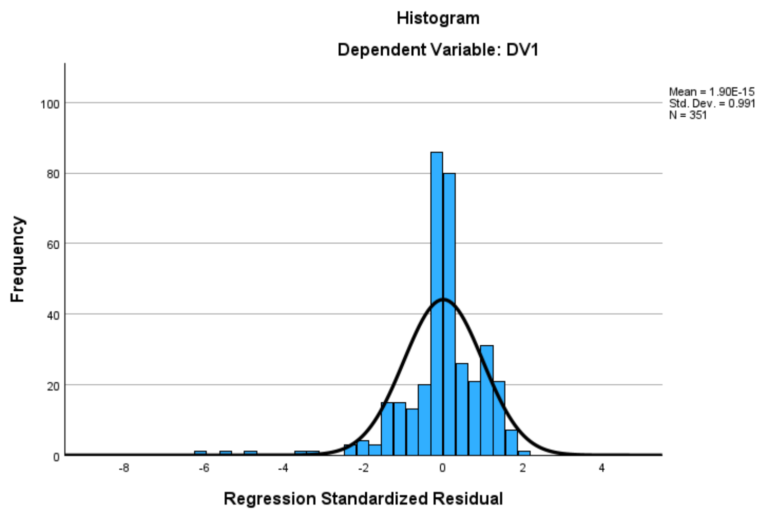
Cook's D value sorted descending

	PRE_1_DV1	SRE_1_DV1	SDR_1_DV1	COO_1_DV1	LEV_1_DV1
1	5.67004	-6.27606	-6.65981	.22801	.03609
2	5.24513	-5.72648	-6.01187	.22655	.04328
3	5.64687	-4.85530	-5.02342	.07139	.01791
4	5.53701	-3.38034	-3.43292	.03724	.01945
5	5.93774	1.46554	1.46800	.02964	.08525
6	5.84487	-3.77405	-3.84909	.02834	.01089
7	5.89325	1.50772	1.51052	.02247	.06186
8	5.58550	1.90232	1.90962	.02172	.03748
9	5.76811	-2.35920	-2.37506	.02044	.02222
10	5.98138	1.38640	1.38826	.01847	.06016
11	5.80521	1.60676	1.61048	.01546	.03739
12	5.66700	-2.22020	-2.23303	.01546	.01863
13	5.18631	1.11632	1.11672	.01502	.07496
14	5.70738	-2.27125	-2.28515	.01437	.01628
15	5.43660	2.08263	2.09284	.01385	.01902

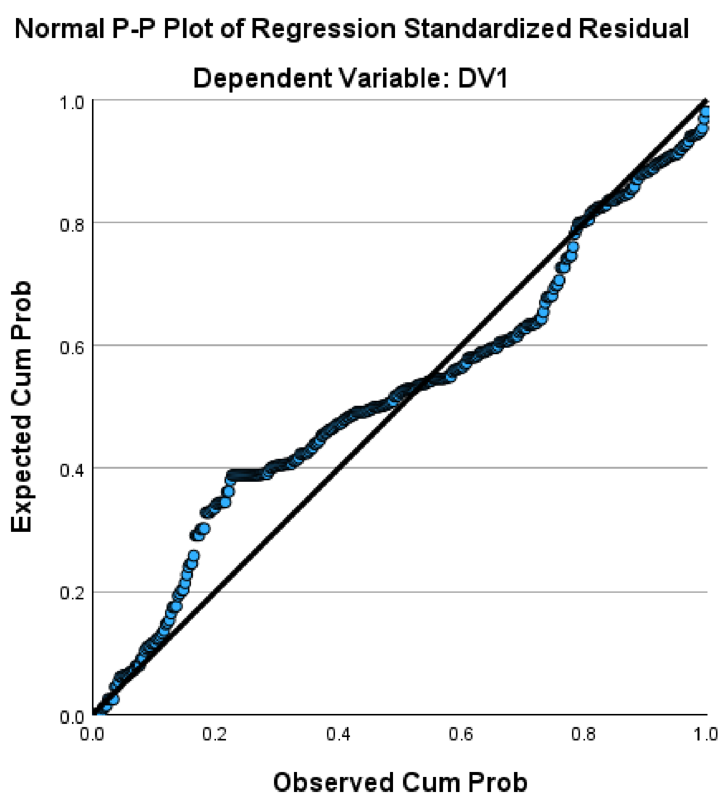
Cook's D value sorted ascending

	PRE_1_DV1	SRE_1_DV1	SDR_1_DV1	COO_1_DV1	LEV_1_DV1
1	6.00034	-.00045	-.00045	.00000	.00836
2	6.00034	-.00045	-.00045	.00000	.00836
3	6.00034	-.00045	-.00045	.00000	.00836
4	6.00084	-.00111	-.00111	.00000	.00623
5	5.99799	.00265	.00265	.00000	.00109
6	5.99760	.00320	.00319	.00000	.02188
7	5.99516	.00644	.00644	.00000	.01676
8	5.99098	.01196	.01194	.00000	.00867
9	5.99348	.00871	.00869	.00000	.02207
10	5.98525	.01949	.01946	.00000	.00253
11	6.00650	-.00873	-.00872	.00000	.03534
12	5.98849	.01528	.01526	.00000	.01222
13	6.01198	-.01591	-.01588	.00000	.01287
14	6.01198	-.01591	-.01588	.00000	.01287
15	6.00781	-.01048	-.01047	.00000	.03290

Standardized Residual Histogram



P-P Plot of Regression Standardized Residual



ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.801	6	3.634	6.307	<.001[b]
	Residual	198.187	344	.576		
	Total	219.989	350			

a. Dependent Variable: DV1

b. Predictors: (Constant), IV11, IV09, IV04, IV06, IV01, IV05

Appendix P: SPSS Output for Correlation and Regression Analysis of Project Scope

This appendix contains the SPSS output for the Spearman's Rho correlation analysis and the linear regression analysis used to investigate the relationship between the independent variables and the cost component of project success. The Spearman's Rho test revealed that two independent variables had a statistically significant correlation with the dependent variable, project scope (DV2). The results of the correlation analysis are shown below. Next, the dependent variable for project scope (DV2) was regressed against the two independent variables that the correlation analysis revealed it has a statistically significant relationship with – the art of simplicity (IV10) and team environment (IV11). The results of the regression analysis are shown below.

Spearman's Rho

Correlations

			DV2	IV01
Spearman's rho	DV2	Correlation Coefficient	1.000	.097
		Sig. (2-tailed)	.	.070
		N	351	351
	IV01	Correlation Coefficient	.097	1.000
		Sig. (2-tailed)	.070	.
		N	351	351

Correlations

			DV2	IV02
Spearman's rho	DV2	Correlation Coefficient	1.000	-.052
		Sig. (2-tailed)	.	.328
		N	351	351
	IV02	Correlation Coefficient	-.052	1.000
		Sig. (2-tailed)	.328	.
		N	351	351

Correlations

			DV2	IV03
Spearman's rho	DV2	Correlation Coefficient	1.000	.055
		Sig. (2-tailed)	.	.308
		N	351	351
	IV03	Correlation Coefficient	.055	1.000
		Sig. (2-tailed)	.308	.
		N	351	351

Correlations

			DV2	IV04
Spearman's rho	DV2	Correlation Coefficient	1.000	.037
		Sig. (2-tailed)	.	.485
		N	351	351
	IV04	Correlation Coefficient	.037	1.000
		Sig. (2-tailed)	.485	.
		N	351	351

Correlations

			DV2	IV05
Spearman's rho	DV2	Correlation Coefficient	1.000	.047
		Sig. (2-tailed)	.	.382
		N	351	351
	IV05	Correlation Coefficient	.047	1.000
		Sig. (2-tailed)	.382	.
		N	351	351

Correlations

			DV2	IV06
Spearman's rho	DV2	Correlation Coefficient	1.000	.087
		Sig. (2-tailed)	.	.104
		N	351	351
	IV06	Correlation Coefficient	.087	1.000
		Sig. (2-tailed)	.104	.
		N	351	351

Correlations

			DV2	IV07
Spearman's rho	DV2	Correlation Coefficient	1.000	.006
		Sig. (2-tailed)	.	.904
		N	351	351
	IV07	Correlation Coefficient	.006	1.000
		Sig. (2-tailed)	.904	.
		N	351	351

Correlations

			DV2	IV08
Spearman's rho	DV2	Correlation Coefficient	1.000	-.026
		Sig. (2-tailed)	.	.629
		N	351	351
	IV08	Correlation Coefficient	-.026	1.000
		Sig. (2-tailed)	.629	.
		N	351	351

Correlations

			DV2	IV09
Spearman's rho	DV2	Correlation Coefficient	1.000	.096
		Sig. (2-tailed)	.	.072
		N	351	351
	IV09	Correlation Coefficient	.096	1.000
		Sig. (2-tailed)	.072	.
		N	351	351

Correlations

			DV2	IV10
Spearman's rho	DV2	Correlation Coefficient	1.000	.182**
		Sig. (2-tailed)	.	<.001
		N	351	351
	IV10	Correlation Coefficient	.182**	1.000
		Sig. (2-tailed)	<.001	.
		N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

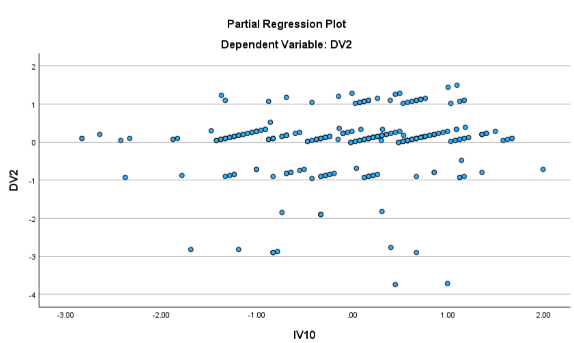
			DV2	IV11
Spearman's rho	DV2	Correlation Coefficient	1.000	.168**
		Sig. (2-tailed)	.	.002
		N	351	351
	IV11	Correlation Coefficient	.168**	1.000
		Sig. (2-tailed)	.002	.
		N	351	351

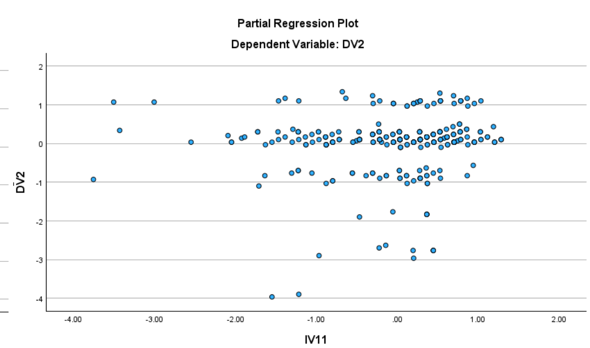
**. Correlation is significant at the 0.01 level (2-tailed).

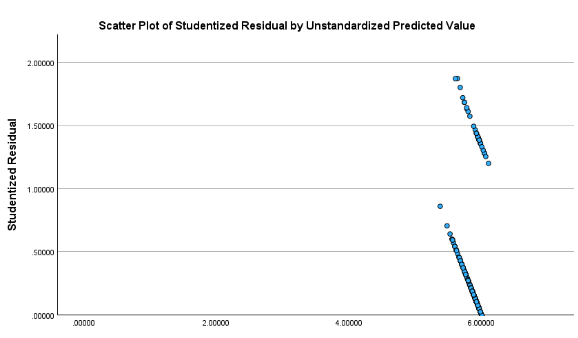
Correlations

			DV2	IV12
Spearman's rho	DV2	Correlation Coefficient	1.000	.016
		Sig. (2-tailed)	.	.767
		N	351	351
	IV12	Correlation Coefficient	.016	1.000
		Sig. (2-tailed)	.767	.
		N	351	351

Scatterplot







Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.176[a]	.031	.025	.750	1.609

a. Predictors: (Constant), IV11, IV10

b. Dependent Variable: DV2

Correlations

Correlations

		DV2	IV10	IV11
Pearson Correlation	DV2	1.000	.152	.113
	IV10	.152	1.000	.174
	IV11	.113	.174	1.000
Sig. (1-tailed)	DV2	.	.002	.017
	IV10	.002	.	.001
	IV11	.017	.001	.
N	DV2	351	351	351
	IV10	351	351	351
	IV11	351	351	351

Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	4.763	.346		13.765	<.001	4.082	5.443					
	IV10	.120	.047	.137	2.557	.011	.028	.212	.152	.136	.135	.970	1.031
	IV11	.084	.050	.089	1.661	.098	-.015	.182	.113	.089	.088	.970	1.031

a. Dependent Variable: DV2

Casewise Diagnostics

Casewise Diagnostics[a]

Case Number	Std. Residual	DV2	Predicted Value	Residual
43	-3.738	3	5.80	-2.803
57	-3.738	3	5.80	-2.803
97	-3.738	3	5.80	-2.803
121	-3.758	3	5.82	-2.819
255	-3.710	3	5.78	-2.782
269	-3.977	3	5.98	-2.983
276	-3.494	3	5.62	-2.621
318	-3.574	3	5.68	-2.681
332	-5.064	2	5.80	-3.798
333	-5.116	2	5.84	-3.837

a. Dependent Variable: DV2

High Leverage Points

High leverage points sorted descending

	PRE_1_DV2	SRE_1_DV2	SDR_1_DV2	COO_1_DV2	LEV_1_DV2
1	5.61611	-.85049	-.85015	.01730	.06410
2	5.37640	.85983	.85951	.01706	.06191
3	5.63698	1.87338	1.88019	.07308	.05595
4	5.67873	1.80205	1.80791	.05003	.04133
5	5.56342	.59250	.59194	.00420	.03178
6	5.56342	.59250	.59194	.00420	.03178
7	5.75327	.33474	.33431	.00132	.03118
8	5.47991	.70494	.70443	.00551	.02936
9	5.66510	.45313	.45261	.00203	.02591
10	5.95663	-1.29337	-1.29462	.01565	.02446
11	5.64422	-.87057	-.87027	.00684	.02352
12	5.62334	.50852	.50797	.00217	.02169

High leverage points sorted ascending

	PRE_1_DV2	SRE_1_DV2	SDR_1_DV2	COO_1_DV2	LEV_1_DV2
1	5.90211	-1.20472	-1.20551	.00148	.00020
2	5.90211	-1.20472	-1.20551	.00148	.00020
3	5.90211	.13073	.13055	.00002	.00020
4	5.90211	.13073	.13055	.00002	.00020
5	5.90211	.13073	.13055	.00002	.00020
6	5.90211	.13073	.13055	.00002	.00020
7	5.90211	.13073	.13055	.00002	.00020
8	5.90211	.13073	.13055	.00002	.00020
9	5.90211	.13073	.13055	.00002	.00020
10	5.90211	.13073	.13055	.00002	.00020
11	5.90211	.13073	.13055	.00002	.00020
12	5.90211	.13073	.13055	.00002	.00020

Cook’s Distance Values

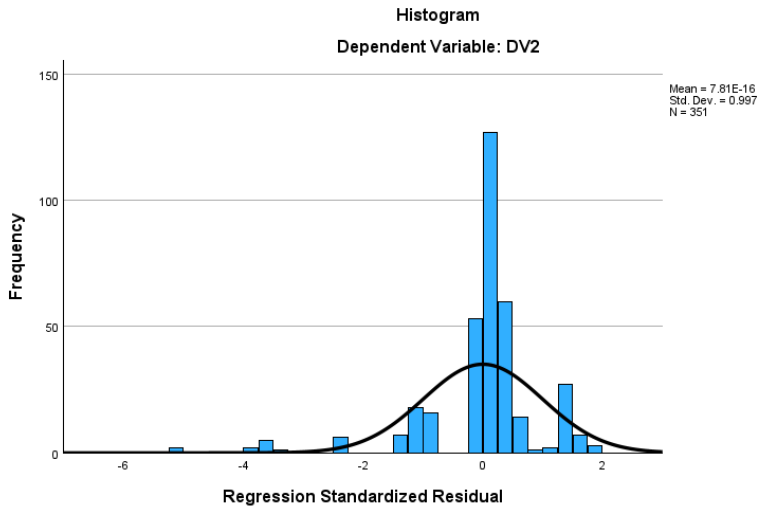
Cook’s D value sorted descending

	PRE_1_DV2	SRE_1_DV2	SDR_1_DV2	COO_1_DV2
1	5.83678	-5.15647	-5.35780	.14069
2	5.79772	-5.08869	-5.28168	.08456
3	5.63698	1.87338	1.88019	.07308
4	5.62064	-3.52063	-3.57990	.06224
5	5.67873	1.80205	1.80791	.05003
6	5.68057	-3.59089	-3.65406	.03994
7	5.81860	-3.77206	-3.84609	.03463
8	5.80313	-3.74900	-3.82157	.02827
9	5.80313	-3.74900	-3.82157	.02827
10	5.80313	-3.74900	-3.82157	.02827
11	5.98291	-3.98752	-4.07600	.02685
12	5.78225	-3.71973	-3.79050	.02448
13	5.61611	-.85049	-.85015	.01730
14	5.37640	.85983	.85951	.01706
15	5.60603	1.87187	1.87866	.01656

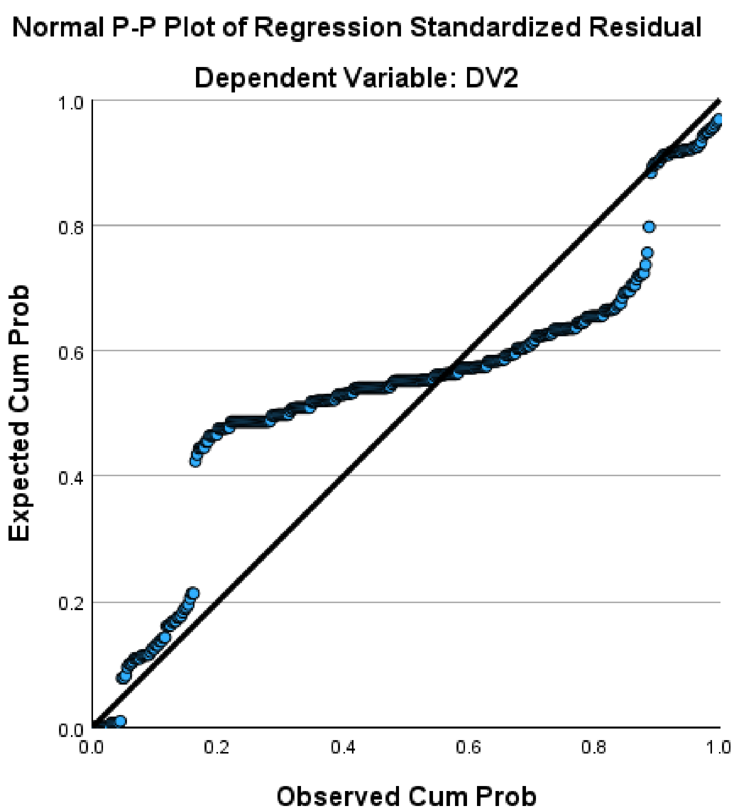
Cook’s D value sorted ascending

	PRE_1_DV2	SRE_1_DV2	SDR_1_DV2	COO_1_DV2
1	6.00378	-.00506	-.00505	.00000
2	6.00378	-.00506	-.00505	.00000
3	6.00378	-.00506	-.00505	.00000
4	6.00378	-.00506	-.00505	.00000
5	6.00378	-.00506	-.00505	.00000
6	6.00378	-.00506	-.00505	.00000
7	6.00378	-.00506	-.00505	.00000
8	5.99188	.01086	.01085	.00000
9	6.00649	-.00869	-.00868	.00000
10	6.00649	-.00869	-.00868	.00000
11	6.00649	-.00869	-.00868	.00000
12	5.98291	.02285	.02281	.00000
13	5.98291	.02285	.02281	.00000
14	5.98291	.02285	.02281	.00000
15	5.98291	.02285	.02281	.00000

Standardized Residual Histogram



P-P Plot of Regression Standardized Residual



ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.246	2	3.123	5.553	.004[b]
	Residual	195.726	348	.562		
	Total	201.972	350			

a. Dependent Variable: DV2

b. Predictors: (Constant), IV11, IV10

Appendix Q: SPSS Output for Correlation and Regression Analysis of Project Timeliness

This appendix contains the SPSS output for the Spearman's Rho correlation analysis and the linear regression analysis used to investigate the relationship between the independent variables and the cost component of project success. The Spearman's Rho test revealed that three independent variables had a statistically significant correlation with the dependent variable, project timeliness (DV3). The results of the correlation analysis are shown below. Next, the dependent variable for project timeliness (DV3) was regressed against the three independent variables that the correlation analysis revealed it has a statistically significant relationship with – delivering working software frequently (IV3), the art of simplicity (IV10), and team environment (IV11). The results of the regression analysis are shown below.

Spearman's Rho

Correlations

			DV3	IV01
Spearman's rho	DV3	Correlation Coefficient	1.000	.054
		Sig. (2-tailed)	.	.313
		N	351	351
	IV01	Correlation Coefficient	.054	1.000
		Sig. (2-tailed)	.313	.
		N	351	351

Correlations

			DV3	IV02
Spearman's rho	DV3	Correlation Coefficient	1.000	-.072
		Sig. (2-tailed)	.	.175
		N	351	351
	IV02	Correlation Coefficient	-.072	1.000
		Sig. (2-tailed)	.175	.
		N	351	351

Correlations

			DV3	IV03
Spearman's rho	DV3	Correlation Coefficient	1.000	.146**
		Sig. (2-tailed)	.	.006
		N	351	351
	IV03	Correlation Coefficient	.146**	1.000
		Sig. (2-tailed)	.006	.
		N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			DV3	IV04
Spearman's rho	DV3	Correlation Coefficient	1.000	.055
		Sig. (2-tailed)	.	.306
		N	351	351
	IV04	Correlation Coefficient	.055	1.000
		Sig. (2-tailed)	.306	.
		N	351	351

Correlations

			DV3	IV05
Spearman's rho	DV3	Correlation Coefficient	1.000	.085
		Sig. (2-tailed)	.	.112
		N	351	351
	IV05	Correlation Coefficient	.085	1.000
		Sig. (2-tailed)	.112	.
		N	351	351

Correlations

			DV3	IV06
Spearman's rho	DV3	Correlation Coefficient	1.000	.094
		Sig. (2-tailed)	.	.077
		N	351	351
	IV06	Correlation Coefficient	.094	1.000
		Sig. (2-tailed)	.077	.
		N	351	351

Correlations

			DV3	IV07
Spearman's rho	DV3	Correlation Coefficient	1.000	.012
		Sig. (2-tailed)	.	.825
		N	351	351
	IV07	Correlation Coefficient	.012	1.000
		Sig. (2-tailed)	.825	.
		N	351	351

Correlations

			DV3	IV08
Spearman's rho	DV3	Correlation Coefficient	1.000	.044
		Sig. (2-tailed)	.	.415
		N	351	351
	IV08	Correlation Coefficient	.044	1.000
		Sig. (2-tailed)	.415	.
		N	351	351

Correlations

			DV3	IV09
Spearman's rho	DV3	Correlation Coefficient	1.000	-.003
		Sig. (2-tailed)	.	.954
		N	351	351
	IV09	Correlation Coefficient	-.003	1.000
		Sig. (2-tailed)	.954	.
		N	351	351

Correlations

			DV3	IV10
Spearman's rho	DV3	Correlation Coefficient	1.000	.197**
		Sig. (2-tailed)	.	<.001
		N	351	351
	IV10	Correlation Coefficient	.197**	1.000
		Sig. (2-tailed)	<.001	.
		N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

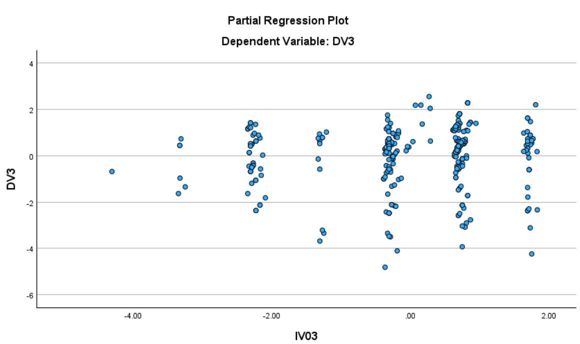
			DV3	IV11
Spearman's rho	DV3	Correlation Coefficient	1.000	.271**
		Sig. (2-tailed)	.	<.001
		N	351	351
	IV11	Correlation Coefficient	.271**	1.000
		Sig. (2-tailed)	<.001	.
		N	351	351

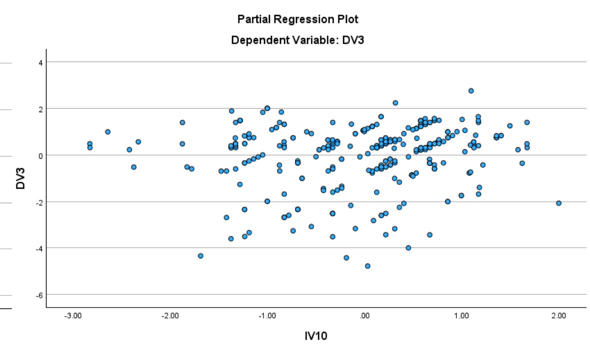
**. Correlation is significant at the 0.01 level (2-tailed).

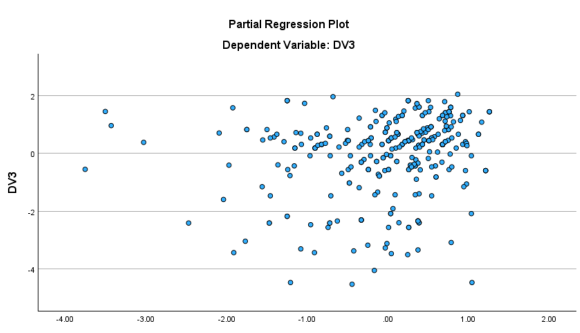
Correlations

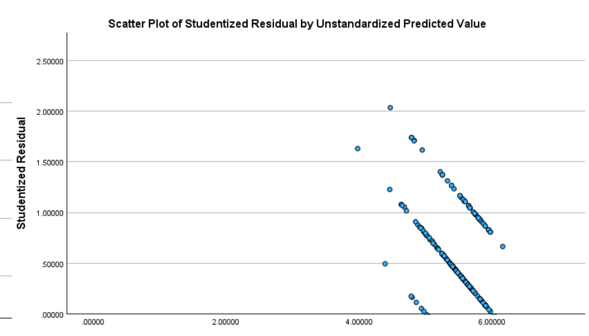
			DV3	IV12
Spearman's rho	DV3	Correlation Coefficient	1.000	-.095
		Sig. (2-tailed)	.	.075
		N	351	351
	IV12	Correlation Coefficient	-.095	1.000
		Sig. (2-tailed)	.075	.
		N	351	351

Scatterplot









Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.265[a]	.070	.062	1.283	1.839

a. Predictors: (Constant), IV11, IV03, IV10

b. Dependent Variable: DV3

Correlations

Correlations

		DV3	IV03	IV10	IV11
Pearson Correlation	DV3	1.000	.086	.169	.216
	IV03	.086	1.000	.008	.052
	IV10	.169	.008	1.000	.174
	IV11	.216	.052	.174	1.000
Sig. (1-tailed)	DV3	.	.053	<.001	<.001
	IV03	.053	.	.441	.166
	IV10	.001	.441	.	.001
	IV11	.000	.166	.001	.
N	DV3	351	351	351	351
	IV03	351	351	351	351
	IV10	351	351	351	351
	IV11	351	351	351	351

Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	2.153	.653		3.298	.001	.869	3.437					
	IV03	.083	.057	.076	1.459	.146	-.029	.195	.086	.078	.076	.997	1.003
	IV10	.206	.080	.135	2.573	.011	.049	.364	.169	.137	.133	.970	1.031
	IV11	.308	.086	.189	3.582	<.001	.139	.478	.216	.189	.185	.967	1.034

a. Dependent Variable: DV3

Casewise Diagnostics

Casewise Diagnostics[a]

Case Number	Std. Residual	DV3	Predicted Value	Residual
158	-3.729	1	5.78	-4.784
276	-3.111	1	4.99	-3.991
332	-3.188	1	5.09	-4.090
339	-3.417	1	5.38	-4.384

a. Dependent Variable: DV3

High Leverage Points

High leverage points sorted descending

	PRE_1_DV3	SRE_1_DV3	SDR_1_DV3	COO_1_DV3	LEV_1_DV3
1	4.38899	.49314	.49261	.00437	.06426
2	3.97634	1.63136	1.63529	.04619	.06207
3	4.46609	2.03620	2.04552	.06491	.05609
4	4.67958	1.05380	1.05397	.01336	.04307
5	4.64166	-1.30792	-1.30927	.01904	.03978
6	4.45926	1.22712	1.22802	.01651	.03916
7	5.32409	-.25804	-.25769	.00072	.03858
8	5.09907	.71687	.71637	.00538	.03736
9	5.69036	-.54819	-.54763	.00282	.03339
10	4.93337	.84635	.84600	.00646	.03197
11	5.48780	-1.97303	-1.98133	.03412	.03102
12	4.79587	.16179	.16156	.00022	.02978
13	4.99430	.79672	.79630	.00520	.02887
14	4.38898	-.30810	-.30770	.00077	.02856
15	5.03078	-.02436	-.02433	.00000	.02700

High leverage points sorted ascending

	PRE_1_DV3	SRE_1_DV3	SDR_1_DV3	COO_1_DV3	LEV_1_DV3
1	5.47523	-2.71344	-2.73874	.00594	.00037
2	5.47523	.40974	.40925	.00014	.00037
3	5.47523	.40974	.40925	.00014	.00037
4	5.47523	.40974	.40925	.00014	.00037
5	5.47523	.40974	.40925	.00014	.00037
6	5.37207	.49032	.48978	.00020	.00050
7	5.37207	.49032	.48978	.00020	.00050
8	5.37207	.49032	.48978	.00020	.00050
9	5.37207	.49032	.48978	.00020	.00050
10	5.37207	.49032	.48978	.00020	.00050
11	5.37207	.49032	.48978	.00020	.00050
12	5.29496	-1.01117	-1.01121	.00086	.00051
13	5.39812	.46998	.46946	.00019	.00055
14	5.39812	.46998	.46946	.00019	.00055
15	5.55233	-.43134	-.43083	.00017	.00074

Cook's Distance Values

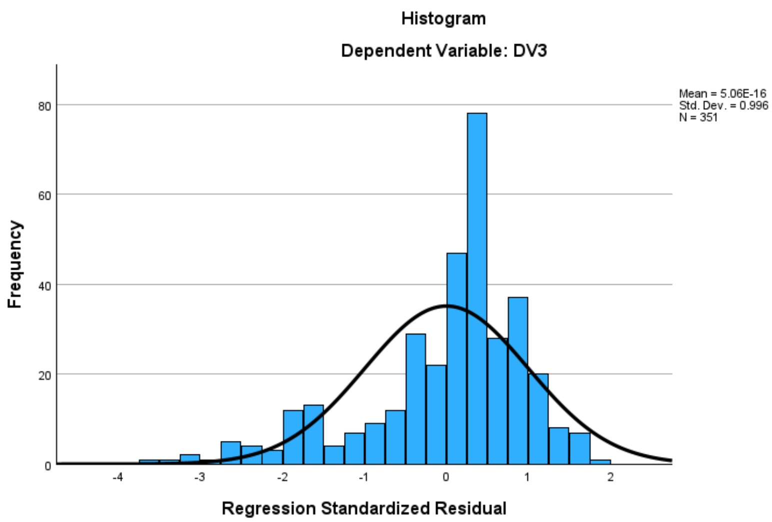
Cook's D value sorted descending

	PRE_1_DV3	SRE_1_DV3	SDR_1_DV3	COO_1_DV3	LEV_1_DV3
1	4.46609	2.03620	2.04552	.06491	.05609
2	3.97634	1.63136	1.63529	.04619	.06207
3	4.99123	-3.13641	-3.17724	.03982	.01308
4	5.48780	-1.97303	-1.98133	.03412	.03102
5	5.38356	-3.43401	-3.48886	.02916	.00695
6	5.78364	-3.74423	-3.81673	.02864	.00526
7	4.83810	-2.23553	-2.24856	.02626	.01773
8	5.08972	-3.20379	-3.24756	.02533	.00693
9	5.25435	-2.55592	-2.57660	.02460	.01199
10	5.31995	-2.60357	-2.62559	.02041	.00905
11	4.64166	-1.30792	-1.30927	.01904	.03978
12	5.57264	-2.79678	-2.82476	.01656	.00555
13	4.45926	1.22712	1.22802	.01651	.03916
14	4.96625	-2.32558	-2.34054	.01557	.00854
15	5.09439	-2.42472	-2.44200	.01530	.00745

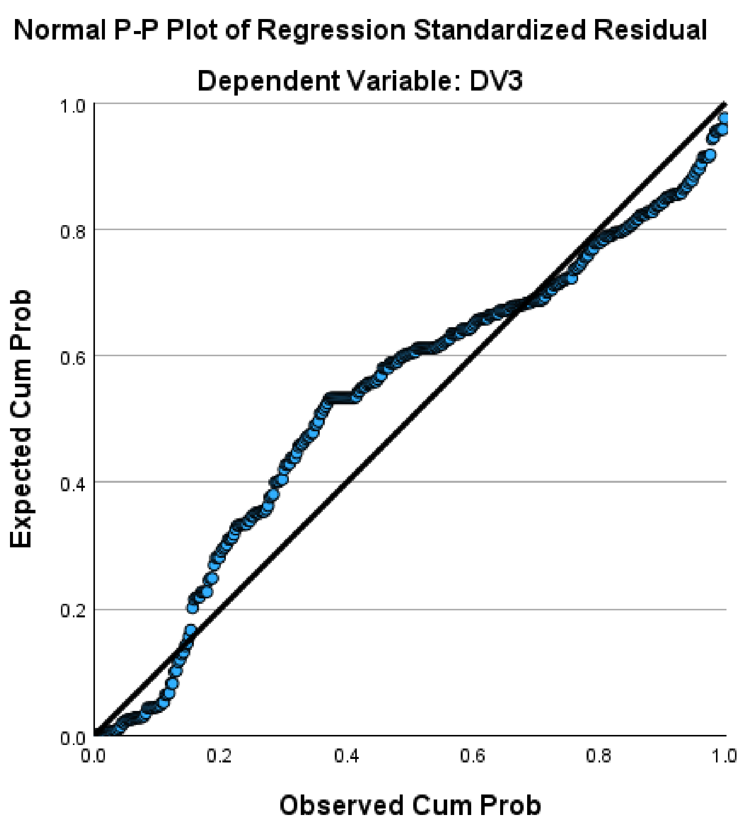
Cook's D value sorted ascending

	PRE_1_DV3	SRE_1_DV3	SDR_1_DV3	COO_1_DV3	LEV_1_DV3
1	5.01154	-.00904	-.00903	.00000	.00648
2	5.96965	.02378	.02374	.00000	.00687
3	6.02751	-.02166	-.02163	.00000	.01694
4	4.97199	.02205	.02201	.00000	.01645
5	5.03078	-.02436	-.02433	.00000	.02700
6	5.94934	.03975	.03970	.00001	.01022
7	4.93444	.05137	.05129	.00001	.00725
8	5.06941	-.05438	-.05430	.00001	.00736
9	5.91860	.06377	.06368	.00001	.00722
10	6.07281	-.05712	-.05704	.00001	.00991
11	5.08864	-.06942	-.06932	.00001	.00628
12	5.08864	-.06942	-.06932	.00001	.00628
13	5.11470	-.08967	-.08954	.00001	.00280
14	5.89255	.08410	.08398	.00001	.00506
15	5.89255	.08410	.08398	.00001	.00506

Standardized Residual Histogram



P-P Plot of Regression Standardized Residual



ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	43.016	3	14.339	8.713	<.001[b]
	Residual	571.024	347	1.646		
	Total	614.040	350			

a. Dependent Variable: DV3

b. Predictors: (Constant), IV11, IV03, IV10

Appendix R: SPSS Output for Correlation and Regression Analysis of Project Cost

This appendix contains the SPSS output for the Spearman's Rho correlation analysis and the linear regression analysis used to investigate the relationship between the independent variables and the cost component of project success. The Spearman's Rho test revealed that five independent variables had a statistically significant correlation with the dependent variable, project cost (DV4). The results of the correlation analysis are shown below. Next, the dependent variable for project cost (DV4) was regressed against the five independent variables that the correlation analysis revealed it has a statistically significant relationship with – management commitment (IV5), face-to-face collaboration (IV6), measuring progress through working software (IV7), the art of simplicity (IV10), and team environment (IV11). The results of the regression analysis are shown below.

Spearman's Rho

Correlations

			DV4	IV01
Spearman's rho	DV4	Correlation Coefficient	1.000	.003
		Sig. (2-tailed)	.	.954
		N	351	351
	IV01	Correlation Coefficient	.003	1.000
		Sig. (2-tailed)	.954	.
		N	351	351

Correlations

			DV4	IV02
Spearman's rho	DV4	Correlation Coefficient	1.000	-.023
		Sig. (2-tailed)	.	.665
		N	351	351
	IV02	Correlation Coefficient	-.023	1.000
		Sig. (2-tailed)	.665	.
		N	351	351

Correlations

			DV4	IV03
Spearman's rho	DV4	Correlation Coefficient	1.000	-.014
		Sig. (2-tailed)	.	.790
		N	351	351
	IV03	Correlation Coefficient	-.014	1.000
		Sig. (2-tailed)	.790	.
		N	351	351

Correlations

			DV4	IV04
Spearman's rho	DV4	Correlation Coefficient	1.000	.024
		Sig. (2-tailed)	.	.651
		N	351	351
	IV04	Correlation Coefficient	.024	1.000
		Sig. (2-tailed)	.651	.
		N	351	351

Correlations

			DV4	IV05
Spearman's rho	DV4	Correlation Coefficient	1.000	.147**
		Sig. (2-tailed)	.	.006
		N	351	351
	IV05	Correlation Coefficient	.147**	1.000
		Sig. (2-tailed)	.006	.
		N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			DV4	IV06
Spearman's rho	DV4	Correlation Coefficient	1.000	.164**
		Sig. (2-tailed)	.	.002
		N	351	351
	IV06	Correlation Coefficient	.164**	1.000
		Sig. (2-tailed)	.002	.
		N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			DV4	IV07
Spearman's rho	DV4	Correlation Coefficient	1.000	.222**
		Sig. (2-tailed)	.	<.001
		N	351	351
	IV07	Correlation Coefficient	.222**	1.000
		Sig. (2-tailed)	<.001	.
		N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			DV4	IV08
Spearman's rho	DV4	Correlation Coefficient	1.000	.069
		Sig. (2-tailed)	.	.198
		N	351	351
	IV08	Correlation Coefficient	.069	1.000
		Sig. (2-tailed)	.198	.
		N	351	351

Correlations

			DV4	IV09
Spearman's rho	DV4	Correlation Coefficient	1.000	.041
		Sig. (2-tailed)	.	.441
		N	351	351
	IV09	Correlation Coefficient	.041	1.000
		Sig. (2-tailed)	.441	.
		N	351	351

Correlations

			DV4	IV10
Spearman's rho	DV4	Correlation Coefficient	1.000	.278**
		Sig. (2-tailed)	.	<.001
		N	351	351
	IV10	Correlation Coefficient	.278**	1.000
		Sig. (2-tailed)	<.001	.
		N	351	351

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

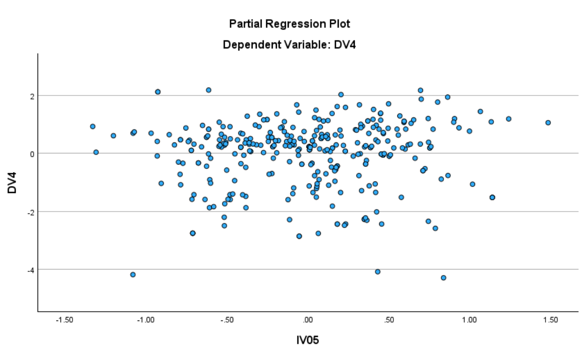
			DV4	IV11
Spearman's rho	DV4	Correlation Coefficient	1.000	.248**
		Sig. (2-tailed)	.	<.001
		N	351	351
	IV11	Correlation Coefficient	.248**	1.000
		Sig. (2-tailed)	<.001	.
		N	351	351

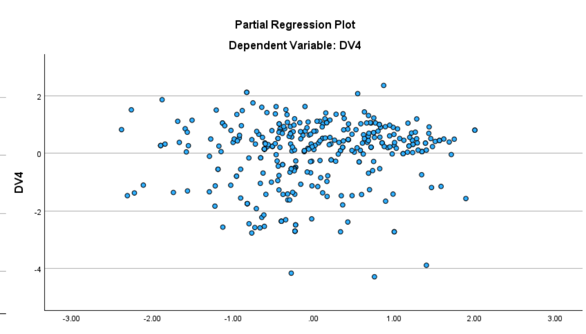
**. Correlation is significant at the 0.01 level (2-tailed).

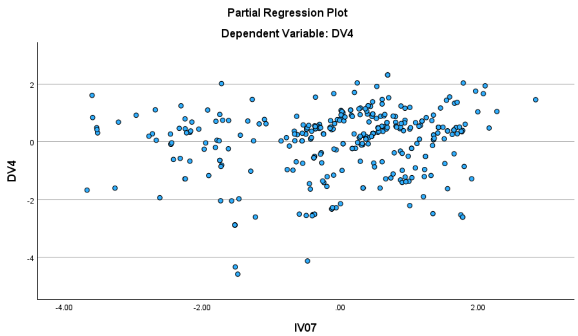
Correlations

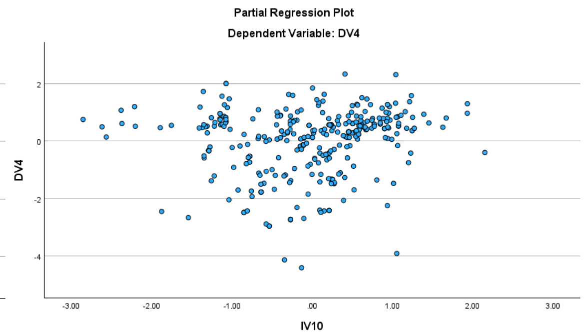
			DV4	IV12
Spearman's rho	DV4	Correlation Coefficient	1.000	.052
		Sig. (2-tailed)	.	.331
		N	351	351
	IV12	Correlation Coefficient	.052	1.000
		Sig. (2-tailed)	.331	.
		N	351	351

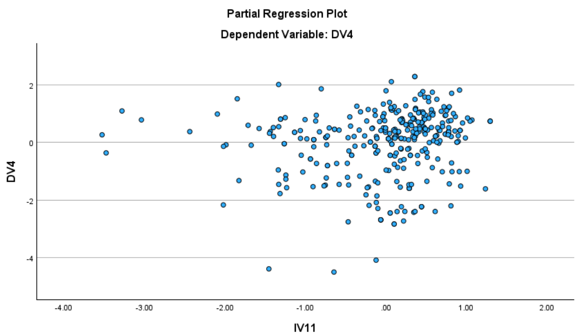
Scatterplot

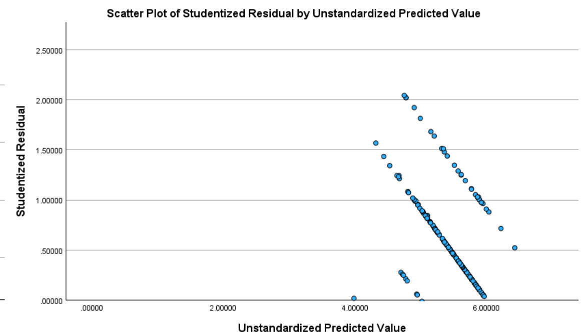












Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.335[a]	.112	.099	1.116	1.634

a. Predictors: (Constant), IV11, IV07, IV06, IV10, IV05

b. Dependent Variable: DV4

Correlations

Correlations

		DV4	IV05	IV06	IV07	IV10	IV11
Pearson Correlation	DV4	1.000	.154	.150	.213	.218	.191
	IV05	.154	1.000	.321	.205	.152	.141
	IV06	.150	.321	1.000	.039	.014	.220
	IV07	.213	.205	.039	1.000	.233	.081
	IV10	.218	.152	.014	.233	1.000	.174
	IV11	.191	.141	.220	.081	.174	1.000
Sig. (1-tailed)	DV4	.	.002	.002	<.001	<.001	<.001
	IV05	.002	.	.000	.000	.002	.004
	IV06	.002	.000	.	.231	.394	.000
	IV07	.000	.000	.231	.	.000	.064
	IV10	.000	.002	.394	.000	.	.001
	IV11	.000	.004	.000	.064	.001	.
N	DV4	351	351	351	351	351	351
	IV05	351	351	351	351	351	351
	IV06	351	351	351	351	351	351
	IV07	351	351	351	351	351	351
	IV10	351	351	351	351	351	351
	IV11	351	351	351	351	351	351

Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	1.393	.724		1.925	.055	-.030	2.817					
	IV05	.110	.120	.050	.914	.361	-.126	.345	.154	.049	.046	.847	1.181
	IV06	.125	.069	.099	1.805	.072	-.011	.260	.150	.097	.092	.861	1.161
	IV07	.136	.047	.154	2.896	.004	.044	.228	.213	.154	.147	.915	1.093
	IV10	.205	.072	.152	2.855	.005	.064	.347	.218	.152	.145	.911	1.098
	IV11	.179	.077	.123	2.330	.020	.028	.330	.191	.124	.118	.920	1.087

a. Dependent Variable: DV4

Casewise Diagnostics

Casewise Diagnostics[a]

Case Number	Std. Residual	DV4	Predicted Value	Residual
306	-3.635	1	5.06	-4.056
333	-3.693	1	5.12	-4.120
339	-3.921	1	5.37	-4.374

a. Dependent Variable: DV4

High Leverage Points

High leverage points sorted descending

	PRE_1_DV4	SRE_1_DV4	SDR_1_DV4	COO_1_DV4	LEV_1_DV4
1	5.09924	.84446	.84411	.01117	.08308
2	4.66801	1.24346	1.24445	.02186	.07533
3	4.31513	1.56840	1.57174	.03223	.07003
4	4.73507	.24615	.24581	.00075	.06651
5	4.83502	-.77265	-.77219	.00654	.05884
6	4.92226	.99059	.99056	.00844	.04621
7	5.09332	.83305	.83268	.00587	.04548
8	3.98316	.01546	.01544	.00000	.04398
9	4.65770	1.23227	1.23320	.01241	.04391
10	4.76982	.21119	.21090	.00036	.04284
11	4.43558	1.43441	1.43662	.01593	.04155
12	4.96031	.95313	.95300	.00698	.04123
13	4.72113	.25533	.25498	.00047	.03879
14	4.89858	1.92334	1.93093	.02635	.03813
15	4.79985	-1.64699	-1.65110	.01912	.03774

High leverage points sorted ascending

	PRE_1_DV4	SRE_1_DV4	SDR_1_DV4	COO_1_DV4	LEV_1_DV4
1	5.26702	-2.03543	-2.04479	.00237	.00057
2	5.26702	-.23974	-.23942	.00003	.00057
3	5.49258	.45561	.45508	.00012	.00066
4	5.49258	.45561	.45508	.00012	.00066
5	5.45103	-.40500	-.40451	.00010	.00081
6	5.45103	-.40500	-.40451	.00010	.00081
7	5.45103	-2.20090	-2.21330	.00296	.00081
8	5.45103	-2.20090	-2.21330	.00296	.00081
9	5.47143	.47466	.47413	.00014	.00091
10	5.34039	-.30570	-.30530	.00006	.00114
11	5.34039	-.30570	-.30530	.00006	.00114
12	5.38513	-.34589	-.34545	.00008	.00115
13	5.49577	-.44527	-.44475	.00014	.00123
14	5.49577	-.44527	-.44475	.00014	.00123
15	5.49577	-.44527	-.44475	.00014	.00123

Cook's Distance Values

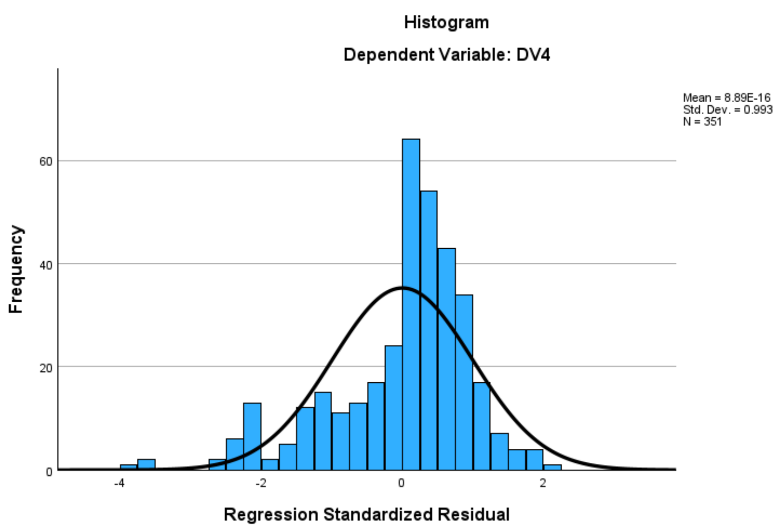
Cook's D value sorted descending

	PRE_1_DV4	SRE_1_DV4	SDR_1_DV4	COO_1_DV4	LEV_1_DV4
1	5.37448	-3.96073	-4.04809	.05342	.01717
2	5.05581	-3.67782	-3.74667	.05310	.02016
3	5.12019	-3.73238	-3.80457	.04984	.01816
4	4.31513	1.56840	1.57174	.03223	.07003
5	4.89858	1.92334	1.93093	.02635	.03813
6	4.66801	1.24346	1.24445	.02186	.07533
7	4.79985	-1.64699	-1.65110	.01912	.03774
8	4.66757	-2.41438	-2.43151	.01912	.01645
9	4.66757	-2.41438	-2.43151	.01912	.01645
10	4.66757	-2.41438	-2.43151	.01912	.01645
11	4.66757	-2.41438	-2.43151	.01912	.01645
12	4.77360	2.02239	2.03153	.01847	.02353
13	4.77360	2.02239	2.03153	.01847	.02353
14	4.74637	2.04507	2.05460	.01745	.02158
15	5.66450	-2.40847	-2.42545	.01647	.01390

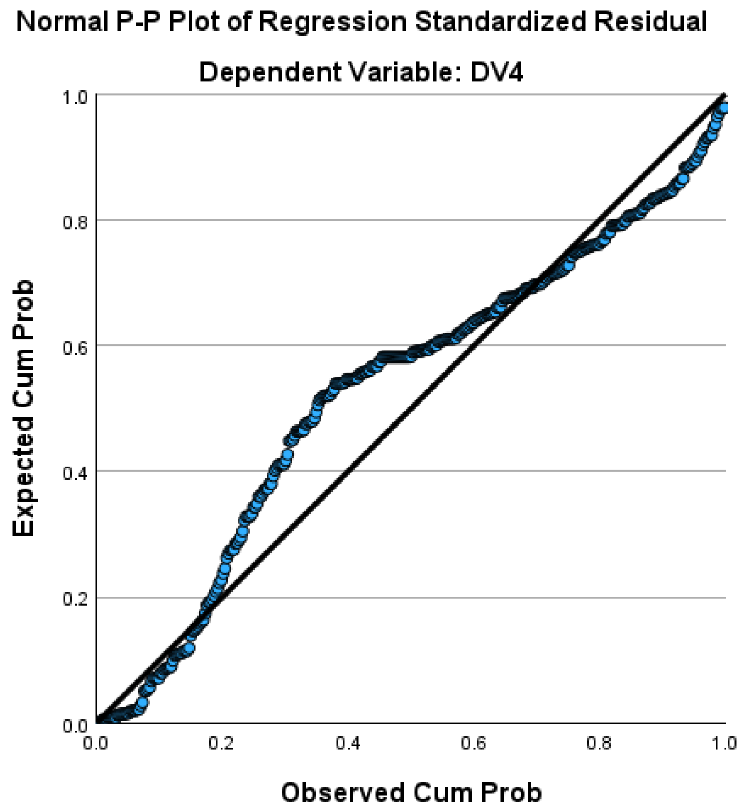
Cook's D value sorted ascending

	PRE_1_DV4	SRE_1_DV4	SDR_1_DV4	COO_1_DV4	LEV_1_DV4
1	5.01562	-.01415	-.01413	.00000	.01885
2	3.98316	.01546	.01544	.00000	.04398
3	5.96132	.03489	.03484	.00000	.00954
4	5.95267	.04265	.04258	.00000	.00752
5	5.94487	.04967	.04960	.00000	.00745
6	5.94487	.04967	.04960	.00000	.00745
7	6.04292	-.03885	-.03880	.00001	.01692
8	5.05575	-.05030	-.05023	.00001	.01042
9	5.94595	.04882	.04875	.00001	.01248
10	6.05978	-.05396	-.05388	.00001	.01092
11	5.92221	.07006	.06996	.00001	.00657
12	5.06868	-.06193	-.06184	.00001	.00931
13	5.06868	-.06193	-.06184	.00001	.00931
14	6.05702	-.05168	-.05160	.00001	.01914
15	4.94485	.05008	.05000	.00001	.02266

Standardized Residual Histogram



P-P Plot of Regression Standardized Residual



ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	54.153	5	10.831	8.701	<.001[b]
	Residual	429.442	345	1.245		
	Total	483.595	350			

a. Dependent Variable: DV4

b. Predictors: (Constant), IV11, IV07, IV06, IV10, IV05

Appendix S: IRB Approval Letter

Subject: [External] IRB-FY22-23-1517 - Initial: Initial - Exempt
Date: Wednesday, May 31, 2023 at 10:11:01 AM Eastern Daylight Time
From: do-not-reply@cayuse.com <do-not-reply@cayuse.com>
To: Stanley, Douglas <dstanley6@liberty.edu>, Kipreos, Mike (Computational Sciences) <mkipreos@liberty.edu>
Attachments: ATT00001.png

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

May 31, 2023

Douglas Stanley
Mike Kipreos

Re: IRB Exemption - IRB-FY22-23-1517 Does Deviating from Agile Principles have an Impact on Project Success in North Carolina Higher Education Institutions

Dear Douglas Stanley, Mike Kipreos,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:104(d):

Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;

Your stamped consent form(s) and final versions of your study documents can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. Your stamped consent form(s) should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document(s) should be made available without alteration.

Please note that this exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this exemption or need assistance in determining whether possible modifications to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

Page 1 of 2

G. Michele Baker, PhD, CIP
Administrative Chair
Research Ethics Office