

The Role of Trust in University-Industry Research Partnership Performance

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ABSTRACT

Academia and industry both report benefits to forming and maintaining collaborative research partnerships. As organizations come together to participate in these partnerships, each brings their own set of operational norms and strategic goals. Some of these norms and goals are complementary, but others can be conflicting. University-industry research partnerships (UIRPs) in particular are susceptible to conflicts for at least four major reasons: 1) there are strategic differences in the purposes of industry and academia that can result in misalignment of goals and unrealistic expectations; 2) each organization has different operational norms and discord can arise from misunderstandings among participants; 3) many UIRPs function as virtual teams and are susceptible to miscommunication that arises when face-to-face communications are missing; and, 4) UIRPs are knowledge-based organizations meaning that their primary purpose is to translate research into applicable technology that is a largely intangible process and therefore, difficult to manage. The conflicts that can arise from these misalignments, misunderstandings, miscommunications, and mismanagement can deteriorate trust and can become detrimental to a partnership. Trust has been cited as being a factor in adequately addressing conflict and reducing the potentially detrimental effects of each characteristic. This makes the need to proactively cultivate trusting relationships in UIRPs critical. The purpose of this study was to empirically investigate the role of trust in university-industry research partnership performance. The study was designed as a convergent parallel mixed methods research design utilizing an online questionnaire administered to boundary role spanning academic and industry UIRP participants for the quantitative study and interviews of the academic-industry leadership teams for the qualitative study. Following independent analyses of each study, an integrative discussion of the results of both studies more holistically described the role of trust in UIRPs. The research results enhance our understanding of the role of trust in UIRPs and suggest empirically-based guidelines for managing trust and sustaining positive, long-term UIRP performance.

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GENERAL AUDIENCE ABSTRACT

University-industry research partnerships (UIRPs) are critical contributors to successful technology transfer and sustainable innovation productivity in the U.S. However, these partnerships are susceptible to challenges associated with bringing the differing purposes of academia and industry together in collaborative partnerships. In light of these challenges, UIRP stakeholders recommend developing strategies to reduce barriers to collaboration and strengthen connection points between academia and industry. Research suggests that inter-organizational trust is effective for reducing barriers to collaboration and for enhancing organizational partnership relations and therefore the purpose of this study was to empirically investigate the role trust plays in UIRP performance in order to develop intentional strategies to build and maintain trust to positively impact partnership performance.

The study was designed as a mixed methods research design utilizing an online questionnaire administered to boundary role spanning academic and industry UIRP participants for the quantitative study and interviews of the academic-industry leadership teams for the qualitative study. Following independent analyses of each study, an integrative discussion of the results of both studies more holistically described the role of trust in UIRPs. The research results enhance our understanding of the role of trust in UIRPs and provided an empirical basis for recommending guidelines for managing trust and sustaining positive, long-term UIRP performance.

Dedication

First, Glory to God

“Now to Him who is able to keep you from stumbling, and to present you faultless before the presence of His glory with exceeding joy, to God our Savior, Who alone is wise, be glory and majesty, dominion and power, both now and forever. Amen.” Jude 24-25 (*NKJV*)

To my Grandfather – Mr. Bostick Whitsell Williams (December 11, 1922 – March 4, 2016) a 1948 Virginia State College graduate in Chemistry; a nuclear submarine inspector; a devout, God-fearing Christian and educated patriarch.

To my Mother - Linda Williams Flora, a 1981 Hampton Institute graduate in Home Economics and a 1996 Georgia Southern graduate in Education (Master’s); a math and science educator for federal government schools; a devout, God-fearing Christian and educated matriarch.

Acknowledgments

“Now to Him who is able to do immeasurably more than all we ask or imagine, according to His power that is at work within us,” Ephesians 3:20 (NIV)

Immeasurably Blessed and Immensely Grateful

There are so many people who supported my journey in so many ways and for all of this support, I am immeasurably blessed and immensely grateful.

To my husband, Jonavon, my most faithful and cherished supporter. Through high and low times, through thick and thin times, you put your money where your mouth was in terms of support and additionally, truly assured me and exemplified that “Nothing beats persistence.” For your prayers and outstanding love and support, I am SO immeasurably blessed and SO immensely grateful.

To my children, Jeremiah, Ariel, and Naomi, my most enthusiastic and gracious supporters. Thanks for self-managing so early in life and for cheering me on as I worked outside of the home. Motherhood is truly the most challenging, yet rewarding experience of my life. I’ve learned so much about myself and matured in so many ways in the process of stewarding over your lives. For just being who you are and doing what you do, I am immeasurably blessed and immensely grateful.

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I also want to acknowledge some supporters who were with me from the very beginning of my time at VT and are still standing in support for this occasion: Dr. Watford – the first person I met, Dr. Goff my first engineering professor who provided the last leg of my full-time GRA funding, and my St. Paul AME Church family who was automatic family even from my pre-college program when I started attending.

As I reflect on the many years of school for undergrad and graduate school at Virginia Tech combined with having and raising children, there are many, many people who deserve acknowledgment, so it is hard to confine my gratitude to a limited space. I wanted to share some of the many ways that I have received support and I hope that my dearest friends and family who provided support in so many ways over time will see themselves reflected and be assured that I acknowledge and I am truly grateful for their support.

For those who have paid bills– tuition and fees, household, or otherwise....For those who have, cared for my family–transportation, babysitting, food, clothing, entertainment....For those who have supported my work – research work, teaching work, classroom work, event/service/program work....For those who have mentored and encouraged in words and/or deeds and prayers, for this and so much more, I am immeasurably blessed and immensely grateful. At this particular juncture in life, I am reflective of how rich I am in friends and family, peace, love, support and now, degrees! Now, more than ever I know that I am immeasurably blessed and for that I am immensely grateful.

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Chapter 1: Introduction

1.1 Trust and University-Industry Research Partnerships

Trust has been defined as "...the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control the other party" (Mayer, Davis, and Schoorman, 1995, p. 712). Inter-organizational trust "refers to mutual trust among organizations, [and] is sometimes even regarded as being constitutive for organizations working together in inter-organizational networks" (Sydow, 1998, p. 32).

A University-Industry Research Partnership (UIRP) was operationalized in this study as the following: *An inter-organizational alliance in which university partners contribute explanations, ideas, new techniques and potentially trained employees to their industry partners while the industry partners communicate industry's objectives in various research areas, and they contribute technical problems as well as financing for research* (Konecny, 1995). UIRPs play a critical role in facilitating research and technology development and commercialization processes related to the transfer of technology in the U.S. (President's Council of Advisors on Science and Technology [PCAST], 2008). Additionally, academia and industry both report benefits to forming and maintaining collaborative research partnerships. For example, industry can benefit from academe via the latest research findings in order to be competitive and academe benefits from industry funding. Unfortunately, alongside the benefits of collaborating, there exist organizational and relational barriers that can hinder the performance of UIRPs (e.g. Siegel, Waldman, Atwater, and Link, 2004). However, there are also research findings that indicate that greater levels of inter-organizational trust helped reduce these barriers (Bruneel, D'Este, and Salter, 2010).

Teaming discipline is a term adapted from Katzenbach and Smith's "The Discipline of Teams" (1992) to encompass the characteristic actions practiced by "high performing teams" that distinguishes their performance from ordinary work-groups. Katzenbach and Smith assert that groups can develop into teams through practicing disciplined actions that include: shaping a common purpose, agreeing on

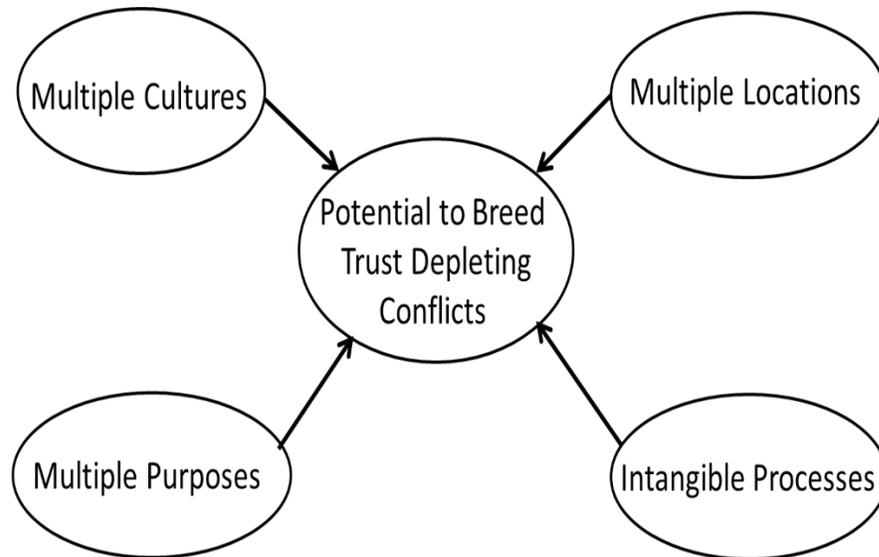
performance goals, defining a common approach to working, and holding themselves jointly accountable for the performance results (1993). Teaming discipline is believed to lead to performing at higher levels (Katzenbach and Smith, 1993) therefore, the four actions associated with teaming discipline are included in this study for the purpose of empirically analyzing the relationship between these actions with respect to performance in the inter-organizational partnership context of UIRPs.

1.2 Problem Statement

There are at least four characteristics that are common among UIRPs (Figure 1-1, below) that make them susceptible to issues of misalignment, misunderstanding, miscommunication, and mismanagement, that can, in turn, lead to conflicts that, when inadequately resolved, can undermine and deteriorate trust:

- 1) Multiple purposes of industry and academe: The purpose of industry is to increase shareholder wealth while the purpose of academe is to educate and disseminate knowledge. Misalignment of purposes and goals can introduce conflict that arises from debating which direction the partnership should take (e.g. Berman, 2008; Perkmann, Neely, and Walsh 2011).
- 2) Multiple cultures among the involved organizations: Operational diversity stems from the fact that different organizations complete work in different ways. The different cultural “norms of operation” can cause misunderstandings that lead to conflicts about how work in a partnership should be accomplished (e.g. Bruneel et al., 2010; Perkmann et al., 2011).
- 3) Multiple locations: Virtual Teaming is especially descriptive of UIRPs that tend to be nationally distributed while working on projects. However, many partnerships, and even the organizations within them, are operating in geographically distributed conditions utilizing virtual teams as well. Virtual teams tend to battle miscommunications due to the missing richness of “face-to-face” non-verbal communications (e.g. McNair, Paretti, and Davitt, 2010; Jarvenpaa and Leidner, 1999).

Figure 1-1. University-Industry Research Partnership Characteristics



4) Intangible Processes: A primary functional purpose of UIRPs is to bring research through development toward commercialization in order to enhance innovative progress in the U.S. The Engineering Advisory Committee (EAC) characterized an “innovation supply chain” that describes the way that the resource of knowledge is “processed” through a technology transfer process much like any other commodity is derived from raw materials through a manufacturing/supply chain (2008). However, in this case, the resource – knowledge - is largely intangible and heavily dependent on human interactions that can vary in effectiveness (Renzl, 2008). Further, mismanagement of knowledge management processes is a prevalent concern in knowledge management literature and in practice (e.g. Lee, 2000; Santoro and Bierly, 2006).

The literature suggests that inadequately resolved relationship-based conflict, is a potential pitfall in each of the four characteristics above. Relationship conflict has an empirically supported negative relationship with trust (Simons and Peterson, 2000). Further, trust is cited as an enabling factor in knowledge sharing (Renzl, 2008). Therefore, assuming the theoretical position that trust has the potential to enable adequate conflict resolution (see Han and Harms, 2010) and enable knowledge sharing (Renzl, 2008), this study focused on methods to cultivate and sustain trust in order to have an impact on the performance of UIRPs.

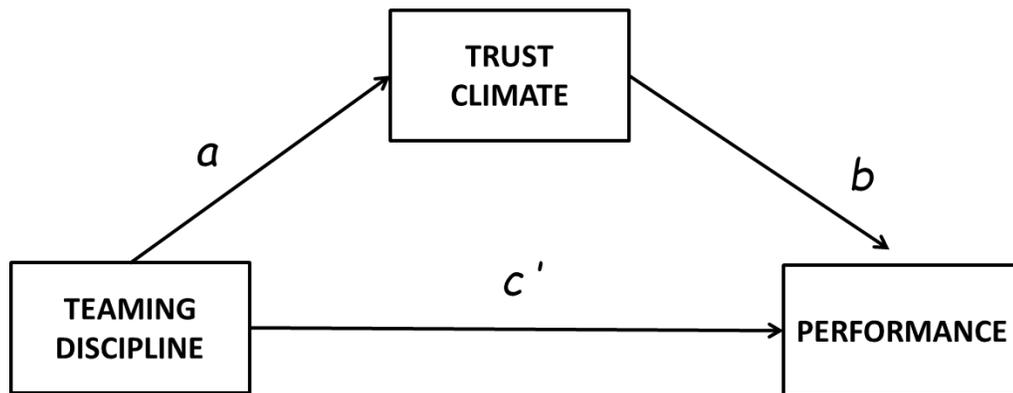
For this study, the focus was on the academic and industry boundary spanning participants, which are those participants who work directly with a person outside of their primary organizational boundary in managing the work of the UIRP within the partnership. Further, the researcher conceptualized the partnerships that these individuals work as self-managed, self-directed work teams (Smith, Casino, and Neck, 2000; Brown, 2002). The focus on UIRPs from this teaming and relational perspective is a differentiating factor in this study from previous studies of UIRPs that tend to focus on transactional processes such as negotiations and commercialization processes (e.g. Siegel, Waldman, Atwater, and Link, 2003). While the context is the partnership, the level of analysis for the study will be at the individual level.

1.3 Purpose and Objectives

Purpose:

To maintain a strong global position through innovation in the U.S., barriers to academic-industry partnering need to be reduced and the connection points of UIRPs need to be strengthened (PCAST, 2008). Research suggests that trust is effective for both overcoming challenges that arise through conflicts (Bruneel et al., 2010) and for strengthening relationships in business or otherwise (e.g. Boersma, Buckley, and Ghauri, 2003; Rempel, Holmes, and Zanna 1985). Therefore, the purpose of this study was to empirically investigate the role of trust in university-industry research partnership performance. Because research in the area of UIRPs still in its infancy (Porac, Wade, Fischer, Brown, Kanfer, and Bowker, 2004), multiple methods were employed for a more holistic investigation. A survey was conducted to examine the relationships between the variables trust climate and performance and then, to test a hypothetical mediation model of trust climate between teaming discipline and performance. See Figure 1-2 below for an adaptation of Baron and Kenny (1986) model of mediation to illustrate the hypothesized relationship between the variables in this study:

Figure 1-2. Hypothetical Mediation Model of Trust in Teaming Discipline and Performance



(Adapted from Baron and Kenny, 1986)

In parallel with the survey study, a separate qualitative phenomenological study was conducted. Interview data from UIRP academic and industry leaders was collected to provide another internal perspective of trust, teaming discipline, and performance in UIRPs. The interview data was transcribed and then analyzed utilizing a synthesis of approaches outlined by Moustakas (1994) and Creswell (2013). The analysis results from the surveys and interviews were corroborated during the interpretation phase of the study. Specifically, statistical results from the quantitative analysis were further explicated with the results from the qualitative data analysis.

Objectives:

To fulfill this purpose, the following objectives were developed and addressed:

1) Conducted a literature review in Engineering Management, Management, Organization, and Team Performance focusing on the following:

- University-Industry Research Partnerships (linkage, strategic alliance, joint venture, relations)
- Definitions and conceptualizations of trust, teaming, and performance.
- Measuring trust within teams, organizations, and inter-organizational relations

2) Adapted an instrument based upon literature and collected survey data on trust climate, teaming discipline, and partnership performance from UIRP academic and industry boundary spanning participants.

- 3) Analyzed survey data with classical statistical analyses to characterize the theoretical relationship between the variables trust climate and performance, to compare the trust climate levels between academic and industry participants, and to test a proposed model that demonstrated mediation of trust climate between teaming discipline and performance variables.
- 4) Developed an interview protocol with expert review and intellectual neighbors and collected interview data from UIRP leaders.
- 5) Utilized the phenomenological procedures (Moustakas, 1994) to analyze the interview transcript data producing a composite description of trust in UIRPs from a leadership perspective.
- 6) Corroborated the analysis results from the quantitative with the qualitative analysis results and interpreted the role of trust in UIRPs.

1.4 Research Questions

The overarching question for this research was:

What is the role of trust with respect to university-industry research partnership performance?

The related sub-questions that have been addressed are:

RQ1: How does trust relate to UIRP performance?

RQ2: How does trust from academic participants compare with trust from industry participants?

RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?

The table below provides a summary of quantitative and qualitative studies that were used to address the research questions.

Table 1-1. Research Questions and Parallel Study Summary

Research Questions	Quantitative Study	Qualitative Study
<p>RQ1: How does trust relate to UIRP performance?</p>	<p>Collected survey data on trust climate and performance from academic and industry boundary spanning participants and statistically described the relationship between the variables of trust, as the independent variable, and performance, as the dependent variable.</p>	<p>Collected interview data about the ways trust is related to performance in UIRPs from the perspective of academic and industry boundary spanning leaders.</p>
<p>RQ2: How does trust from academic participants compare with trust from industry participants?</p>	<p>Survey data on trust climate were compared between the academic participants and the industry participants.</p>	<p>Collected interview data from both the academic leaders and the industry leaders about trust from each of their perspectives.</p>
<p>RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?</p>	<p>Tested the actions associated with teaming discipline in a hypothetical mediation model. A mediation analysis that involves series of regression analyses were performed to describe the significance of relationships between teaming discipline, trust climate, and performance.</p>	<p>Collected interview data to understand what behaviors or practices leadership feels should be followed that contribute to higher levels of trust and performance in UIRPs.</p>

1.5 Overview of Approach and Methodology

Approach

A Macroergonomics perspective was utilized in this study. Macroergonomics is a subdiscipline of human factors and ergonomics that is concerned with human-organization interface technology (Hendrick and Kleiner, 2002). In this study, the specific human-organization interfaces are the boundary spanning teams of participants that specifically interact across organizational interfaces.

Macroergonomics theory is based upon a Socio Technical Systems (STS) theory of work system model that holistically model organizational structure and work processes considering the interaction of internal and external environmental systems, technical systems, and personnel subsystems (Hendrick and Kleiner, 2002). Within an STS work approach, organizations are viewed as agencies that transform inputs into outputs (Hendrick and Kleiner, 2002).

Considering the goal of this study was to develop methods for strengthening the connection points at the human-organization interface to improve the performance in UIRPs, the nature of the connection points must be considered and, there are both technical and social aspects that need to be addressed in strengthening these points. Macroergonomics is a human-centered design approach that was useful to address a social relational aspect of UIRPs that is currently missing in the study of UIRPs.

Another theoretical framework that was useful for this study, stakeholder theory, assumes the following (Jones, 1995): “The firm is characterized by relationships with many groups and individuals ("stakeholders"), each with (a) the power to affect the firm's performance and/or (b) a stake in the firm's performance (Freeman, 1984).” This is the theoretical basis for the importance of studying relationships among participants who have the power to affect performance as boundary spanning persons affect the performance of UIRPs utilized in this study.

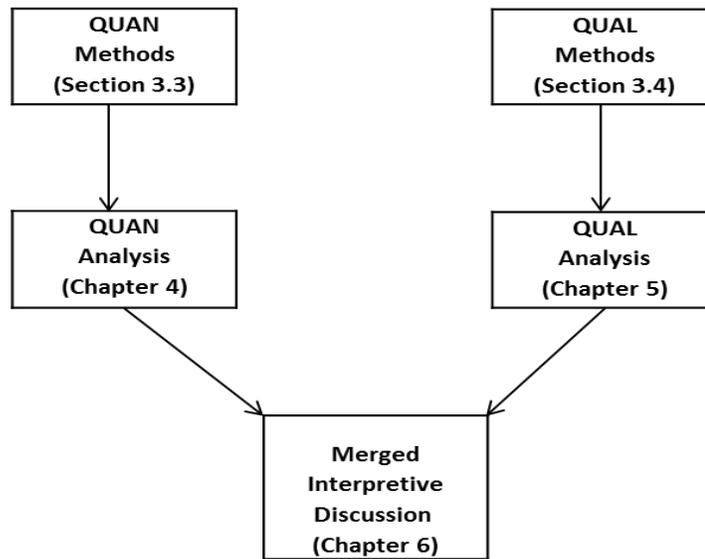
Table 1-2. Theory-Application Mapping

Theory	Application in this study
<p>Macroergonomics (Hendrick and Kleiner, 2002) Socio-technical Systems Theory (Emery and Trist, 1969)</p>	<ul style="list-style-type: none"> - Perspective of human-organization interface as a focal point of this study - An empirical study of human relations (socio-) considered along with previous studies that focus on transactions (-technical) - Human-centered design focus.
<p>Stakeholder Theory (Jones, 1995)</p>	<p>Theoretical support that relationships matter and have the power to affect performance in organizations.</p>

Methodology

A convergent parallel mixed methods research design was used in this study (Creswell and Plano Clark, 2011). A quantitative survey study was conducted in parallel with a qualitative phenomenological study and the results of the independently analyzed studies were merged and interpreted jointly. A diagram of the overall flow of the research design is below:

Figure 1-3. Convergent Parallel Mixed Methods Research Design with section mapping



The quantitative portion of the study consisted of survey data. A questionnaire was validated through expert panel review and correlation analysis and used in the process of collecting data on trust climate, teaming discipline, and performance from academic and industry boundary spanning UIRP participants. Groups of university-industry research partnerships in the U.S were chosen for participation in this study. A director was contacted first for permission to invite the UIRP participants of the partnership organization to participate in the survey study. The questionnaire was managed and administered online after informed consent to participate in the study was obtained. Following the data collection, descriptive and inferential statistical analyses were performed to test the relationship between trust climate and performance and a hypothetical trust climate mediation model.

Table 1-3. Survey Data Collection Outline Mapping

Research Questions	Variables	Data Collection	Sample
RQ1: How does trust relate to UIRP performance?	Trust Climate	Questionnaire (Items 1-21)	University-industry boundary role participants
	Performance	Questionnaire (Items 81-88)	
RQ2: How does trust from academic participants compare with trust from industry participants?	Trust Climate	Questionnaire (Items 1-21) and demographic identification as academic or industry participant.	University-Industry boundary role participants
RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?	Trust Climate	Questionnaire (Items 1-21)	University-industry boundary role participants
	Teaming discipline	Questionnaire (Items 22-80)	
	Performance	Questionnaire (Items 81-88)	

In parallel, the qualitative phenomenological study was based on the interviews of the academic and industry leaders in UIRPs. Through analysis of transcribed interview data, composite descriptions were developed in describing the phenomenon of trust in UIRP from the leadership perspective. Following the completion of each of the studies, the independently analyzed results were merged for interpretation to provide a holistic, empirically supported explanation of the role of trust in UIRP performance.

1.6 Research Justifications

This research focused on university-industry research partnerships - an understudied group of strategic alliance organizations (Plewa and Quester, 2007, Santoro and Saporito, 2003) – with a goal to provide empirically based recommendations of distinct actions to take to cultivate trust in an effort to improve and/or sustain performance in UIRPs. The work from this study provided insight regarding inter-organizational partnering as a broad concept. Studying inter-organizational arrangements from the perspective of the relationships, rather than formal business transaction processes (Plewa and Quester, 2007) between individuals and organizations provided an insightful lens and a different path to address challenges associated with inter-organizational arrangements – particularly UIRPs. Future work from this study could lead to methods of predicting partnership performance and avoiding potential pitfalls in partnerships by not only addressing conflict early, but proactively building trusting relationships through a discipline of teaming.

Overall, expanding inquiry in university-industry collaborative research partnerships to the relationship realm with a focus on trust, that is part of every type of partnership, created an opportunity for systematic insight and enhancement to university-industry collaborative research partnerships as a whole. Moreover, trust is often alluded to as a pivotal factor in organizational and team performance, however; the concept still lacks empirical validation (Porter and Lilly, 1996). In general, trust is believed to be important, yet, how to systematically achieve and measure trust at the organizational and inter-organizational level remains challenging in research and in practice.

1.7 Document Overview

Chapter 2 is a literature review that provides background information on university-industry research partnerships and their critical role in innovation in the U.S. The chapter also presents evidence supporting the importance of building trust in UIRPs. Further, the literature review includes discussion of the theoretical bases for the operational definitions for trust, boundary spanning (role) persons, and self-managing work teams, and also the relationships among trust, trust climate, teaming discipline, and performance. The chapter concludes by distinguishing how this study is different from other published studies on inter-organizational trust and from studies on UIRPs.

Chapter 3 details the convergent parallel mixed methodology used for this study. For the quantitative study, the procedures for instrument development, including a pilot study are described. Also, the procedures for administering an online questionnaire for data collection were specified. Next, the procedures for developing the interview protocol for conducting semi-structured interviews and the plans for a phenomenological analysis were described. The concluding sections of Chapter 3 includes the initial plans for data analysis in the context of the research questions and the overall convergent parallel mixed methods design.

Chapter 4 includes a discussion of the results of the quantitative study data analysis with respect to the research questions. The results of the correlation analysis characterizing the relationship between trust climate and performance to address the first research question are presented. Next, the results of an independent t-test are presented to describe the results of a comparison of trust between academic and industry boundary spanning persons. Finally, the results of the mediation analysis for testing the hypothetical mediation model of trust are presented.

Chapter 5 includes details of the phenomenological analysis and the resulting composite description of the phenomenon of trust in UIRPs. Chapter 6 contains a merged, interpretive discussion of the both the quantitative and qualitative studies along with the overall implications of the research. Additionally, Chapter 6 serves as a closing chapter for the dissertation and concludes the current research and provides recommendations for future work.

Chapter 2: Literature Review

This literature review begins with background information on university-industry research partnerships (UIRPs) and their critical role in technological innovation in the U.S. Next, the researcher provides an explanation of the need to focus on building trust in UIRPs in order to strengthen the connection points between academia and industry in partnerships. Next, the literature basis for conceptualizing, defining, and measuring trust in organizational and inter-organizational contexts is presented to provide literature-based support for the design of this dissertation study analyzing trust in the inter-organizational context of UIRPs. Finally, this chapter concludes with an explanation of the operational definitions for trust (Mayer et al., 1995), boundary spanning (role) persons (Adams, 1976; Currall and Judge, 1995), and teaming discipline (Katzenbach and Smith, 1993).

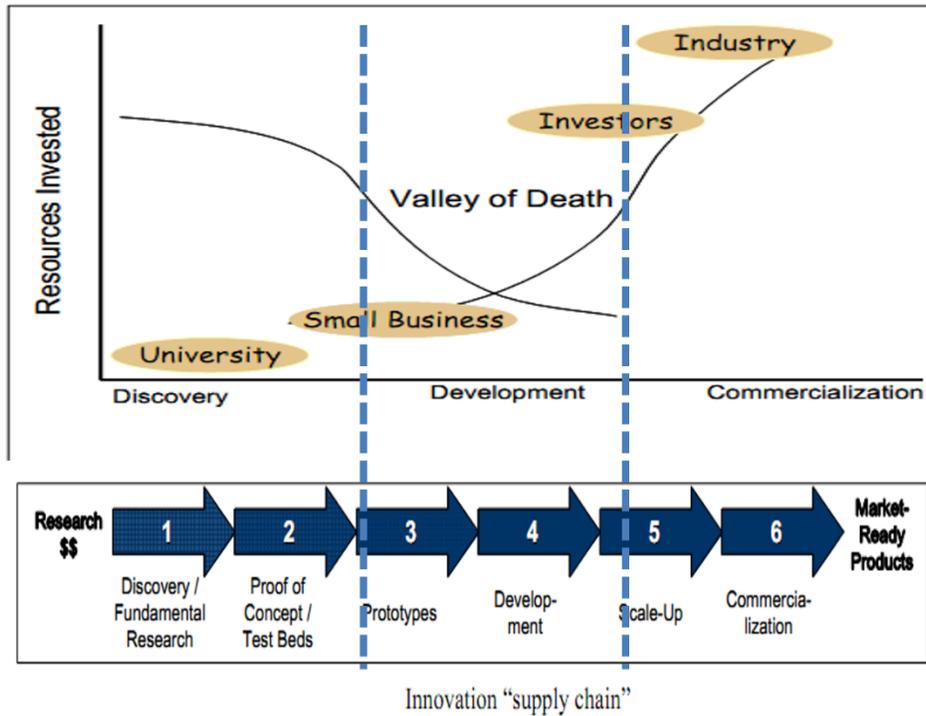
2.1 University-Industry Research Partnerships in the U.S.

2.1.1 Background

The EAC introduced the reference of an innovation “supply chain” that describes the way that the resource of knowledge is “processed” through a technology transfer process much like any other commodity is derived from raw materials through a manufacturing or supply chain process (EAC, 2008). Figure 2-1 below provides a depiction of the resources flowing into the process of translating research ideas into commercialized products in this supply chain.

Referring to the steps of the innovation “supply chain” in Figure 2-1 below, universities tend to excel at steps 1 and 2 involving fundamental research and discovery and proof of concepts, while industry organizations tend to excel at steps 5 and 6 which involve scaling up products and preparing them for commercialization. The “Valley of Death” (EAC, 2008) in the middle of the image in Figure 2-1 corresponds with the gap in steps 3 and 4 that involve creation of prototypes and development of technologies. This represents a point in the supply chain where innovations are subject to stall and never make it through the valley toward commercialization.

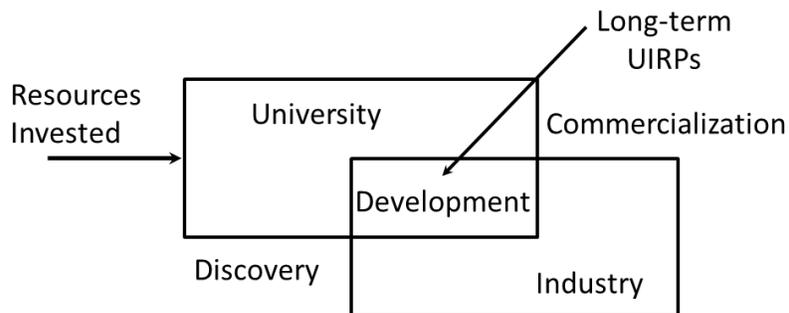
Figure 2-1. Resources across the “innovation supply chain”



Images adapted from “Encouraging Industry-University Partnerships: Report from the Engineering Advisory Committee Subcommittee on Industry-University Partnerships” (2008)

When universities and industries form long term collaborative research partnerships in a manner similar to the depiction in Figure 2-2 below, the steps 3 and 4 that are largely missed by either group alone tend to be covered making it easier to navigate through “the valley of death” toward commercialization.

Figure 2-2. UIRPs – long term partnering emphasis
(Adapted from Dooley and Kirk, *European Journal of Innovation Management*, 2007)

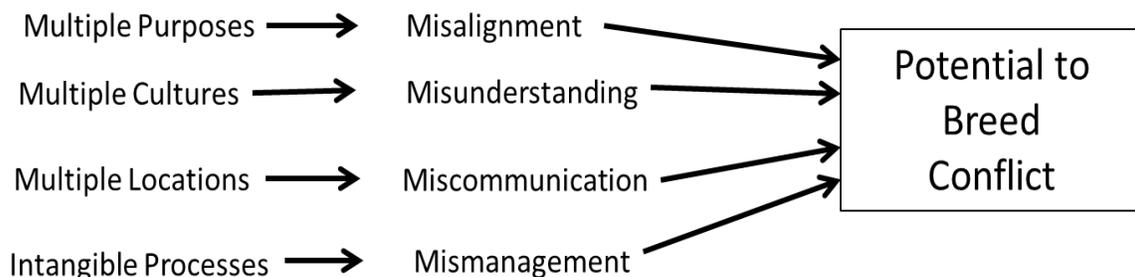


The President’s Council of Advisors on Science and Technology (PCAST) described the innovation ecosystem as, “the dynamic system of interconnected institutions, persons, and policies that are necessary to propel technological and economic development” (PCAST, 2008, p.1). Because of the documented evidence of university-industry partnerships’ ability to succeed in moving innovation along the supply chain, PCAST acknowledges the critical role partnerships play in the U.S. innovation ecosystem and recommends that methods for reducing barriers to partnering and strengthening connection points of partnerships should be investigated (PCAST, 2008). The types of connection points to be strengthened and barriers to be reduced have been limited to addressing institutions and policies, for example, the process negotiating at the starting point of partnership formation that focuses on improving the business transactions such as formal contracts (University-Industry Demonstration Partnership [UIDP], 2009). This dissertation study focused on the connection points between the people and institutions with an emphasis on trust and its potential role in affecting partnership performance.

2.1.2 Benefits and Challenges in UIRPs

While there are noted benefits to university-industry partnering both for individual organizations and for the benefit of national innovation, there are challenges that come along with sustaining long-term UIRPs. At least four characteristics of UIRPs make them susceptible to relationship conflicts that have the potential to deplete trust subsequently destructive in a UIRP. Figure 2-3 depicts four characteristics that can contribute to conflicts. Each characteristic is described in turn following Figure 2-3.

Figure 2-3: Characteristics of UIRPs that practically inevitably breed conflict



Multiple Purposes: The primary purpose of academe is centered on knowledge creation and dissemination. The primary purpose of industry is centered on creating shareholder wealth. These purposes are complementary in the context of the research commercialization process as outlined in the innovation “supply chain” context (EAC, 2008). However, along with the complementarity there can also be misalignments from having multiple stakeholders and potentially multiple purposes. Trust has been cited as a key mediating variable in the industry-university context of advancing knowledge and new technologies (Santoro and Saporito, 2003). Further, trust was also cited as reducing barriers associated with this different orientation of industry and universities (Bruneel et al., 2010)

Multiple Cultures: Organizations have climates and norms that boundary spanning persons might carry into inter-organizational exchanges such as UIRPs. While the diversity of ideas can result in beneficial, complementary skill sets, there can also be misunderstanding when work processes and relationships are handled differently. Conflict in particular can arise in the area of negotiating intellectual property (IP). Bruneel et al. (2010) found evidence to support inter-organizational trust effective for reducing barriers associated with transaction processes between universities and industry.

Multiple Locations: A rapidly growing area of literature is in the area of virtual teams. More organizations are operating under geographically dispersed circumstances. Many UIRPs are nationally distributed centers of academia working on fundamental research projects with industry. A commonly cited challenge in the area of virtual teams and virtual organizations is the challenge of miscommunication due to the missing richness of “face-to-face” non-verbal communications (e.g. McNair, Piretti, and Davitt, 2010; Jarvenpaa and Leidner, 1999). Trust has been cited as a critical factor in the performance of virtual teams (e.g. Jarvenpaa and Leidner, 1999).

Intangible Processes: A primary functional purpose of UIRPs is to bring fundamental research through to commercialization in order to enhance the innovative advantage in the U.S. The resource of knowledge is “processed” through a technology transfer process much like any other commodity is derived from raw

materials and handled throughout a manufacturing/supply chain (ref. EAC, 2008). However, in this case, the resource – knowledge - is largely intangible and heavily dependent on human interaction that can vary in effectiveness (Renzl, 2008). Perkmann et al. (2011) cite the intangible nature of the outcomes as a challenge for designing measurement systems in UIRPs. Further, mismanagement of largely intangible knowledge management processes is a prevalent concern in knowledge management literature and in practice (Lee, 2000; Santoro and Bierly, 2006). However, in the context of knowledge management, again, trust is cited as a critical component enabling knowledge sharing in organizations (Levin, Cross, Abrams, and Lesser, 2002).

Combining multiple purposes of industry and academe can lead to misalignments; combining multiple cultures of different organizations can lead to misunderstanding; combining multiple locations (e.g. geographically dispersed virtual teams) can lead to miscommunication; and, performing intangible knowledge-based innovation processes can lead to mismanagement. Each of these can become a source of conflict, particularly relationship conflict in UIRPs. Yet, based on literature on each of these characteristics, trust has also been cited as a means to offset and/or dampen the practically inevitable deteriorating effects of these characteristics inter-organizational/partnership arrangements.

The literature suggested conflict, more specifically, relationship conflict, as a pitfall in each of the four characteristics above (e.g. Panteli and Sockalingam, 2005). Relationship conflict has an empirically supported negative relationship with trust (Simons and Peterson, 2000). Further, trust is cited as an enabling factor of knowledge sharing (Renzl, 2008; Panteli and Sockalingam, 2005). Therefore, assuming the theoretical position that trust has the potential to reduce conflict (Han and Harms, 2010) and enable knowledge sharing (Renzl, 2008), the researcher will focus on methods to cultivate and sustain trust in order to have an impact on the performance of UIRPs.

2.2 Trust

In beginning his discussion about the benefits of trust, John Child (2001) quotes James R. Houghton, a former chairman of Corning Inc. who said, “The key ingredient in a successful alliance is trust.” In his article, “Trust-The Fundamental Bond in Global Collaboration,” Child (2001) emphasizes the critical role that trust plays in collaborations by stating, “Informal understanding, based on trust, often proves to be a more powerful factor [than formal contracts] in determining how the collaboration works out” (Child, 2001, p. 274). It is this sentiment that motivated the research in this study – an empirical investigation of the role of trust with respect to performance in an inter-organizational alliance context.

Seppanen, Blomqvist, and Sundqvist, (2007) herald trust as possibly one of the most critical success factors in inter-organizational relationships. Santoro and Saporito (2003) echo the sentiment and refer to trust as “an essential element in inter-organizational relationships” (Santoro and Saporito, 2003, p. 363). Other researchers speak of a reduction in transactional uncertainty and costs facilitated by appropriate trust presence between parties (Bstieler and Hemmert 2008; Nooteboom, 1996; Williamson 1993). While there seems to be agreement among researchers and practitioners about the benefits of trust, there are many challenges in theory and in practice regarding both understanding what trust is and realizing the benefits of trust. Further, there is general agreement that trust is important, but why it’s important and how it is managed underpinned the empirical investigation in the current dissertation research study.

There has been an increase in inter-organizational exchange relations and in the uncertainty and complexity of business environments that, according to Lane and Bachmann (1998) cannot be handled unless interpersonal and/or inter-organizational trust is present. When a high level of trust is present between inter-organizational exchange partners, they may be inclined to expand the availability of the knowledge – both implicit and proprietary - between them (Sako, 1998; Ring and van de Ven, 1992). Along with knowledge, information may be exchanged more accurately, comprehensively, and timely in a relationship of trust (Chiles and McMackin, 1996). In inter-organizational exchange relationships like collaborative university-industry research partnerships, the essential function of collaborating on research

projects necessitates sharing potentially sensitive knowledge and information, making trust a highly desired property (Sherwood and Covin, 2007; Lane and Bachmann 1998).

However, while there are many agreed upon benefits of inter-organizational trust, it still remains difficult to develop and sustain (Lane and Bachmann, 1998). Also, there are still many theoretical and practical challenges in conceptualizing, measuring, and analyzing trust and its potential impacts on performance (Seppanen et al., 2007; Bachmann and Zaheer, 2006). This research addressed some of the challenges with conceptualizing and defining trust along with the challenges in measuring and analyzing trust. Further, this study considered trust primarily as a social phenomenon that has implications at both interpersonal and inter-organizational levels (Lane and Bachmann, 1998) in UIRPs.

2.2.1 Definition and Conceptualization of Trust

Definition

In their book *Trust Theory: A Socio-Cognitive and Computational Model*, Castelfranchi and Falcone (2010) cite a content analysis performed by Castaldo (2002) that analyzed 72 definitions of trust from four domains – Management, Marketing, Psychology, and Sociology. Over half of these definitions were published between 1990-1999. According to Castelfranchi and Falcone (2010), there is one definition of trust accepted by “the great majority of other authors” (p.19) that is found in a classic book *Trust: Making and breaking cooperative relations* by Gambetta (1988). Castelfranchi and Falcone (2010) translate Gambetta’s definition of trust as “... the subjective probability by which an individual, A, expects that another individual, B, performs a given action on which *its welfare depends*” (translation from Italian) (p.19). There have been many definitions proposed since Gambetta’s and there is a myriad of contextual differences for studying trust that would logically justify using different definitions for different purposes. This highlights a key challenge in studying trust – defining and conceptualizing such a dynamic and complex construct.

Colquitt, Scott, and LePine (2007) referred to vulnerability and positive expectation as two primary components that are prevalent in definitions of trust in the literature. Lane and Bachmann (1998)

described a sense of vulnerability that is apparent in the inherent risk and uncertainty in social relationships and the fact that a trustor may or may not be able to monitor and/or control the actions of a trustee (Mayer et al., 1995). There is a positive expectation (Rousseau, Sitkin, Burt, and Camerer, 1998) or confidence (Covey, 2006) that the trustee will do as expected, not act opportunistically (Williamson, 1993). There is a belief or expectation on behalf of a trustor that a trustee will not take advantage of the trustor's vulnerability (Lane and Bachmann, 1998; Mayer et al., 1995).

Two definitions that are highly cited in management and organizational studies are Rousseau et al. (1998) and Mayer et al. (1995). Rousseau et al., (1998) proposed a definition with the intention of adopting "a multidisciplinary view of trust within and between firms..." (p. 393). The definition they proposed was "Trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Rousseau et al., 1998 p. 395). The psychological state was problematic for use in this study where trust was being analyzed at an inter-organizational partnership level. The researcher had to be careful to avoid creating a situation whereby an organization was anthropomorphized (Zaheer, McEvily, and Perrone, 1998; Bachmann and Zaheer, 2006) by hypothesizing that an organization has a "psychological state." A state also sounded like it was limiting trust to the concept of propensity that again represents an inherently individual phenomenon. Bachmann and Inkpen (2011) disagreed and claimed that an organization can trust. For this study, the theoretical standpoint was such that an organization cannot trust, but, rather, people in an organization can have a collective trust that can impact organizational level outcomes (e.g. Bachmann and Zaheer (2006); Serva, Fuller, and Mayer, 2005).

The second definition from Mayer et al. (1995) is a definition of trust that is highly cited in current organizational trust literature. They defined trust as "...the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control the other party" (p. 712). For the context of organizational literature, the translation from "individual" to "party" was a methodologically helpful implication that there could be an interpersonal interaction or a group or organizational

interaction. Additionally, Mayer et al. (1995) made an effort in their model to distinguish trust from trust propensity, trustworthiness, and risk taking – that are all associated with trust, yet, not explicitly trust. This distinction in this particular model of trust has directed the trust literature in considering antecedents and outcomes of trust (Mayer et al., 1995). The definition by Mayer et al. (1995) was favorable to use because it included the two commonly agreed upon characteristics of a trust definition - vulnerability and positive expectation (Colquitt et al., 2007) and also allowed for easier consideration of trust beyond the individual level of conceptualization. In addressing the concern of utilizing an agreed upon definition of trust, this one emerged as robust and appropriate for this study.

Conceptualization

In considering conceptualizations for trust, a main concern was understanding the notions of what trust is and how trust works. Arrow described trust as a ‘lubricant’ of business transactions and therefore an efficient governance mechanism (1974). Other trust researchers explicitly separated the notion of trust from notions of a propensity to trust and trustworthiness (Colquitt et al., 2007; Mayer et al. 1995). Colquitt et al. (2007) referred to “confusion” about the conceptualization of trust in their work on distinguishing trust from trustworthiness and trust propensity and analyzing the three concepts’ effects on job performance and risk taking. For the present study, focused in an inter-organizational context, the practical notion of what trust is and how it might be developed and sustained was based upon Giddens’ theory of structuration (Giddens, 1990).

Theory of structuration

The structuration perspective allowed for avoidance of an ‘undersocialized’ conceptualization of inter-organizational trust that one finds prevalently in economic theory (e.g. Williamson, 1993) and an ‘oversocialized’ conceptualization that is common in sociology related theories (e.g. Rempel, Holmes, and Zanna 1985), inter-organizational trust can be conceptualized as an outcome of the recursive interplay between action and structure (Sydow, 1998; Granovetter, 1985). The pivotal message in Anthony Giddens’s (1990) theory of structuration was that structure can simultaneously be conceived of as both a

medium and outcome of action. Sydow (1998) provided an explanatory illustration of combining the notion of recursiveness with the notion of a structure that is both a medium and outcome of action by describing a situation of trust increasing power and then power opening the opportunity for developing even more trust. The idea of this recursiveness of trust escalating in this manner was called a 'self-heightening cycle of trust' by Golembiewski and McConkie (1975) (Lane and Bachmann, 1998). It can be contrasted with a concept of a spiral of distrust that might not only reduce transaction efficiency, but may also result in disempowerment (Lane & Bachmann, 1998; Sitkin and Stickel, 1996). Along with the structuration perspective, the notion of trust as being constitutive of a network relation was useful for conveying the possibility that trust could be created intentionally, but could also emerge with development (Sydow, 1998). This study utilized structuration theory as a conceptual basis for being able to investigate trust and methods to build and sustain trust in inter-organizational relation networks.

Zucker (1986) introduced three types of trust that are directly relevant for conceptualizing trust in organizational studies (Lane and Bachmann, 1998; Sydow, 1998) and identified them as sources for which a trustor may base his trust. The three types were characteristic-based trust, process-based trust, and institutional-based trust. In characteristic-based trust, the sources for which a trustor based his trust were personal characteristics like gender, age, or belonging to a particular ethnic community (Sydow, 1998). Characteristic-based trust occurred independent of an actual, concrete exchange (Sydow, 1998). Lane and Bachmann (1998) explained that a trustor and trustee possess 'a world in common' (Lane and Bachmann, 1998, p.12) by belonging to the same social community or group. Because this kind of trust was based on 'ascribed characteristics' (Lane and Bachmann, 1998, p.12) it was not able to be created deliberately (Lane and Bachmann, 1998) - an inhibiting characteristic for trust in this study.

Process-based trust, however, can be developed from concrete social and/or exchange experiences (Lane and Bachmann, 1998) and it also involves incrementally building trust by gradually accumulating knowledge about one another party (Lane and Bachmann, 1998). Process-based trust, over time, may finally culminate into reputation that can be defined as a set of attributes ascribed to a particular person or system (Sydow, 1998). Again, because these attributes are ascribed based on

experiences rather than personal characteristics and therefore may provide an opportunity for deliberately creating trust through creating behavioral or situational experiences.

In light of ongoing discussion in the literature regarding whether trust can be built or not, this distinction between characteristic-based and process-based trust provided some clarity. If the trust present in a relationship was based on characteristics, then because the characteristics were not likely to change, this kind of trust could mostly be considered present in a static state. On the other hand, process-based trust could be developed through positive experiences or destroyed through negative experiences. A practical limitation with analyzing process-based trust was that the amount of time and/or experiences needed to build or rebuild this kind of trust varies among individuals and groups and this study was designed to be cross-sectional.

For the third kind of trust – institution-based trust - a trustor's sources for trusting were based on formal social structures that “generalize beyond a given transaction and beyond specific sets of exchange partners”, and...becomes part of the ‘external world known in common’ i.e. it becomes institutionalized (Zucker 1986:63)” (Lane and Bachmann, 1998, p. 12). Sydow (1998) provided some examples of sources for this kind of trust: “...traditions, professions, certifications, licenses, brand names, or membership in certain associations” (p.43). Lane and Bachmann (1998) further explained that institution-based trust did not depend on a common history or social experience. Bachmann and Inkpen (2011) recently emphasized this form of trust as the basis for considering trust at a macro-level in addressing “how and when institutions matter with regard to trust building” (p. 282) in organization studies. Bachmann and Inkpen (2011) made the distinction that a macro-level conceptualization of ‘institutional-based trust’ like Zucker’s (1986) institution-based trust should be distinguished from micro-level conceptualizations of ‘interaction based trust’ like Zucker’s characteristic-based trust and process-based trust (1986). This study focused on a process-based conceptualization of trust.

Lewis and Weigert (1985) and McAllister (1995) posed a breakdown of trust in the forms of affect-based trust and cognition-based trust. Affect-based trust described trust in light of emotional bonds that may exist between individuals, while cognition-based trust described the reasons an individual

would base their judgment of trustworthiness of another (McAllister, 1995; Lewis and Weigert, 1985). Costa and Anderson (2011) proposed formative and reflective indicators of trust that manifest themselves as cognitive-based in formative and behavior-based in reflective. Formative indicators included trust propensity and trustworthiness while reflective indicators included monitoring behaviors and cooperative behaviors.

Costa and Anderson (2011) developed measures that were used for measuring a trust climate in this study. The conceptualization of trust in this study was of a process-based trust (Zucker, 1986) with cognitive and behavior bases. Trust was measured at the individual level and then further conceptualized as a climate in order to relate the individual trust levels to an organizational level in order to investigate its relation to organizational level performance.

2.2.2 Challenges Measuring Trust in Organizational Settings

Trust is a complex phenomenon that literature supports as being critical to inter-organizational alliances. While there is general support that trust is important, there are still outstanding questions such as why trust is important and how it matters to various organizational constructs. Further questions that remain are how can one detect and manage trust? Also, how does one know how much they have and if they need more? These concerns were the pivotal in this dissertation study.

Measuring trust in organizational and inter-organizational settings remains a challenging endeavor for at least three reasons. First, as previously addressed, there is “confusion” among trust researchers about the definition, conceptualization, and dimensions of trust in trust literature (Colquitt et al., 2007; Mayer et al., 1995). Secondly, there are also problems – particularly, misalignments – with the levels of analysis for measuring trust (e.g. claiming to measure organizational trust but only capturing interpersonal trust) (Currall and Inkpen, 2002; Mayer et al., 1995; Seppanen et al., 2007). Third, there remains a “...notable lack of validated measures of trust in organizational settings at the team or work group level of analysis” (Costa and Anderson 2011 p.120). Seppanen et al. (2007) conducted a critical review of empirical studies on measuring inter-organizational trust. One thematic quote from their

critique was that "...there have not yet been any theoretically and empirically coherent attempts to measure trust in an inter-organizational context" (Seppanen et al. 2007, p. 250).

Simons and Peterson (2000) cited work by Zand (1972) in characterizing trust at the group level as entailing the generalized expectations for all group members. Simons and Peterson (2000) reported on the pivotal role of intragroup trust in task and relationship conflicts in management teams, yet, while they emphasized what "intragroup trust" does, they did not provide an explicit definition for what intragroup level trust actually is. Currall and Inkpen (2002) and Inkpen and Currall (2004) offered a useful consideration for group level trust by viewing trust as a decision to act in ways that placed one's fate in another's hands, because viewing trust as a decision to take action rather than an expectation also allowed the researcher to extend the level of measurement to the group or firm (i.e. to make a group decision).

Costa and Anderson (2011) cited Kramer (1999) and Puusa and Tolvanen (2006) in specifically clarifying trust as, "...both an interpersonal and collective phenomenon... expressed at three levels within organizations: individual, teams, and organizational" (p. 119-120). It was important to consider the concept that a group was not just a collection of individuals, but that groups "...exhibit characteristics reflective of the whole" (Serva et al., 2005, p.627). In their study on the reciprocal nature of trust among teams, Serva et al. (2005) stated that "a group's trust for another can be thought of as a shared belief by members of a focal group about how willing that group is to be vulnerable to a target (i.e., trustee) group (p. 627).

Serva et al. (2005) expanded their discussion of the issue of measuring a team at the group level offering three different options alongside some drawbacks. The first option was to bring members together to respond to questions about trust with a unanimously collaborated decision of trust as a group. The drawback with this method was that there are too many socially influential biases (e.g. groupthink) from using this method (Serva et al. 2005). The second option they mentioned was to collect data at the individual level and then aggregate individual level responses to a higher level (Serva et al. 2005 citing Van Der Vegt, Emans, & Vliert, 2001). The problem with this method was that the aggregated response

may not be a valid representation of the collective perception of the team (Serva et al. 2005). The third method that Serva et al. (2005) incorporated was to word the questions with a team referent rather than an individual referent. The researcher speculated that a drawback to this method would be an ambiguity of the actual object of trust in question. Further, an individual considering a “team” in name, may also consider certain individuals disproportionately to their true sense of holistic trust in a team.

These three methods were considered in proposing a process for extending the measurement of trust beyond the interpersonal level toward the group, team, organization, and inter-organizational level trust in the present study. Costa and Anderson (2011) argued that “trust within teams reflects a climate that is shared among team members and is likely to influence and be influenced by individual propensities and perceptions of trustworthiness and lead to behavior (sic) patterns that reflect that climate” (p.123). Costa and Anderson adapted Mayer’s definition of trust, taking advantage of the ability to interpret “party” as an individual or, in the case of their study, a team (2011). Costa and Anderson (2011) utilized the third method and recommended the use of a team referent. This method was also utilized in this study.

In conclusion, trust can be envisaged both between individual persons and between organizations (Lane and Bachmann, 1998) as interpersonal and inter-organizational trust. Zaheer et al., (1998) found interpersonal trust and inter-organizational trust to be two distinct, but related constructs in their pivotal study. The current study adopted a conceptualization of trust from a team level rather than an organizational level and perceived of trust as a climate to which individual levels of trust contributed. Specifically, UIRPs were conceptualized as a self-managed, inter-organizational work teams composed of academic and industry boundary spanning members who contributed individual levels of trust toward a trust climate within a partnership.

2.3 Operational Definitions

2.3.1 Boundary Spanning (Role) Persons

A boundary role person (Adams, 1976) can be defined as an “individual who provides the linking mechanism across organizational boundaries” (Currall and Judge, 1995, p. 152). The terms “boundary-spanners” and “boundary-role persons” were used interchangeably in the current study and referred to participants in UIRPs who provided the linking their home organization to the others in the partnership. In their explanation of trust in organizations, Sydow (1998) described boundary spanners as specific individuals to which organizations strongly tied trust to (p.55). Sydow (1998) further described the critical process of the personal relationship re-embedding in building of systems of trust and that ‘access points’ (Giddens 1990:85), where this personal relationship re-embedding takes place, are most often found in boundary-spanning roles. According to Sydow, organizational boundary spanners must do a lot of personally interactive work for building up trustful relationships (1998).

Based on the theoretical support for the critical role of boundary spanners, this study considered boundary-spanners [(or boundary role persons (BRPs) by Adams (1976) via Currall and Judge (1995))], who made up an inter-organizational team of representatives in UIRPs, as participants to operationally measure inter-organizational trust specifically at a conceptualized at a team level. In considering the structuration perspective for this study, these personal relationships between boundary spanners could form and transform the dynamic structures of inter-organizational collaborations (Jarillo, 1988 and Ring and van de Ven 1994 cited in Currall and Judge, 1995)

Because boundary spanners conduct much of the face-work across networked organizations, the level of trust in their relationships was likely to be important in considering the performance of an alliance (Sydow, 1998). The interpersonal and inter-organizational networks interact in a way such that personal relationships open opportunities for increasing mutual understanding of diverse or shared schemes, actions, and norms while making it possible for individual exchanges that are trustworthy to ‘lead to strong form trust, even though the firms, themselves, may not be strong form trustworthy’ (Barney and Hansen 1994: 182) (Lane and Bachmann, 1998). For further emphasis, boundary role persons were critically important from both the structuration perspective and in inter-organizational

practices; and, therefore, boundary spanning participants from both academe and industry were the unit of analysis for this study of university-industry research partnerships.

2.3.2 Teaming Discipline

In Katzenbach and Smith's article "The Discipline of Teams" (1993), the authors posited that work groups who followed certain actions consistently – in a disciplined manner – had the potential to become true, high performing teams. The actions that were derived from Katzenbach and Smith's (1992) definition of a team are:

- 1) Committing to a common and meaningful purpose
- 2) Setting specific goals to aligned with accomplishing the purpose
- 3) Agree upon a clearly defined approach to working together
- 4) Assume mutual accountability for the performance results.

There are additional characteristics of teams that position them for high performance effectiveness that are not directly applicable for this partnership context. The first is the size of the team. In these partnerships, the sizes are determined by membership fee payment or by research proposals for academic partnering. Katzenbach and Smith suggest that teams remain small, that may be the case for partnerships, but not necessarily the goal in light of membership fees represent research investments that, in general, more is better. The second trait is that the members should have complementary skills. This is already the nature of the setup for the partnerships in this study. The members are attracted to various centers based upon their aligned research areas. Further, the major belief behind encouraging academic partnerships is that there are major research and development performance benefits when the entities interact. So, in this study, complementary skills are viewed as inherent, rather than actionable.

2.4 Differentiating the Current study

Trust has been studied extensively in organizations (e.g. Dirks and Ferrin, 2001; Kramer and Tyler, 1996; Lane and Bachmann, 1998). Studies have been emerging in the inter-organizational context but often, limited to the supply-chain context (e.g. Zaheer et al., 1998). The few studies that focus on UIRPs tend to focus on transactional processes while largely neglecting relational ones (Plewa and Quester, 2007; Siegel et al., 2004). The researcher acknowledges that there are some studies of UIRPs (e.g. Santoro and Saporito, 2003; Davis and Bryant, 2010; Bruneel et al., 2010) that provide background support for focusing on relationships among individuals in UIRPs with an emphasis on trust as a mechanism to reduce barriers and improve performance.

Santoro and Saporito (2003) conducted a study of industry-university alliance relations that considered the role of trust from a social-psychological perspective. Their investigation was limited to the firm's point of view of trust in a university partner. The findings of their study suggested that trust is a mediator between knowledge and communication and the technological outcomes of the partnership.

Bruneel et al. (2010) investigated factors that may mitigate the barriers to university-industry collaborative alliances. They classified "barriers" into two categories: "orientation-related barriers" that characterize the different work orientations of academia and industry and "transaction-related barriers" that related to firms interactions with university administrators, particularly when negotiating intellectual property (IP). The results of the study suggested that greater levels of inter-organizational trust reduced both types of barriers. The study by Bruneel et al. (2010) was also limited to the firm's point of view.

Davis and Bryant (2010) conducted a study with industry/university cooperative research centers that examined the relationship between a theoretical model of leadership, trust, and research center performance. Trust was not the focal point of the study, but the findings suggested that trust center performance fully mediated a relationship between the leadership model and trust. The study by Davis and Bryant limited the investigation of the relationships to the perspective of university administrators.

There is a myriad of ways universities inter-organizationally partner (see Rothaermel, Agung, and Jiang, 2007 for literature taxonomy study), but the focus in the current study was on long-term academic-

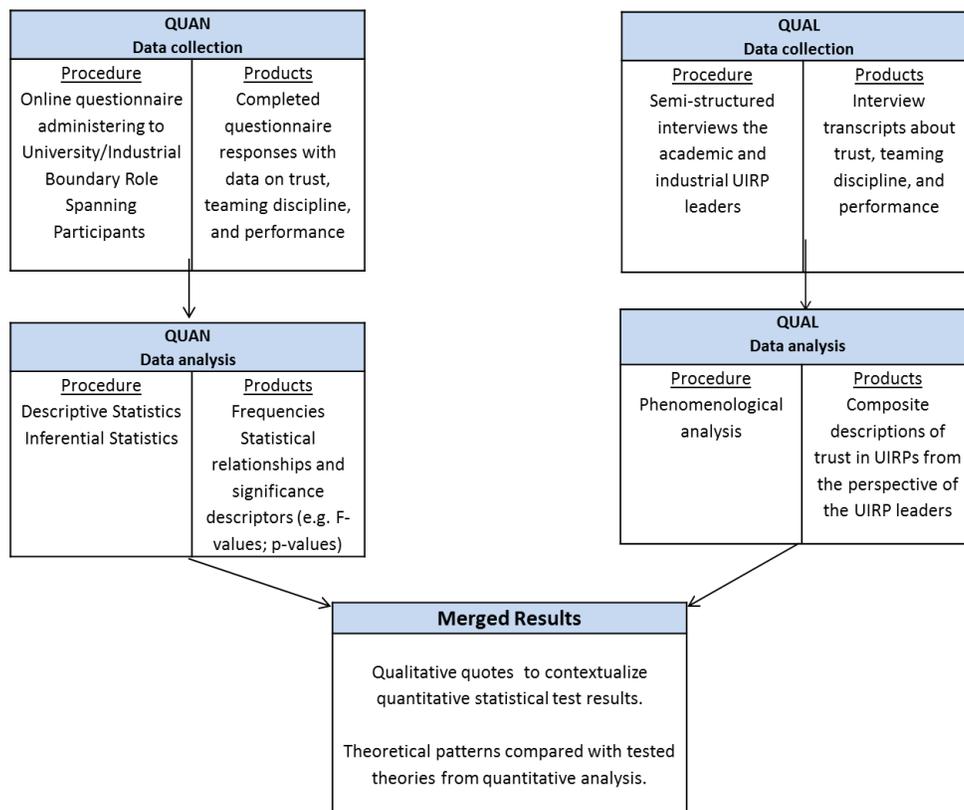
industry collaborative research partnerships following after Santoro and Saporito (2003) and Davis and Bryant (2010) described above. The current study was differentiated by centralizing the focus on the role of trust and including both academic and industry perspectives in the investigation. Further, there was emerging literature on university-industry partnerships that heavily focused on the transactions associated with formation and contract negotiating aspects of partnering (University-Industry Demonstration Partnership [UIDP], 2009). The current dissertation study focused a relational perspective, investigating trust among the individual, academic and industry boundary spanning participants who participate in UIRPs and how trust relates to research center performance. Successful implementations of UIRPs positively contribute to innovation efforts at a national level in the U.S.

Chapter 3: Methodology

3.1 Overview of the Convergent Parallel Mixed Methodology

The purpose of this mixed methods study was to describe the role trust plays in university-industry research partnership (UIRP) performance in the U.S. Because this area of empirical research is still relatively new, multiple methods were used for a more holistic explanation of the role of trust. This study utilized a convergent parallel mixed methods design (Creswell and Plano Clark, 2011) that involved conducting equally weighted qualitative and quantitative studies independently, but in parallel. The data collected from each study were analyzed independently and finally merged during the interpretation phase where both analysis results contributed to a merged understanding of the role trust plays in UIRP performance. A diagram of the convergent design study, adapted from Creswell and Plano Clark, (2011), is below:

Figure 3-1. Convergent Design – Procedures and Products



The convergent design has previously been conceptualized as concurrent triangulation (Creswell, Plano Clark, Gutmann and Hanson, 2003) where multiple research methods are used to triangulate results about one singular topic (Creswell, 2006). The purpose of this type of design is “to obtain complementary data on the same topic” (Morse, 1991, p. 122). A convergent design is useful for researchers, like the researcher in this study, who have limited time for collecting data and researchers who feel there is equal value in quantitative and qualitative studies for understanding the problem (Creswell, 2006).

This chapter includes a description of the population and sample for the study, the procedures for the independent analyses of the quantitative and qualitative studies, and a description of the merged interpretive analysis. Before any of the study initially took place, Internal Review Board (IRB) approval was required and obtained. Once this approval was received, the researcher proceeded with the procedures for the research study outlined below.

3.2 Sample: Boundary Spanning Participants in Industry/University Cooperative Research Centers

The population for this study was composed of academic and industry boundary spanning participants who work directly with other academic researchers and industry members across organizational boundaries to conduct research. The researcher contacted the Center Directors affiliated with a major research institution to invite the centers to participate in the study. Three centers agreed to participate in the study.

The three centers who agreed to participate as research sites identified academic participants across 26 universities and industry participants from over 200 companies. Each center was co-led by an academic faculty member who serves as Center Director and an industry member who serves as the Industry Advisory Board Chair of the center. The industry members pay membership fees and the industry participants compose an industry advisory board that interacts with the academic faculty on research endeavors. The sample of this study is composed of faculty members and industry advisory board members who work directly with another individual across their organizational boundary in the

context of research within the centers. A summary of the number of individual industry and academic boundary spanning participants from each center is described below in Table 3-1.

Table 3-1. Academic and Industry Participants per Center

	Academic Participants	Industry Participants	Total
Center A	11	18	29
Center B	35	159	194
Center C	142	211	353
Total	188	388	576

**Industry memberships include government agencies that pay membership fees are managed similar to industry memberships and for the purpose of this study are considered the same category.*

The researcher invited all 576 boundary spanning participants to participate. Therefore, the final sample size was determined by participants' willingness to respond.

3.3 Quantitative Study – Survey Design

The purpose of this quantitative study is to better understand and describe the relationship between the variables trust climate, teaming discipline, and performance in university-industry research partnerships in the U.S. Survey methodology is an economical and effective way to collect data from academic and industry boundary spanning participants on trust climate, teaming discipline, and performance. In this study, an instrument was developed, validated, and then administered online to academic and industry boundary spanning participants in UIRPs in the U.S. After the data were collected, correlation analysis and regression analyses were conducted to examine and describe the relationships between the variables. The following table provides an introductory outline of the methods that will be presented in detail in this chapter.

Table 3-2. Survey Data Collection Outline with Overview Data Analysis

Research Questions	Variables	Data Collection	Data Analysis
RQ1: How does trust relate to UIRP performance?	Trust Climate	Questionnaire (Items 1-21)	1) Correlation Analysis
	Partnership Performance	Questionnaire (Items 81-87)	2) Regression Analysis
RQ2: How does trust from academic participants compare with trust from industry participants?	Trust Climate (comparing academic responses with industry responses)	Questionnaire (Items 1-21) and demographic identification as academic or industry participant.	Independent samples T-Test
RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?	Trust Climate	Questionnaire (Items 1-21)	Mediation Analysis (combination of path coefficient estimation and statistical significance evaluation)
	Teaming discipline	Questionnaire (Items 22-80)	
	Partnership Performance	Questionnaire (Items 81-88)	

3.3.1 Survey Methodology

The general purpose of a survey is to obtain data from a sample to be generalized to a population (Babbie, 1990). The aim of the current study was to describe relationships between the variables of trust climate, teaming discipline, and performance in the context of UIRPs. Cross-sectional survey data on trust climate, teaming discipline, and performance were collected from academic and industry boundary spanning participants in UIRPs. Data were analyzed and inferences made about the role of trust among these participants in relation to teaming discipline and UIRP performance.

A web-based questionnaire was deployed in the data collection phase of this study. For a web-based survey, e-mail was used to contact individuals who are asked to participate in completing a

questionnaire and submitting it by computer (Rea and Parker, 2005). There were several advantages and disadvantages to this collection process. Some advantages of using questionnaires, in general, were the relatively low cost of the design and the rapid turnaround for the data collection (Rea and Parker, 2005). Some specific advantages for using a web-based questionnaire included convenience and efficiency in reaching potential respondents; cost-effectiveness due to eliminating the need for paper and postage necessary for traditional questionnaire mailings; and, ease of data protection since the questionnaire was hosted on a secure server (Rea and Parker, 2005). Some disadvantages of a web-based questionnaire were potentially lower response rates than face-to-face survey methods like structured interviews and the lack of researcher involvement to clarify questions or instructions (Rea and Parker, 2005). The researcher allowed three weeks for respondents to complete the questionnaires and sent reminders to respondents in an effort to increase response rates. A pilot study was conducted that addressed the process of survey administration, tested out response rates, and received commentary on the clarity of questions. The preliminary results from the pilot study were used to refine the instrument. Details of the pilot study are included in the next chapter along with the overall quantitative study results.

For the current study, the sample frame was nationally distributed, so the web-based questionnaire simplified the process of reaching potential participants that are geographically dispersed. Also, the cost savings of having to print and mail paper questionnaires was reduced to a relatively small amount of time to send e-mails. The researcher believed the advantages outweighed the disadvantages and the online questionnaire was deployed in this study.

3.3.2 Data Collection

Sample

The researcher contacted the Center directors affiliated with a major research institution to invite the Centers to participate in the study (see Appendix D for the formal invitation letter). If the director accepted the invitation, the researcher presented two options for distributing the questionnaire to the respondents: 1) the organization could provide an email list of potential survey potential respondents to

the researcher and the researcher was able to contact the potential respondents directly or 2) the organization could receive an email invitation that the researcher developed (see Appendix E) and distribute this email within their internal channels; thereby retaining the contact information of the potential respondents. The researcher desired to remain as unobtrusive as possible in the data collection process and Centers utilized both options.

When the researcher received the contacts, then, the email invitations to respond to the questionnaire were sent out immediately. The invitation letters and informed consent forms that were given to potential respondents are included in Appendix E. Potential respondents completed an electronic version of the consent form before access was granted to the survey. The initial questions on the questionnaire asked respondents to identify themselves as academic or industry participants. A student identification option was given and if this option was chosen, the participant was directed to the end of the survey in an effort to exclude students from participating in the survey. Individual respondents remained anonymous and the Center identifications were coded and held in confidence.

After ten days – roughly halfway through the three week period - a reminder email was sent out to the potential respondents. A final reminder was sent to participants one day before the questionnaire access was closed. In order to preserve anonymity of the survey, all potential respondents received the follow up email because there was no way to discern completion. If the organization chose to distribute the email internally, the researcher requested to receive confirmation of the date of distribution and the number of academic and industry invitees. Then, the researcher followed up with the director (or a director appointed administrator/contact person) after ten days following the date of distribution and one day before the questionnaire access was closed.

When all of the responses were received from all of the Centers, the names of individuals who voluntarily entered a drawing were obtained from a secure website and assigned a random number from an online random number generator (Random.org). Then two numbers were randomly chosen, again by the random number generator and the two individuals were contacted to receive electronic gift cards. After the data collection was complete, a thank you note for participation was sent to director of the

organization to share with the organization. All names from the drawing were disposed of at the conclusion of the drawing process.

Eight Centers were contacted and invited to participate in the full study. Three Centers responded to the invitation and distributed the questionnaire among the participants in their Center. Overall, there were 576 academic and industry boundary spanning individuals invited to participate in the survey and 105 responses for an 18% response rate. After removing severely incomplete responses, there were 78 completed individual responses (31 academic and 47 industry) included in the analysis for the study. The data were analyzed at the individual level of analysis.

Instrumentation

A survey instrument was assembled from components of several instruments. Measures of trust climate, teaming discipline, and performance were obtained from different instruments during the literature review. The measures of trust climate remained largely intact while the measures for teaming discipline and performance were adapted from measures previously published in a different organizational context, and therefore the entire instrument was assessed for validity in this study.

Trust

Costa and Anderson (2011) developed a 21-item instrument for assessing trust at the team level. Costa and Anderson (2011) conducted a dual sample cross-validation study in the development of the instrument. There were 14 teams and a total of 98 individuals in the first sample and 112 teams and a total of 395 individuals in the second sample (2011). Their initial pool of 50 items went through an expert content validation process in addition to the first sample. A reduced questionnaire containing 38 items was administered to the second sample and following testing through a confirmatory factor analysis, consensual and discriminant power testing, and construct validity testing, the team presented the final 21-item questionnaire for use by teams (2011).

Costa and Anderson (2011) identified formative indicators of trust propensity and perceived trustworthiness and reflective indicators of monitoring behaviors and cooperative behaviors and presented the 21-item instrument in terms of these four factors. Instrument reliability was reported in terms of Cronbach's (1951) alpha as follows: propensity to trust, $\alpha = .84$; perceived trustworthiness, $\alpha = .87$; cooperative behaviors, $\alpha = .81$; monitoring behaviors $\alpha = .71$. The instrument utilized a 7-point Likert-type scale ranging from "Completely agree" = 7 to "Completely disagree" = 1. In the current study, the term "completely" was modified to "strongly" (Vagias, 2006). The seven-point scale was utilized throughout the rest of the instrument in the current study to maintain consistency and standardization for comparing the different variables in the study.

Teaming discipline

Katzenbach and Smith (1993) defined a team as "...a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable" (p.45). Katzenbach and Smith (1993) argued that teams – as opposed to ordinary work groups - exhibit the following characteristics*: 1) a truly meaningful purpose 2) a common set of specific goals 3) clear, agreed upon working approach 4) a sense of mutual accountability. Those teams that take action to maintain these characteristics in a disciplined manner have potential to become high performing teams (1993). Katzenbach and Smith (1993) outline questions one should use in assessing the extent that these actions of teaming discipline are practiced in groups as an indicator for potential high performance. The questions were converted from yes/no response to a 7-point Likert-type scale for consistency throughout the instrument and serve as items in the questionnaire (items 22-80) for assessing teaming discipline according to Katzenbach's and Smith's own definition of teaming.

**Two other characteristics that follow along with the Katzenbach and Smith definition of team are "small enough in number" and "complementary skills." These were omitted from this questionnaire due to the nature of the partnerships in that numbers are based on membership payments and subject matter projects- rather than assignments where one could adjust team size. This is a difference and adjustment*

made for adapting the instrument to this inter-organizational teaming context from the traditional intra-organizational teaming context.

Performance

Piña, Martínez, and Martínez (2008) published a review of measures implemented in team effectiveness that included specific measures of performance used for “self-managed teams.” The measures from their review were also adapted for measuring performance in UIRPs in this study. The measures and the references provided by Piña et al. (2008) are summarized in a table below.

Table 3-3. Summary pool of measures used in developing performance measures (ref. Piña et al., 2008)

Summary of measures for trust in self-managed teams
Production
Quality
Productivity
Costs
Efficiency
Overall performance
Initiative
Timeliness
Machine reliability and response time
Customer satisfaction
Service profitability

For this study, a holistic set of performance measures were generalized for use across a set of teams rather than team specific. In other words, since the purpose of this assessment is not primarily to give feedback to teams for intra-team performance improvement directly, a generalized set of performance measures was desired. Jones and Schilling (2000) cite four general areas of team performance that should be measured: timeliness, cost, quality, and quantity. The sets of measures outlined by Piña et al. (2008) cover these areas and more (e.g. productivity, efficiency, satisfaction, etc.). In the review, Piña et al. (2008) cite several researchers on self-managing teams who contributed the list of performance measures above. The researcher searched the references for each measure to find actual items that had been previously validated. The list of items were refined to omit items that were not

relevant to the knowledge-based organizational nature of UIRPs (e.g. machine reliability and response time). Further, two items were added to the set of performance measures to address the inter-organizational alliance and the knowledge-based organizational contexts of UIRPs. The following table presents the items for partnership performance with references for each of the measures:

Table 3-4. Performance measures for instrument

PERFORMANCE
81. Team members meet or exceed productivity requirements. (Alper, Tjosvold, and Law, 1998)
82. Team members are committed to producing quality work. (Alper et al., 1998)
83. Team members have successfully implemented ideas to reduce costs (Alper et al., 1998)
84. Generally speaking, team members are very satisfied with their work. (Alper et al., 1998)
In the time of your experience with the team, how satisfied are you with the following:
85. Timeliness of results (Tata and Prasad, 2004)
86. Knowledge sharing (Zollo, Reuer and Singh, 2002; Santoro and Bierly, 2006; Lawson, Petersen, Cousins, and Handfield, 2009)
87. Return on investment (Bhagwat and Sharma, 2007)
88. Overall performance (Tata and Prasad, 2004)

Table 3-5 below outlines the variables and respective questionnaire items. A complete version of the finalized questionnaire is found in Appendix A.

Table 3-5. Variables and Items

Variable	Sub-Scales	Item on Survey	Example Items
Trust Climate		Items 1-21	“The typical person in this Center is sincerely concerned about the problems of others.”
			“We have complete confidence in each other’s ability to perform tasks.”
			“In this Center we work in a climate of cooperation.”
			“In this Center people watch each other very closely.”
Teaming Discipline	Meaningful Purpose	Items 22-33	“In this Center, we have a broad, meaningful purpose that all members aspire to.”
	Common Goals	Items 34-48	“In this Center, we have a specific set of team goals that members have agreed upon.”
	Agreed Approach	Items 49-65	“In this Center, we have a clearly understood and commonly agreed upon working approach.”
	Mutual Accountability	Items 66-80	“In this Center, we are individually and mutually accountable for the Center’s collective results.”
Performance		Item 81-88	Center members are committed to producing quality work.
			Generally speaking, Center members are very satisfied with their work.
			How satisfied are you with...: Timeliness of results? Knowledge sharing?

Due to the numerous modifications to the existing instruments and the combining of the instruments proposed for the current study, the original validity and reliability may not have held and it was necessary to reassess validity and reliability. The researcher chose to conduct a content validity assessment to assess the relevance of the questionnaire items to this new context of university-industry research partnerships. The researcher also conducted a construct validity assessment (Carmines and Zeller, 1979). Reliability was assessed and reported in terms of Cronbach’s (1951) alpha. Details of the procedures for each are described below.

Procedures

Content Validity Assessment

Content validity can be defined as, “...the extent to which an instrument adequately samples the research domain of interest when attempting to measure phenomena” (Wynd, Schmidt, & Schaefer, 2003, p. 509). While the Content Validity Index (CVI) has mostly been attributed to an educational specialist named Martuza (1977), researchers often cite others (e.g. Lynn, 1986; Waltz, Strickland, and Lenz, 2005) in using CVI in research studies (Polit and Beck, 2006). Polit and Beck (2006) provided a general definition for CVI as, [the] “Degree to which an instrument has an appropriate sample of items for construct being measured” (p. 493). Polit and Beck (2006) further distinguished between two levels of computation that are considered in CVI as an item level or I-CVI and a scale level or S-CVI. Polit and Beck (2006) emphasized the importance of a researcher specifying which method he or she was using in a given study. In this study scale level CVI was chosen. Two methods considered for S-CVI considered in this study were S-CVI/UA (unanimous agreement) and S-CVI/Ave (average) (Polit and Beck, 2006). For calculating the S-CVI/UA, a researcher reports the proportion of items on a scale that are rated relevant (3 or 4, on a scale ranging from 1-4) by all of the experts. For calculating the S-CVI/Ave, a researcher should compute the average of the I-CVIs for all of the items on the scale. This study utilized the S-CVI-Ave in agreement with the reasoning by Polit and Beck (2006), that the S-CVI/Ave places computational (and therefore, conceptual) focus on the average quality of the items, rather than on the experts’ average agreement performance.

The following steps were taken to conduct a CVI assessment for this study:

- 1) The researcher identified and invited 8 experts to participate in the study. An expert was defined as a faculty or industry professional with 5 or more years working in an evaluating, leadership, or managing role in UIRPs). At least 6, but no more than 10 experts are generally practical (Polit and Beck, 2006; Lynn, 1986).

- 2) The researcher instructed respondents to rate a level of relevance to each item on the proposed instrument for this study on a scale of 1-4, where 1= not relevant, 2= somewhat relevant, 3= quite relevant, 4 = highly relevant.
- 3) Experts were given one week to complete the process.
- 4) For the S-CVI, the scale was dichotomized so that items with a 1-2 by a proportion of experts were potentially discarded while those items with a 3 or 4 were candidates to be retained.

Each expert received an email invitation to participate in the study (Appendix B). Once they accepted, the experts received an informed consent form (see Appendix C) and were asked to report a level of relevance to each of the proposed questionnaire items (see Appendix C). Those that had a high enough relevance score were considered to be retained while those with low relevance scores were considered for discarding or rewording as commented by experts. Once the item level CVIs were calculated a total scale CVI was calculated and reported. Polit and Beck (2006) recommend that researchers adopt the following standard for “excellent content validity”: I-CVI = 1.00 with 3-5 experts, and a minimum of 0.78 for 6 -10 experts; and S-CVI-Ave at least 0.90 (Lynn, 1986; Polit and Beck, 2006).

Pilot Study

A pilot study was conducted to test the adequacy of the proposed instrument. The online survey administration technique was tested and preliminary data were partially analyzed. Participants were asked to respond to the questionnaire items that were described above, and additionally, a few questions about the functionality of the survey. The pilot study has been conducted among the participants within a center where the researcher had an affiliation.

The researcher contacted the Center Director who agreed to participate in the study. The desire of the Director was for the questionnaire to be administered internally - thus they retained their contact information. The administrative assistant informed the researcher that the survey invitation was sent to a

total of 114 individuals that included 85 faculty members and 29 industry members. The survey was available for 2 weeks.

Data Management

The online questionnaire was administered using Qualtrics ® software. This software is approved by Virginia Tech Internal Review Board (IRB) as a secure online questionnaire platform (virginiatechqualtrics.com). The data from the questionnaire was stored on a secure scholar site that was accessible to the research team consisting of the researcher and two faculty advisors as required by IRB policies. The data was retained until the conclusion of the research study.

3.3.3 Quantitative Data Analysis

Academic and industry boundary spanning individuals in UIRPs responded to questions about trust climate, teaming discipline, and performance within their Center in the form of an online administered questionnaire. The data was imported into EXCEL ® for cleaning and checked for completeness before they were imported into SPSS ® for statistical analysis. The analysis procedure for each research question is detailed in turn below. The following table outlines the procedures for each question. The steps for each analysis process are also presented in this section.

Table 3-6. Quantitative Analysis Plans

Quantitative Research Questions	Variables	Data Analysis	Outcomes/Results
RQ1: How does trust relate to UIRP performance?	Trust climate	1) Correlation Analysis 2) Simple Linear Regression	1) Spearman's coefficient (ρ) ; p -value 2) R^2 proportion of variance; F-value and p -value; Regression equation
	Performance		
RQ2: How does trust from academic participants compare with trust from industry participants?	Trust climate	Independent samples T-Test (group mean comparison)	Means, standard deviations; confidence interval; t-test value; p -value (box plot)
RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?	Trust climate	Baron and Kenny (1986) Judd and Kenny (1981)	b -value and p -value; Regression equation coefficients Interpretation of significance of direct effects and indirect effects indicated a degree of mediation.
	Teaming discipline	MacKinnon, Fairchild, and Fritz (2007)	
	Partnership Performance	analysis processes for testing statistical mediation (Regression Analyses)	

RQ1: How does trust climate relate to UIRP performance?

The variable “trust climate” was treated as the independent variable and “performance” as the dependent variable in a correlation analysis to test the following hypotheses:

H_A: Trust climate will significantly, positively correlate to partnership performance.

H₀: Trust climate will not significantly, positively correlate to partnership performance.

A regression analysis was conducted to characterize the relationship between trust climate and performance.

Prior to conducting a bivariate correlation analysis on the variables trust climate and performance, certain assumptions had to be tested to ensure that the general linear models used in the analysis were applicable to the data set. Data must demonstrate a generally linear trend and an approximately normal distribution (Field, 2013). Linearity was tested by observing a scatter plot of the trust climate and performance data. Normality was assessed by observing p-p plots, and by conducting a Shapiro-Wilk test for normality.

Each of the indicators of trust climate and each of the items for performance were averaged into a single “trust climate score” and “performance score,” respectively, for each case. The scores for performance and trust climate were included in correlational analysis. The specific steps for the correlation analysis were generating a scatterplot to observe linearity, generating a p-p plot and running a Shapiro-Wilk test to assess normality, and then computing and reporting Spearman’s correlation (ρ)*.

Upon confirming that Spearman’s correlation (ρ) not equal to or nearly zero, simple linear regression analysis was performed to describe the relationship between trust climate and performance and to test how much of the variation in performance was explained by the independent variable trust climate. In addition to linearity and normality, several other assumptions were tested as well before performing a regression analysis to model a theoretical relationship (Field 2013):

- Absence of significant outliers or influential cases
- Error independence
- Normally distributed error, with equal variances

RQ2: How does trust from academic participants compare with trust from industry participants?

$$H_0: \mu_{AC} \neq \mu_{IN}$$

$$H_A: \mu_{AC} = \mu_{IN}$$

The mean trust climate score of academic participants (TrustAC) was compared to the mean trust climate score of industry participants (TrustIN) and tested for significant differences (i.e. do academics report higher levels of trust than industry OR do industry report higher levels of trust than academics). TrustAC was compared with TrustIN in an independent sample t-test. As in the previous tests, there were assumptions that needed to be met: normality, absence of outliers, and homogeneity of variance. The means and standard deviation were reported along with confidence intervals and a resulting *p*-value for reporting significance. While this test provided a resulting statistical significance, it does not indicate practical significance.

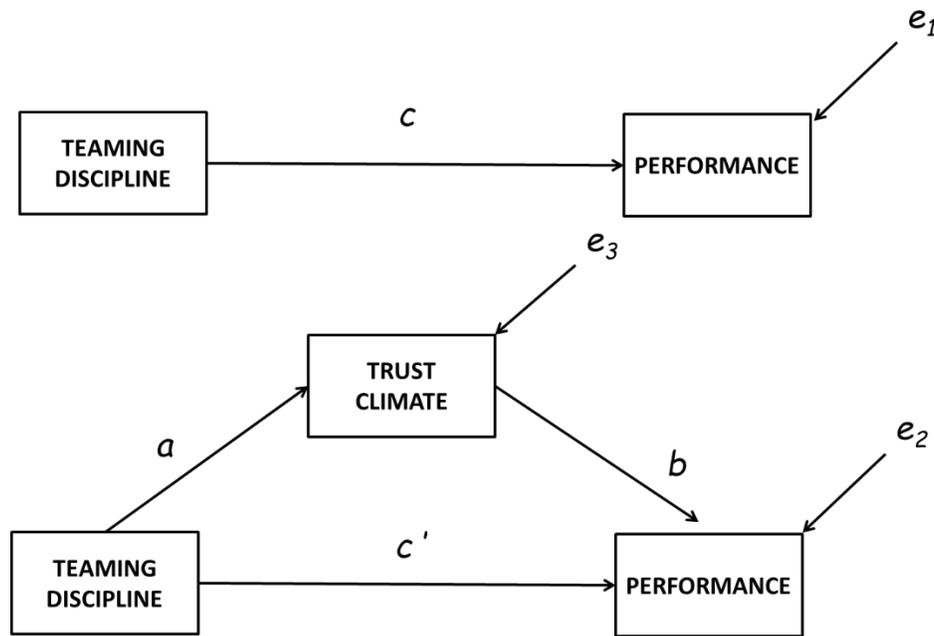
RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?

Mediation analysis is designed to test a set of sequence causal hypotheses that an initial predictor variable may influence an outcome variable by way of a mediating variable (Warner, 2013). Mediation is described as occurring when the strength of the relationship between the outcome variable and the predictor variable decreases with the inclusion of the mediating variable (Field, 2013).

MacKinnon, Fairchild, and Fritz (2007) described a causal steps analysis for testing mediation by Baron and Kenny (1986). This analysis was utilized to address RQ2 in testing specifically if the actions associated with teaming discipline might be a mechanism for positively affecting trust climate and impacting performance. According to MacKinnon et al. (2007) there are recent studies in psychological

research that “an intervention is designed to change mediating variables hypothesized to be causally related to a dependent variable” (p. 596). In this study, teaming discipline was likened to an “intervention” that might be designed to impact the trust climate of a partnership that is related to the dependent variable performance. The specific steps for the mediation analysis are described below. Figure 3-2 was adapted from a generic depiction of a mediation model by MacKinnon et al. (2007) and provides a visual depiction of the relationships that were tested in the analysis.

Figure 3-2: Mediation model for analysis



(Adapted from Baron and Kenny, 1986; Field, 2013)

The general overview of the steps Baron and Kenny (1986) outlined were that if the three simple regression analyses of paths *a*, *b*, and *c* in the figure above are significant, then the fourth step of a multiple regression with the independent and mediating variables predicting the dependent variable was conducted. The next step was to test the significance of the indirect effect. The regression equations that correspond to Figure 3-2 are as follows:

$$(1) \text{ Performance} = i_1 + c \text{ Teaming Discipline} + e_1$$

$$(2) \text{ Performance} = i_2 + c' \text{TeamingDiscipline} + b \text{TrustClimate} + e_2$$

$$(3) \text{ TrustClimate} = i_3 + a \text{TeamingDiscipline} + e_3,$$

where i_n are intercepts, e_n are the residuals, the dependent variable is Performance, the independent variable is TeamingDiscipline, and mediating variable is TrustClimate. The variables a , b , c , and c' represent the path coefficients (MacKinnon et al., 2007).

The same procedures that were used to describe the linear regression in RQ1 above were used, but there are three different variable cases for the first three steps:

Step 1: Simple regression analysis of the path for TEAMING DISCIPLINE predicting PERFORMANCE.

Step 2: Simple regression analysis of the path for TEAMING DISCIPLINE predicting TRUST CLIMATE.

Step 3: Simple regression analysis of the path for TRUST CLIMATE predicting PERFORMANCE (analysis already conducted in RQ1).

Step 4: Multiple regression of TEAMING DISCIPLINE and TRUST CLIMATE predicting PERFORMANCE.

In addition to the testing assumptions of linearity, normality, no influential cases, error independence, and homoscedasticity as in linear regression, in a multiple regression there should have also been no multicollinearity. This was checked by making sure that no independent variable correlation was larger than 0.7. Additionally, each independent variable had a variance inflation factor less than 10 (Field, 2013).

If either of the first steps that test for significance in the direct effects resulted in a non-significant relationship, then mediation was most likely not possible (Mackinnon, Fairchild, and Fritz, 2007). However, as all three relationships were significant, the researcher proceeded to step 4 to conduct the multiple regression. The next stage was to observe that the effect of TRUST CLIMATE remained

significant after controlling for TEAMING DISCIPLINE, so that either full or partial mediation was supported. If TEAMING DISCIPLINE was no longer significant when TRUST CLIMATE was controlled, then the finding supported full mediation. If TEAMING DISCIPLINE was still significant, then the finding supported partial mediation.

One notable problem with this analysis was that these steps alone did not include a test for the significant pathway that TEAMING DISCIPLINE affects PERFORMANCE through the compound of paths from TEAMING DISCIPLINE AND TRUST CLIMATE and TRUST CLIMATE and PERFORMANCE (path $a + \text{path } b$ in the diagram). Also, MacKinnon et al. (2007) found that this method was subject to Type II errors of missing some true mediation effects; and, therefore, they proposed an alternative analysis that involved calculating the indirect effect and testing it for significance. MacKinnon et al. (2007) recommended utilizing one of two equivalent ways to calculate the indirect effect: the difference of coefficients (Judd and Kenny, 1981) and the product of the coefficients. Once the coefficient was calculated, it had to be tested for significance. SPSS® was utilized for the calculations related to the indirect effects.

3.4 Qualitative Study – Phenomenology on Trust

To investigate the role of trust in university-industry research partnerships from a qualitative perspective, the researcher decided to follow a phenomenological approach for the study. A phenomenological approach was useful to explore the phenomenon of trust through the lived experiences of the leaders in UIRPs. Leedy and Ormrod (2009) define a phenomenological study as “a study that attempts to understand people’s perceptions, perspectives, and understandings of a particular situation.” In this study, the researcher focuses on the phenomenon of trust as experienced from the perspectives of academic and industry leaders in research partnerships.

Interview data from the academic-industry leadership team members in each of the three Centers were collected and analyzed. Following the methodology of Moustakas (1994), composite descriptions were developed from the textural descriptions of the participants’ leadership experiences related to trust and partnership performance in the context of the three research sub-questions: trust related to performance, differences in academic and industry trust, and actions for building and managing trust in UIRPs. Leedy and Ormrod (2009) described the final result of a phenomenological study as a general description of a phenomenon from the people with firsthand experience. In this study the final description of the role of trust in UIRPs is presented in Section 5.1.5.

Creswell (2013) succinctly outlines the features that define a phenomenological study. Below, the outline from Creswell (2013) is used to describe the features as they pertain to the qualitative portion of the current research study.

- 1) There is an emphasis on a phenomenon to be explored (Creswell, 2013). In this study, the focus was on trust from the leadership perspective in university-industry research partnerships.
- 2) There is an exploration of this phenomenon with a group of individuals who have experienced the phenomenon (Creswell, 2013). In this study, the academic leaders and industry leaders of UIRPs were asked to describe their experiences with trust in relation to performance.

- 3) There is a philosophical discussion of the subjective, lived experiences in relation to the objective experiences compared with other people (Creswell, 2013). The leaders of the centers were chosen to participate in this study because of their lived experiences of participating in the partnerships. However, the subject of the discussion is on the phenomenon of trust, not primarily on their general experiences in the partnership. The participants are asked to describe their experiences with the phenomenon of trust in the partnership from their perspective of leaders in the partnerships.
- 4) Husserl (1931) coined the term “Epoché” to describe the process of the investigator setting aside preconceived ideas and biases. Moustakas (1994) described the process as the researcher “bracketing” himself/herself out of the study by setting aside personal experiences with the phenomenon (Creswell, 2013). In this study, the researcher acknowledged experiences working within a university-industry research partnership, but was cognizant and careful to exclude this experience from the discussion and analysis in determining the experiences of participants (e.g. through interviews and composite development).
- 5) The data collected in a phenomenological study is [usually] solely interview data (Creswell 2013), as was the case in this study.
- 6) The analysis follows systematic steps to interpret narrow units of analysis – in this case, significant statements – in terms of broader units of analysis (Creswell 2013). The broader units of analysis were clustered (Creswell, 2013; Moustakas, 1994) and used to develop composite descriptions to describe the role of trust in relation to partnership performance.

The analysis ended with a passage that incorporated how the participants experienced trust and described the essence of the experience from the perspective of UIRP leadership. The experiences of the leaders were combined into composites relating all of the experiences and describing the role of trust in UIRPs.

3.4.1 Procedures of a Phenomenological Study

After the researcher identified a phenomenon for study, the following synthesis of procedures outlined by Creswell (2013), Leedy and Ormrod (2009), and Moustakas (1994) were conducted:

- 1) Epoché (Husserl, 1931): The researcher described her experiences related to affiliation with a partnership similar to the organizations in this study. This process is also called bracketing (Moustakas, 1994) and the researcher shared potential biases to be aware throughout the data collection and analyses in this study.
- 2) Data Collection: Semi-structured interviews with Center leadership members were conducted and transcribed by the researcher (e.g. Creswell, 2013; Leedy and Ormrod, 2009)
- 3) Data Analysis: The following defining steps for a phenomenology were conducted: Horizontalization, Clustering, Imaginative Variation and Structural Description, Essential Description (Creswell, 2013; Moustakas 1994). A final composite was constructed that describes the role of trust in UIRPs from the firsthand perspectives of the people who experience it (Leedy and Ormrod, 2009).
- 4) Trustworthiness: Member checking and peer examinations were conducted as a validation for the data interpretation and overall analysis processes in this study (e.g. Creswell, 2013).

3.4.2 Sample and Data Collection

Sample

For this study, purposeful sampling was utilized in inviting the center's leadership team, consisting of at least one academic leader and at least one industry leader, to participate in interviews. Center Directors are faculty members who lead the centers at a national level. Each center also has an Industry Advisory Board Chairperson who serves as a leader for the industry members in the center. Since some Centers have co-directors of joint academic faculty, the leadership team may have three people rather than only a single academic leader and industry leader. Each Director from the three Centers in this study was asked if they were willing to participate in an interview and they extended the invitation to their respective Center's Industry Advisory Board Chair to participate as well.

Semi-structured Interview Protocol

Leedy and Ormrod (2009) describe a typical interview for a phenomenology as one that is informal and conversational with the participant contributing most of the talking. In order to focus on the research questions addressed in the study, yet still retain some aspects of freely flowing conversation, a semi-structured interview approach was chosen. Additionally, the interview was audio recorded so that the researcher could accurately analyze quotes for the phenomenological data analysis.

The questions for the interview protocol were developed by the researcher in the context of the overall research questions and sub-questions in this study. There were to efficiently triangulate the results with the quantitative in similar context as a larger outcome of the study. Creswell (2013) recommends that the researcher begin the interview session with a question or two to “open up” the participant to conversing before presenting the core questions which are aligned with research questions. The first few interview questions were designed to acquire background information from the participant about their leadership role and acquire some context about the performance of their respective centers. The core questions were open-ended questions on the topics of trust and UIRP performance, industry versus academic trust, and actions managing trust in UIRPs. Following the core questions, the researcher began to conclude the interview by asking the leaders about their general perspectives of success in UIRPs. The final question, openly requesting comments about any topic concerning UIRPs, was designed so that the researcher may consider topics that might fill in any missing discussion points or inform future research. Finally, the protocol concluded with a thank you to the participant for their time and comments.

An initial set of interview questions were piloted with a colleague of the researcher. The pilot study was conducted via telephone with a trial run of audio recording. The colleague gave general feedback on the questions and the experience interviewing by telephone. Considering the feedback, the researcher finalized the interview questions and included optional probe questions in the protocol. The final protocol includes the required IRB informed consent and interview description along with adequate space for note-taking to supplement the audio recording (e.g. Creswell, 2013).

The final set of core interview questions are presented in Table 3-7 below along with the research questions and the expected outcomes related to each question. The full protocol is presented in Appendix F.

Table 3-7: Qualitative Data Collection Summary

Research Questions	Interview Questions	Outcomes
RQ1: How does trust to relate to UIRP performance?	Question: What role do you feel trust plays in Center performance?	Composite of leaders' experiences of trust and how they feel it affected partnership performance
RQ2: How does trust from academic participants compare with trust from industry participants?	Question: Is there evidence of a difference of trust levels between industry members and academic participants?	Composite of leaders' perception of any differences in the trust between industry participants and academic participants.
RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?	Question: What actions/best practices are performed in the Center to build/maintain trust?	Composite of practices within the Center that the leaders feel attribute to building trust

Procedures

Each Center Director was invited to participate and then asked to invite their industry advisory board chairperson to participate in an interview. Once the invitation had been accepted, the researcher asked the Center Director or designated contact person for contact information of the Industry Advisory board chair in order to schedule and conduct the interviews.

The interview took place by telephone and lasted about 30 minutes each. The interviews were audio recorded and the researcher also retained hand-written notes of the conversation in a data collection notebook. As specified by IRB guidelines, the researcher emailed a copy of the informed consent form to each participant, but obtained consent verbally before beginning to ask the interview questions.

Data Management

As the interviews were completed, the data were transcribed by the researcher. The data files from the interviews and the transcriptions were stored on a secure scholar site that remained accessible to the research team consisting of the researcher and two faculty advisors as required by IRB policies. The data were retained until the research study was concluded.

3.4.3 Phenomenological Data Analysis

The interview recordings were transcribed by the researcher and entered into qualitative data analysis software Atlas.ti ®. The researcher utilized handwritten notes for memos that were also entered into Atlas.ti ® for further analysis. The relevant statements were exported from Atlas.ti® and imported into an Excel ® file for refining and clarifying statements and for conducting the remaining procedures in the analysis.

- 1) Data Analysis: The following defining procedures for a phenomenology were conducted:
 - a. *Horizontalization*: The researcher extracted statements from the transcripts that were related to experiencing trust in UIRPs. The relevant or “significant statements” (Moustakas, 1994) were refined and clarified and presented as "meaning units” that each represented a single thought.
 - b. *Clustering*: The meaning units were clustered into groups that reflected some aspect of experiencing the phenomenon of trust in UIRPs. Titles were given to the clusters to reflect the theme of the units in the cluster (e.g. Creswell, 2013; Moustakas, 1994).
 - c. *Imaginative Variation and Structural Description*: The meaning unit clusters for each participant were combined into participant summaries in order to reflect a holistic experience for each participant. The thematic clusters were also described in terms of each of the research sub-questions as a structural description of trust from the combined experiences of the participants. (e.g. Creswell, 2013; Moustakas, 1994)
 - d. *Essential Description*: The final result of the analysis was a composite description of the phenomenon that reflects the essential and common themes from all of the

participants' experiences related to the role of trust in UIRPs. (e.g. Creswell, 2013; Leedy and Ormrod, 2009)

Trustworthiness

In qualitative research, trustworthiness is a similar concept to “rigor” in quantitative research (Leydens, Moskal, and Pavelich, 2004). The researcher used specific methods to address the study’s credibility, dependability, confirmability and transferability. A summary of the methods associated with each of the study attributes that contribute to a study’s trustworthiness are presented below in Table 3-8.

Table 3-8. Proposed Methods for Establishing Trustworthiness in the Current Study

Attribute of the Study	Method(s) <i>(as described by Leydens’ et al., 2004, Table 2, p. 68 adapted from Creswell (1998))</i>
Credibility	Peer Examination; Member Checking
Dependability	Detailed, Descriptive methodology; Audit Trail
Confirmability	Triangulation; Clarifying Researcher Bias
Transferability	Background Description

Leydens et al. (2004) provides a glossary of the terms for the attributes that contribute to the trustworthiness of the study and they define credibility as “The relative truth value of qualitative findings and interpretations” (p. 70) based on definitions by Guba (1981) and Skrtic (1985). For addressing credibility, the researcher utilized peer examination and member checking. The researcher asked a peer with experience in qualitative research to examine the methods used in the study and the interpretations made from the data (Leydens et al., 2004; Creswell, 1998). The researcher also asked interview participants to review and give feedback on the participant summaries that summarized the transcript data and the researcher’s interpretation of the data (Leydens et al., 2004; Creswell, 1998). The details of the peer examination and member checking processes are presented in Section 5.2 with supporting documentation in Appendix I and Appendix J.

Dependability is described as similar to reliability in quantitative research (Leydens et al., 2004) and “Refers to the consistency of the research findings” (p. 70) as defined by Skrtic (1985). The researcher has followed a detailed methodology as described in this section and created an “audit trail” (Leydens et al., 2004, p. 70) to be able to track back from findings to transcript data (Leydens et al., 2004). These documents available for auditing have been stored in a secure online site. The documentation includes the statements extracted from transcripts, the translation of the statements into units of relevant meaning, the clusters of the meanings, and the participant summaries.

Confirmability is described as similar to objectivity in quantitative research and, according to Skrtic (1985) is a method for checking for researcher bias effects (differentiated from a researcher perspective) (Leydens et al., 2004). The researcher utilized triangulation of the results from the quantitative analysis in the interpretive discussion of this study presented in Section 6.2 that merges the qualitative findings and quantitative findings in the context of the research question and sub-questions. Additionally, the researcher clarified her biases by commenting on experiences and orientations that likely shape both the approach and interpretation of the study (Leydens et al., 2004). The epoché, that is a defining procedure in a phenomenology, was used to address confirmability in this study. The details of the epoché are described below in Section 5.1.1.

Transferability is described as similar to external validity in quantitative research (Leydens et al., 2004) and is defined as “The degree to which aspects of research findings can apply to contexts other than the study context from which the findings emerged” (p.70) by Guba (1981) in Leydens et al., (2004). The researcher provided background descriptions of the leadership roles of the participants relative to this particular type of university-industry research partnership in order to allow the reader to decide about transferability (Leydens et al., 2004). These descriptions are below in Section 5.1.2.

3.5 Merged Analysis – Joint Quantitative and Qualitative Interpretation

For the convergent parallel mixed methods research design, the quantitative and qualitative studies were conducted and analyzed independently and then merged in the interpretation of the analyses phase following each independent analysis. In this study, the qualitative analysis was merged with the quantitative analysis and both related back to the initial research question: What is the role of trust in UIRP performance?

The studies were merged through written discussion comparing the emergent meaning clusters and essential descriptions from the qualitative analysis to the statistical test results of the quantitative analysis. Confirming and disconfirming findings from the qualitative study were discussed in the context of the hypotheses that were tested in the quantitative study. The research sub-question topics - trust related to partnership performance, academic versus industry trust, and actions building and managing trust in partnerships – again served as an outline for merging the discussion of the quantitative and qualitative studies. A set of recommended guidelines was presented as a deliverable result of merging the results in the study (Section 6.3).

Chapter 4: Quantitative Analysis Results

This chapter contains the results of a survey instrument development and administration for the portion of this research study conducted to quantitatively describe the role of trust with respect to UIRP performance. The following chapter details the results of the procedures for validity and reliability assessment of the instrument and the statistical analyses addressing the role of trust in UIRP performance. The results are presented in the context of addressing the following research sub-questions summarized in Table 4-1 below:

Table 4-1. Research Questions addressed in the Quantitative Analysis

Research Questions	Quantitative Analysis
RQ1: How does trust relate to UIRP performance?	The variables TRUST CLIMATE and PARTNERSHIP PERFORMANCE are analyzed in a correlational analysis. The resulting Pearson's coefficient (r) and effect size describe the direction and strength of the relationship between these two variables. Also a linear regression is conducted and presented as a quantitative model of the relationship between trust and performance in the UIRPs in this study.
RQ2: How does trust from academic participants compare with trust from industry participants?	The TRUST CLIMATE scores from academic participants are compared with those of industry participants utilizing a (t-test) mean comparison.
RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?	Test the actions associated with teaming disciplines in hypothetical mediation models. A mediation analysis involves series of regression analyses performed to describe the significance of relationships between the teaming disciplines, trust climate, and performance.

4.1 Instrument Validity and Reliability Assessment Results

4.1.1 Content Validity Results

Four of the eight individuals who were invited, participated in the panel and completed the online-administered questionnaire with relevance ratings that were described in the methods Section 3.3.

Upon receiving the responses, the S-CVI/AVE was calculated and the results are as follows:

Table 4-2. S-CVI/AVE results by variable

Trust Climate	S-CVI = .74
Teaming Discipline	S-CVI = .46
Performance	S-CVI = .56

These values are all lower than the “excellent” rating of S-CVI = .9 alluded to in Polit and Beck (2006). However, there still remains no agreed upon criterion for declaring the extent that a measure has content validity (Carmines and Zeller, 1979). One potential reason for the less than “excellent” ratings could have been due to the ambiguously defined constructs such as “trust” and “partnership” in the survey.

Another reason for the low ratings could be that the expert selection criteria was too loosely defined. The various roles that academic faculty play in the context of academic-industry partnerships (Wilcox, 2015) likely differ to the extent that agreeing on what would be relevant content from different perspectives would be a difficult task. For instance, Research parks, Technology Transfer Offices (TTOs), and sponsored research offices, have differing objectives. Compounded with the differences between academics and industry experts, it is not surprising that the expert participants in these varied entities would view trust and teaming concepts in partnership differently as reflecting in their low agreement.

In addition to completing the relevance ratings on the questionnaire, participants also provided comments on some of the items and about the overall instrument. One expert commented on the need to specify the level of referent – particularly who was on the teams in question for the responses. This comment was addressed by signifying the context of reference as “In this Center...” for the questions.

Additionally, the terms such as “purpose” and the concept of a “work approach” were also too ambiguous and could have different interpretations between for different types of members and result in lower agreement in relevance ratings. After making these adjustments, the questionnaire was administered to the pilot study participants.

4.1.2 Pilot Study Results

A pilot survey was administered to a center with which the researcher was affiliated. There were 114 academic and industry boundary spanning participants invited. There were 15 total responses, but only 13 were completed and usable for a response rate of only 8%. The respondents included 9 from academia and 4 industry. Due to the low response rate, the following adjustments were made for administering the survey to the larger study:

- The survey was available for a longer duration of time – instead of two weeks, the larger study participants were given four weeks to complete the questionnaire.
- An incentive was implemented that participants could enter themselves into a raffle upon submission of their completed survey.

Excel ® was used to perform a preliminary correlation analysis using data for trust climate and performance for the 13 respondents. The results of a Pearson correlation between trust climate and performance $r = .577, p = .039$ that was a significant, positive relationship.

As a result of the pilot study, the practice of the electronic administration was tested successfully. Some additional feedback was obtained through a comments section at the end. One notable comment was that the instrument was too long. Since about half of the respondents made this comment, the researcher remained cognizant of the length and considered analyses for reducing the size of the questionnaire upon obtaining a larger data set. Additionally, the completion time for most participants was within the 10-15 minute range as anticipated. Respondents also voiced a concern about the use of the term “partnership,” so the word was changed to “Center” to more adequately address the context of participants’ consideration in the questionnaire.

4.1.3 Scale Reliability

Reliability refers to the tendency toward consistency of measures upon repetition of measurement (Carmines and Zeller, 1979). Further, Carmines and Zeller (1979) recommend that a measure of internal consistency should be computed for any multiple item scale used in a study. Cronbach's (1951) alpha coefficient is the most commonly used indicator of internal consistency in a set of items in a questionnaire (ex. Carmines and Zeller, 1979, Warner, 2013). SPSS® was used to perform the computation of Cronbach's alpha for the items in the questionnaire. The items utilized the same scale throughout the instrument so the table below presents the raw Cronbach's alpha coefficients.

Table 4-3 Cronbach's alpha (raw)

Scale	Number of Items	Cronbach's Alpha (raw)
Trust Climate	21	0.90
Teaming Discipline		
Meaningful Purpose	12	0.89
Common Goals	15	0.92
Agreed Upon Approach	16	0.95
Mutual Accountability	15	0.90
Performance	9	0.93

The items for each of the scales in this study exhibited high reliability in that each Cronbach's alpha was greater than or equal to $\alpha = .89$.

4.1.4 Construct Validity Assessment

According to Carmines and Zeller (1979) "construct validity is concerned with the extent to which a particular measure relates to other measures consistent with theoretically derived hypotheses concerning the concepts (or constructs) that are being measured" (p.23). Carmines and Zeller (1979) specify three distinct steps involved with construct validation: 1) specify the theoretical relationships between the concepts themselves 2) examine the empirical relationships between the measures of the constructs and 3) interpret the empirical evidence in terms of how it clarifies a measure's construct validity.

In this study the following hypotheses were presumed based on the review of the literature:

- 1) Trust climate positively related to performance.

- 2) Teaming disciplines are positively related to performance
- 3) Teaming disciplines are positively related to trust climate.

The hypotheses above were tested by inspecting correlation patterns. The relationships between each variable are in the expected and confirmed to be in the positive direction. The following table shows the correlations within and between the variables used in the study. Spearman’s rho coefficient is reported for this study as a more conservative measure of correlation.

Table 4-4. Spearman’s ρ correlations between trust, performance, and teaming discipline (n = 78)

Variables	1	2	3	4	5	6
1. Trust Climate	1.000					
2. Performance	.633	1.000				
3. Meaningful Purpose	.694	.716	1.000			
4. Common Goal	.591	.671	.730	1.000		
5. Agreed Approach	.665	.768	.812	.800	1.000	
6. Mutual Accountability	.491	.498	.608	.663	.706	1.000

Additionally, correlations among items within the constructs (convergent validity) and dissimilar between constructs (discriminant validity) were considered. Specifically, some items should have theoretically converged and had higher correlation to each other than with other differing constructs. Confirmatory factor analysis is a widely used method for assessing construct validity (e.g. Pedhazur and Schmelkin 1991), but requires a greater sample size than was available in this study for the size of the instrument that needed to be assessed.

4.2 Trust Climate and Partnership Performance

RQ1: Trust Climate and Performance

Correlation Analysis

To address the question about the role of trust in UIRP performance, the first question the researcher examined was: How does trust climate relate to UIRP performance? A correlation analysis followed by a simple regression analysis was performed to examine whether or not trust climate significantly related to performance and how much variability in performance could be accounted for by

trust climate. Prior to performing the correlation analysis, the assumptions of linearity and normality were tested. Linearity was examined by inspection of a scatterplot between the variables trust climate and performance in Figure 4-1 below. The data points demonstrated a linear pattern, therefore the researcher concluded that the linearity assumption had been met sufficiently ($r=.62$) to continue the linear correlation analysis between the variables trust climate and performance.

Figure 4-1. Scatterplot Trust v. Performance

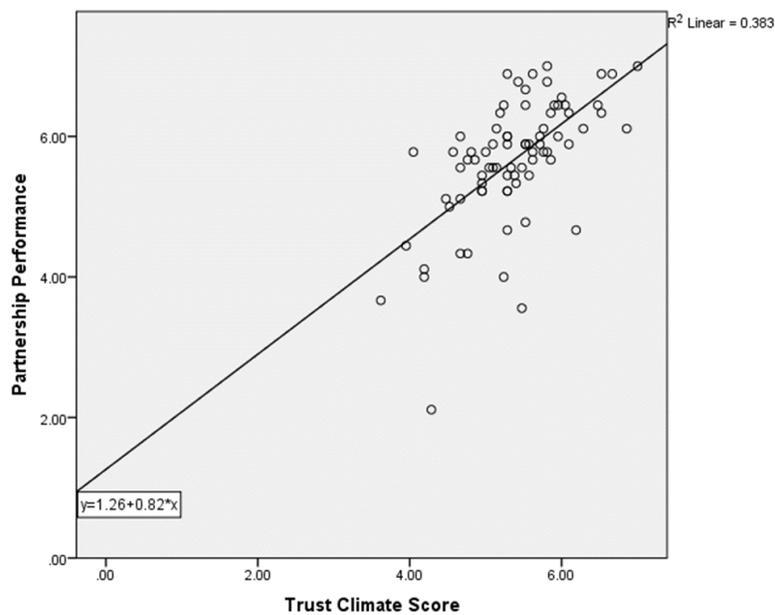
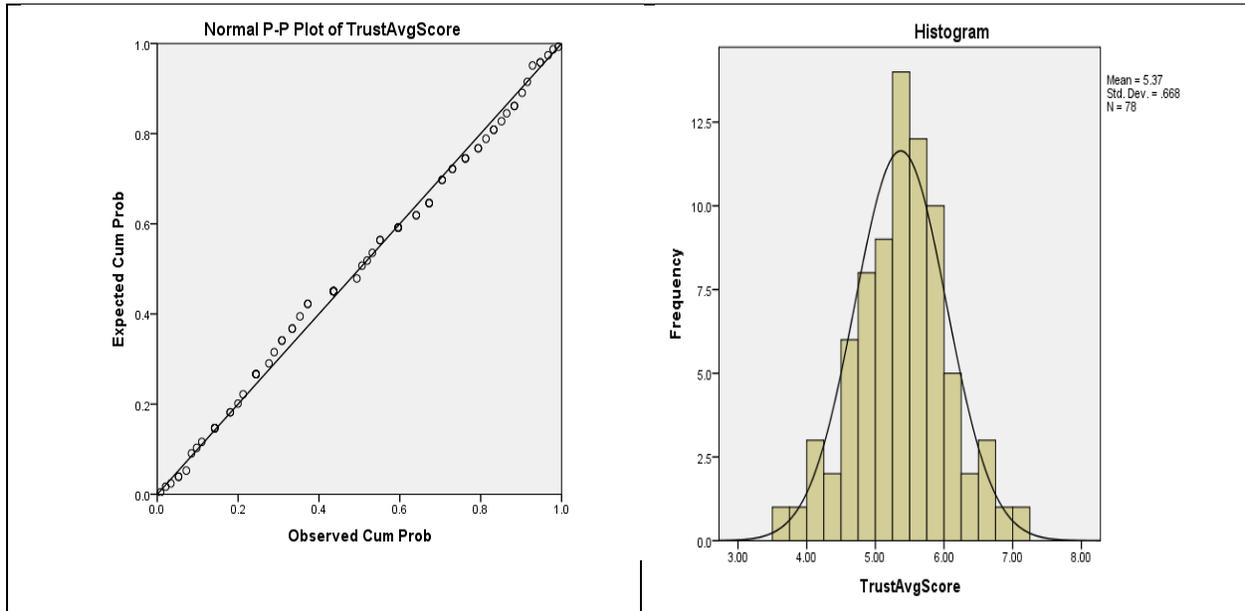


Table 4-5. Assumption Test Summary for Trust Climate in Correlation Analysis

Assumptions	Test	Results	Action
Linearity	Scatterplot (above) Inspection	Acceptable linear pattern ($r = .62$)	Continue with analysis
Normality	p-p plot (below) Inspection	Acceptable linear pattern	Continue with analysis
	Histogram (below) Inspection	Acceptable normal curve similarity	Continue with analysis
	Shapiro-Wilk Test	Not significant ($W=.993, p=.934$)	Continue with analysis

Normality was assessed both graphically through interpreting data points on a p-p plot and observing a normality curve on a histogram (Figure 4-2 below) and numerically using a Shapiro-Wilk test.

Figure 4-2. Graphical information for assessing normality of trust data



Upon the inspection of p-p plot and the histogram, the trust climate data distribution follows patterns that can be interpreted as meeting the normality assumption (Figure 4-2 above). Also, the Shapiro-Wilk test indicated normality in that it was not significant ($W = .993, p = .934$).

Upon inspection of the p-p plot and histogram of the performance data (Figure 4-3, below), there was evidence of negative skew. Also, the Shapiro-Wilk test for normality was significant for performance ($W = .919, p < .001$) indicative of a statistically significant deviation of the performance data distribution from a normal distribution. Pearson's correlation test tends to be robust to violations of normality particularly in large enough sample sizes (over 50) (Field, 2013). Therefore, the decision was made to compute and utilize Pearson's correlation coefficient. Field (2013), however, advised using a bootstrapping technique in order to obtain more robust confidence intervals.

Figure 4-3. Graphical information for assessing normality for performance data

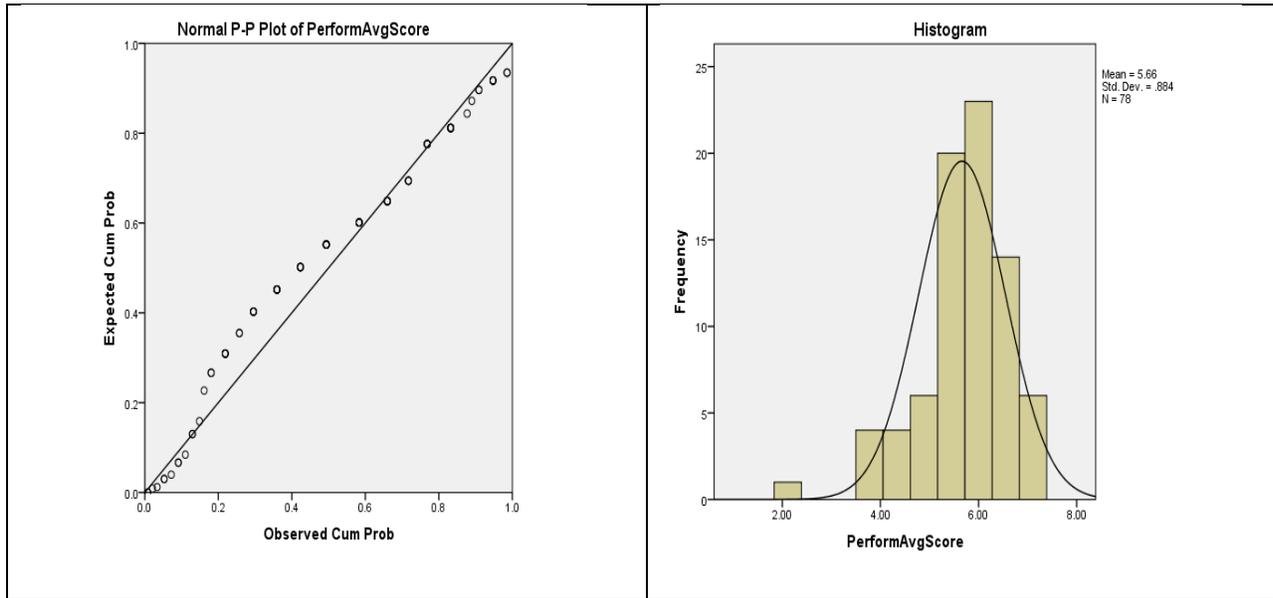


Table 4-6. Assumption Test Summary for Performance variable in Correlation Analysis

Assumptions	Test	Results	Action
Linearity	Scatterplot (above) Inspection	Acceptable linear pattern	Continue with analysis
Normality	p-p plot (below) Inspection	Unacceptable linear pattern	Inspect Histogram
	Histogram (below) Inspection	Skewed pattern	Shapiro-Wilk Test
	Shapiro-Wilk Test	Significant ($W=.919, p<.001$)	Continue with Pearson Correlation but with Bootstrap Confidence Intervals for Analysis

Bootstrapping, a widely known simulation technique in which repeated samples are taken with replacement from a data set for the purpose of estimating the sampling distribution of a statistic such as a mean or a regression coefficient was used in this study. (Field, 2013). Field (2013) recommends utilizing a “Bias corrected and accelerated” (BCa) estimation procedure (refer to Fritz and MacKinnon, 2007) that was offered in SPSS to correct for skewness in the sampling distribution.

The results of the correlation analysis indicate trust climate was significantly related to performance, $r=.62$, 95% BCa CI [.460, .743], $p<.001$. The positive Pearson r coefficient indicated a positive relationship that supported the hypothesis of trust climate being positively related to performance in UIRPs. Further, the confidence interval did not contain 0 indicative of a statistically significant relationship between the trust climate variable and performance variable.

Regression Analysis Results

In order to examine the predictive relationship between trust climate and performance, a regression analysis was performed in SPSS ®. This section describes the results of the assumption testing and the model summary from the regression analysis. Simple linear regression analysis was performed to describe the relationship between trust climate and performance and to test how much of the variation in performance is explained by the independent variable trust climate. The linearity and normality assumptions that were tested in the previous correlation analysis continue to hold for this analysis. However, several additional assumptions were tested as well before performing the linear regression analysis:

- There should be no significant outliers or influential cases.
- There should be independence of errors (residuals),
- There should be constant error variance (homoscedasticity)
- There should be normally distributed errors

Table 4-7. Assumption Test Summary for Trust Climate and Performance Regression Analysis

Assumptions	Test	Results	Action
No Outliers/Influential points	SPSS Case wise diagnostic indication of standardized residual >3	2 outliers	Check Cooks' distance
	Any Cook's Distance greater than 1?	Maximum Cook's distance $D = .375$	Continue analysis; monitor potentially influential points
Homoscedasticity	Scatterplot (below) of standardized residuals	Acceptable: Evenly spread	Continue with analysis

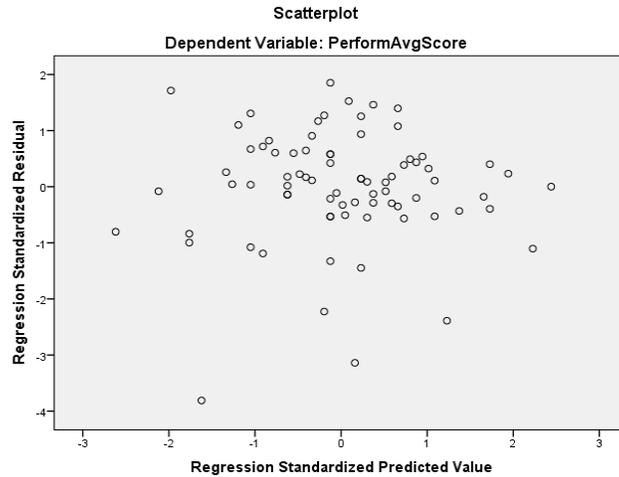
Error Independence	Durbin-Watson test	Acceptable $d = 1.976$	Continue with analysis
Normally distributed errors	p-p plot of regression residual	Unacceptable, negative skew	Continue analysis with bootstrapping

The first run of the regression analysis indicated that there were two influential cases affecting the model as indicated in the “case wise diagnostics” table. Cases with standardized residuals greater than 3 (Field, 2013) could be problematic and would require follow up analysis before proceeding with regression modeling. There were two observed outliers from the SPSS results table in cases 7 and 20 that had standardized residuals greater than 3. The researcher checked the data entries and no errors were detected. The Cook’s distance indicated a measure of the overall influence of a single case on a given regression model. According to Field (2013), Cook and Weisberg (1982) suggest that values of Cook’s distance that were greater than 1 might have been concerning. The maximum Cook’s distance is $D=.375$, well below the value of 1. Therefore, the researcher decided to retain the values but continue to monitor them throughout the rest of the analysis.

Independence of errors were tested utilizing the Durbin-Watson test (Durbin and Watson, 1951). The value of the Durbin-Watson test statistic ranges from 0 to 4 with 2 indicating uncorrelated residuals (Field, 2013). The Durbin-Watson generated from the SPSS ® run is $d=1.976$ that was judged close enough to 2 for support the assumption of independence of errors.

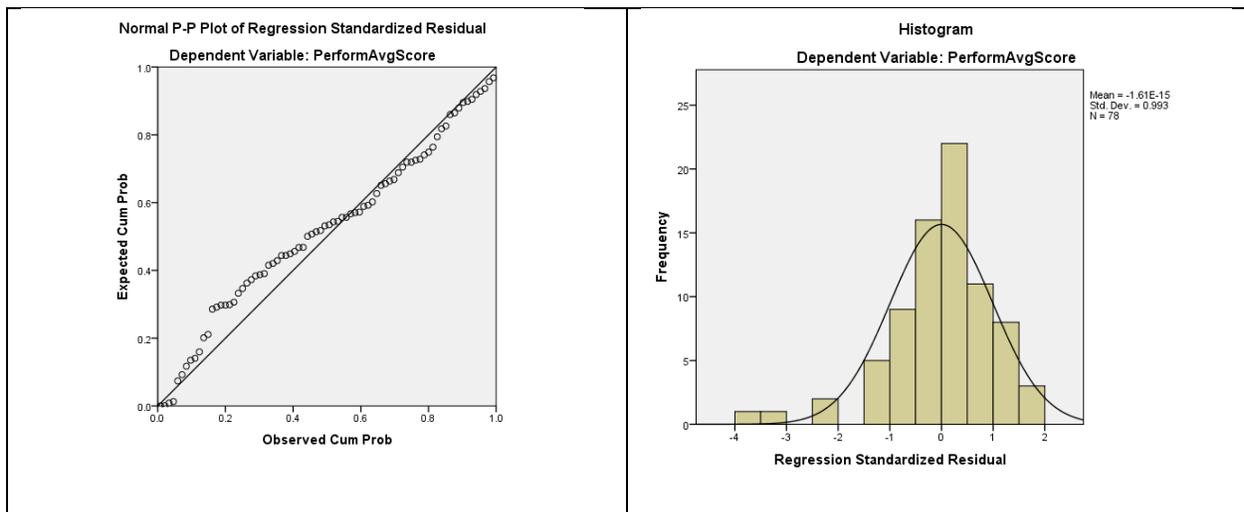
Homoscedasticity was tested by inspecting a scatterplot of the standardized residuals across the predicted values (Figure 4-4 below). The residuals appeared to be evenly spread and the researcher did not detect a curved or funnel shape across the predicted values and therefore judged the homoscedasticity assumption to have been met for the model.

Figure 4-4. Scatterplot of standardized residuals for assessing homoscedasticity



The assumption for normal distribution of errors is tested by observing a p-p plot and histogram of the standardized residuals (Figure 4-5, below).

Figure 4-5 Graphical information to assess performance residual normality



The deviation from the line in the p-p plot indicated a violation of normality and specifically indicated negative skew. However, if normality assumptions are violated, Field (2013) again recommends using bootstrap confidence intervals that tend to be robust despite deviations from

normal distribution. Therefore, a bootstrapping technique was deployed to arrive at more robust confidence intervals when reporting significance (Field, 2013).

The bootstrapped linear regression established trust climate could statistically significantly predict performance, $F(1, 76) = 47.275, p < .001$ and trust climate accounted for 37.5% of the explained variability in performance. The regression equation was:

$$\text{Performance} = 1.262 + 0.820 * \text{TrustClimate}$$

The bootstrap confidence interval for the value of b [.584, 1.048], $p = .001$ did not include zero and therefore the researcher concluded that there was a statistically significant, positive relationship between trust climate and performance scores in this study.

Summary:

A Pearson correlation was performed to assess whether levels of partnership performance in UIRPs could be predicted from levels of trust climate obtained from self-reported questionnaire data from 78 academic and industry participants in UIRPs. The trust climate assessment scores were obtained by averaging items on the trust climate scale adapted from Costa and Anderson (2011) and the performance assessment scores were averaged items of the scale adapted for this study that was comprised of items for performance from several organizational performance references (*refer to Appendix A for full instrument*).

Examinations of histograms indicated that the distribution shapes for trust climate were normal while those for performance were skewed. The distribution for performance data was negatively skewed indicating the existence of ceiling effects (Hessling, Traxel, and Schmidt, 2004). However, the skew was not judged severely enough to require transformation or removal of outliers. The scatterplot of trust climate with partnership performance suggested a positive, linear relationship. The correlation between trust climate and partnership performance was statistically significant, $r(78) = .62, p < .01$ (two-tailed). The R^2 was .375; thus about 37.5% of the variance in partnership performance could be predicted from levels of trust climate. The regression equation for predicting partnership performance score from trust climate score was found to be:

$$\text{Performance} = 1.262 + 0.820 * \text{TrustClimate}$$

The pattern of correlation was consistent with the possible existence of causal connection; however, the non-experimental research design limits ability to infer a causal association. The positive relationship is consistent with previous findings and theories regarding trust and performance (e.g., Zaheer et al., 1998; Dirks and Ferrin, 2001)

4.3 Mean Comparison: Academic Trust Climate and Industry Trust Climate

RQ2: How does trust from academic participants compare with trust from industry participants?

$$H_0: \mu_{AC} \neq \mu_{IN}$$

$$H_A: \mu_{AC} = \mu_{IN}$$

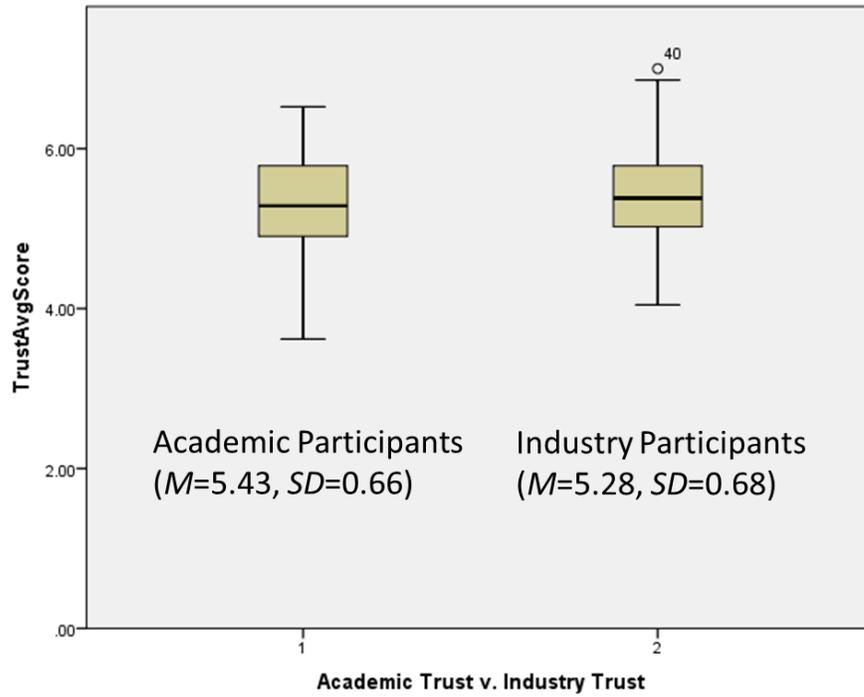
The trust climate scores of academic participants were compared to the trust climate scores of industry participants and tested for significant differences (i.e. is there a statistically significant difference in the trust climate score of academics compared with the trust climate of industry participants?). There were 47 academic participants and 31 industry participants who participated in the study and whose trust climate scores were compared in an independent samples t-test. As in the previous tests, there were assumptions that need to be tested: no outliers, normality, and homogeneity of variance (Field, 2013).

Table 4-8 Assumption Test Summary for Trust Climate Independent Samples T-Test

Assumption	Test	Result	Action
Normality	Histogram, Shapiro-Wilk	Yes; ($W=.993, p=.934$, non-significant)	Proceed with t-test calculation
No Outliers	Box-Plot	No substantial outliers	Proceed with t-test
Homogeneity of Variance	Levene’s Test	$F=.027, p=.869$ (small, non-significant)	Report equal variance assumed/pooled variance t-test statistic

Despite the unequal sample sizes, the Levene’s test of homogeneity of variance did not indicate a significant violation of the assumption for equal variances ($F=.027, p=.869$). Therefore, the pooled variances version of the t-test was calculated in SPSS. The means did not differ significantly, $t(76) = -0.92, p=.361$, two-tailed. The mean trust climate score for the industry participants ($M=5.28, SD=0.68$) was not significantly different from the trust climate score for academic participants ($M=5.43, SD=0.66$).

Figure 4-6. Boxplot of Academic and Industry Trust Mean Comparison



4.4 Trust Climate Mediation Model Analysis

Mediation can be defined as a type of three variable relationship that a variable, X, causes a mediator, M, and M causes Y (MacKinnon et al., 2007). There were three major approaches to mediation that were considered in this analysis: 1) Causal steps approach (Baron and Kenny, 1986) that tests the joint significance of the linear regression paths between a predictor, mediator, and outcome; 2) calculating the indirect effect (mediation) through a difference of coefficients ($c-c'$) with a bootstrapped coefficients of the indirect effect; and 3) calculating the indirect effect through a product of coefficients (ab) method with a Sobel test for significance. The assumptions for mediation analyses were the same as those for regression and the preliminary analysis results for each variable in the analysis are include below in the table. Following a process similar to that in section 4.3 in comparing trust and performance, the assumptions for each of the teaming disciplines were considered with trust climate and partnership performance. The scores for each of the teaming disciplines were reasonably linear, with independent errors and homogeneous variance. There was one influential case (#20) that was identified as having a standardized residual value greater than 3. Upon investigating the Cook's Distance (1982) the value was less than 1 and the case remained part of the analysis. Further, the scores were slightly negatively skewed as evident in p-p plots and therefore, bootstrapping techniques are used in conducting the mediation analysis.

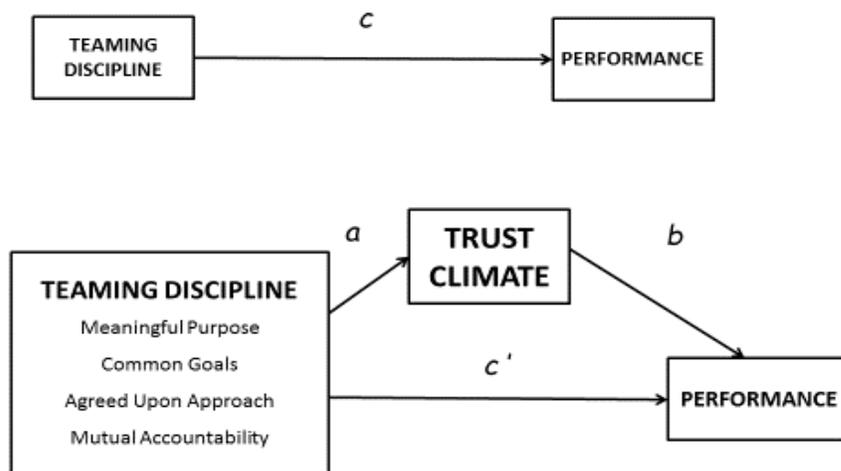
Table 4-9. Assumptions Test Summary for Mediation Analysis

Assumption	TDPurpose	TDGoal	TDApproach	TDAccount
Linearity	Scatterplot yes	Scatterplot yes	Scatterplot yes	Scatterplot yes
Normality	negative skew			
Variance Homogeneity	yes	yes	yes	yes
Error Independence	yes	yes	yes	yes
No significant Outliers	check*	check*	check*	check*

*One case was identified with $SD > 3$. However, upon inspecting the Cook's (1982) distance (< 1) the case was considered not influential enough to remove from the analysis.

One recent application of the mediation model framework has been in the design of interventions to induce change in an outcome variable by first targeting a mediating variable (or variables) that have a hypothesized influence on an outcome variable (Mackinnon et al., 2007). In this study, the researcher was interested in exploring an intervention that might positively impact trust in order to ultimately positively impact partnership performance. Specifically, the variable trust climate was conceptualized as a mediating variable that was influenced by the predictor variable teaming discipline and possibly influenced the outcome variable of interest performance. Due to the non-experimental nature of the design, causality cannot be assessed; however, an outcome of positive correlations indicates that causality was possible. The following figure is helpful in seeing the proposed mediation model that was tested. The top figure shows the simple model of the predictor-outcome relationship and the lower figure specifically includes the proposed model of the mediated relationship:

Figure 4-7. Proposed mediation model (*Adapted from Baron and Kenny, 1986; Field, 2013*)



The researcher utilized Field's (2013) description and terminology for the mediation model relationship as follows: the predictor variable (X) predicted the mediator (M) through path *a*; and the mediator (M) predicted the outcome (Y) through path *b*. Path *c* represented the predictor variable (X) predicting the outcome variable (Y) without the presence of the mediator, while path *c'* represented the predictor

variable (X) predicting the outcome (Y) in the presence of the mediator (M). The path notations a , b , c , and c' represented unstandardized regression coefficients between the variables that they connected and were symbolic of the strength of the relationship between those two variables. According to Field (2013) mediation has occurred when the strength of the relationship between the outcome variable and the predictor variable decreases with the inclusion of a mediating variable. In other words, if $c' < c$ then, mediation has occurred. In a perfect or full mediation, c' is reduced to zero.

The four conditions (Baron and Kenny, 1986) that have been tested for mediation in this study are:

- (1) Teaming discipline significantly predicted performance
- (2) Teaming discipline significantly predicted trust climate
- (3) Trust climate significantly predicted performance
- (4) Teaming discipline predicted performance more strongly in the mediated relationship model than in the simple x-y relationship model.

Field (2013) as well as MacKinnon et al. (2007) described a limitation of the Baron and Kenny method that there was not an explicit measurement of the combination of paths a and b , referred to as the indirect effect or ab , to compare with that of path c' , referred to as the direct effect. Field (2013) therefore, recommended an alternative method of estimating the indirect effect along with its significance through the use of a Sobel test (Sobel, 1982). The Sobel (1982) test involved testing the null hypothesis $H_0: ab=0$ using the following estimate for standard error of ab (SE_{ab}) provided by Sobel (1982).

$$SE_{ab} \approx \sqrt{(b^2s_a^2 + a^2s_b^2)} \text{ (from Equation 16.1 in Warner 2013 p.657)}$$

Then SE_{ab} was used as a divisor for the Z ratio for the Sobel (1982) test.

$$z = ab / SE_{ab} \text{ significant if } [z] > 1.96 \text{ (Equation 16.2 in Warner 2013 p.657)}$$

Further, Field (2013) recommended calculating the size of the indirect effect by examining the regression coefficient and its confidence interval. Field (2013) recommended using an SPSS customized dialog add-in called *PROCESS* which was developed by Andrew F. Hayes (Hayes, 2012) to perform the calculations for simple mediation analysis. SPSS® was used to conduct the mediation analysis

computations. According to Warner (2013) authoritative researchers on mediation analysis recommend the use of bootstrapping methods for obtaining confidence intervals for the estimation of the indirect effect of mediation (*ab*). Therefore, the bootstrapping technique (1000 bootstrap samples) was used to compute the confidence intervals in this study. The direct analysis output is included in the Appendix H. Mediation analyses were used to test each of the teaming discipline variables for which data was collected from participants in the research partnerships. The variables and descriptions are included below as a reminder:

Meaningful Purpose (TDPurpose): A truly meaningful purpose, understood by all participants

Common Goals (TDGoal): A common set of specific goals

Working Approach (TDApproach): A clear, agreed upon working approach

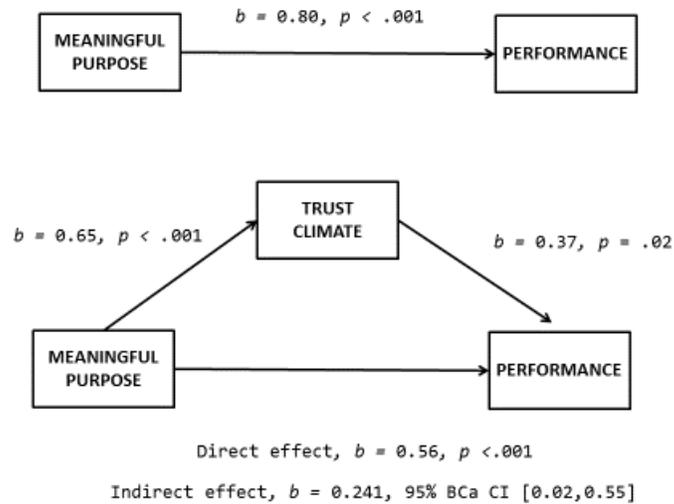
Mutually Accountable (TDAccount): A sense of mutual accountability for partnership outcomes

The results are summarized in the tables (Tables 4-10 through 4-13) and diagrams (Figures 4-8 through 4-11).

Table 4-10. Table of results for paths of “Meaningful Purpose” Mediation model

Path	Unstandardized Coefficient <i>b</i>	<i>t</i>	<i>p</i>
a	0.65	9.02	<i>p</i> < .001
b	0.37	2.37	<i>p</i> = .02
c'	0.56	3.97	<i>p</i> < .001
c	0.80	7.92	<i>p</i> < .001

Figure 4-8. Results for “Meaningful Purpose” mediation model (Adapted from Baron and Kenny, 1986; Field, 2013)

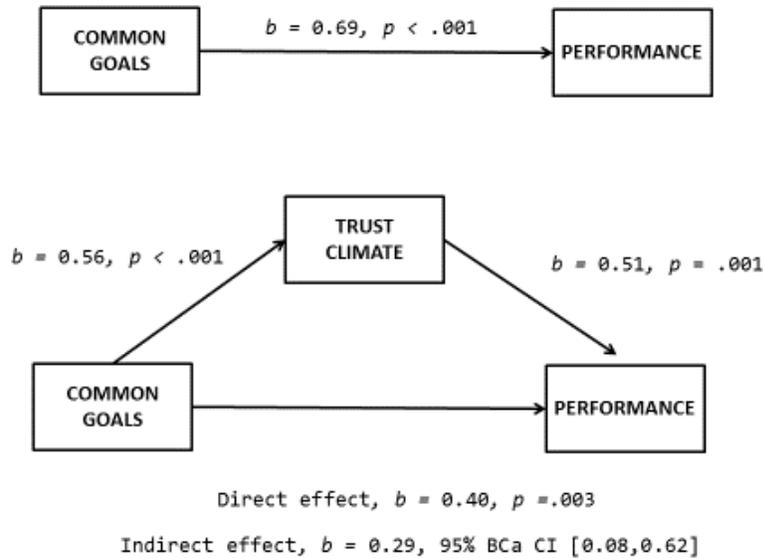


The model above that depicts trust climate mediating the relationship between the partnership having a meaningful purpose and positively affecting performance, yielded results consistent with theory that trust partially mediates the relationship between a partnership operating with a meaningful purpose, positively related to partnership performance. The path a , b , c , and c' were all positive and significant. The p values are presented in Table 4-10 above. Additionally, the indirect effect $ab = 0.24$, 95% BCa CI [0.02, 0.55]. The bootstrapped confidence intervals do not contain zero indicating that mediation likely occurred.

Table 4-11. Table of results for paths of Common Goal Mediation model

Path	Unstandardized Coefficient b	t	p
a	0.56	7.59	$p < .001$
b	0.51	3.43	$p = .001$
c'	0.40	3.11	$p = .003$
c	0.69	6.66	$p < .001$

Figure 4-9. Results for “Common Goals” mediation model (*Adapted from Baron and Kenny, 1986; Field, 2013*)

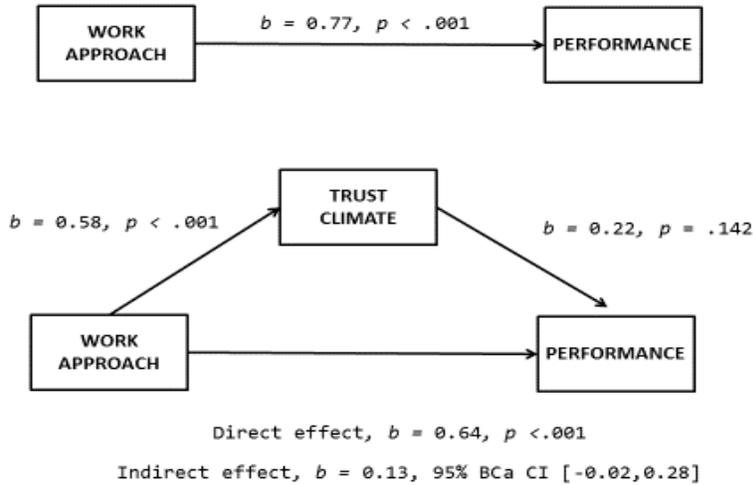


The mediation model above depicts a partnership operating with common goals that influence trust climate and consequently partnership performance. The model with trust climate mediating the relationship between the partnership having common goals for the partnership and positively affecting performance, yielded results consistent with theory that trust partially mediates the relationship between teaming discipline of establishing common goals and partnership performance. The path a , b , c , and c' were all positive and significant. The p values are presented in Table 4-11 above. Additionally, the indirect effect $ab = 0.29, 95\% \text{ BCa CI } [0.08, 0.62]$. The bootstrapped confidence intervals do not contain zero indicating that mediation likely occurred.

Table 4-12. Table of results for paths of Work Approach Mediation Model

Path	Unstandardized Coefficient b	t	p
a	0.58	9.38	$p < .001$
b	0.22	1.49	$p = .142$
c'	0.64	5.49	$p < .001$
c	0.77	9.59	$p < .001$

Figure 4-10. Results for “Work Approach” mediation model (Adapted from Baron and Kenny, 1986; Field, 2013)

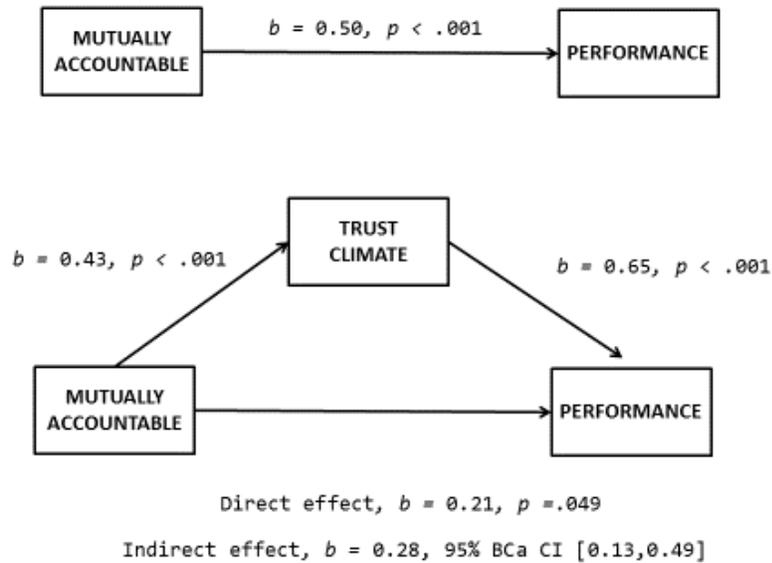


The mediation model above depicts a partnership utilizing an agreed upon approach to working that influences trust climate and consequently partnership performance. The model with trust climate mediating the relationship between the partnership having an agreed upon work approach for the partnership and positively affecting performance, yielded results inconsistent with theory that trust partially mediates the relationship between teaming discipline of establishing common goals and partnership performance. The path a , c , and c' were all positive and significant; however, path b was not significant. The p values are presented in Table 4-12 above. Additionally, the indirect effect $ab = 0.13$, 95% BCa CI [-0.02, 0.28]. The bootstrapped confidence interval contains zero indicating that mediation is not likely to have occurred.

Table 4-13. Table of results for paths of Mutual Accountability Mediation model

Path	Unstandardized Coefficient b	t	p
a	0.43	6.16	$p < .001$
b	0.65	4.57	$p < .001$
c'	0.21	2.00	$p = .049$
c	0.50	5.06	$p < .001$

Figure 4-11. Results for “Mutually Accountable” mediation model (*Adapted from Baron and Kenny, 1986; Field, 2013*)



The mediation model above depicts a partnership with members who are mutually accountable for outcomes of the partnership that positively influences trust climate and consequently partnership performance. The model with trust climate mediating the relationship between mutual accountability for the partnership and positively affecting performance, yielded results consistent with theory that trust partially mediates the relationship between teaming discipline of mutual accountability and partnership performance. The path a , b , c , and c' were all positive and significant. The p values are presented in table 4-13 above. Additionally, the indirect effect $ab = 0.28, 95\% \text{ BCa CI } [0.13, 0.49]$. The bootstrapped confidence intervals do not contain zero indicating that mediation likely occurred in this test.

Additionally, for each of the mediation analyses, a Sobel (1982) test was conducted and the effect size (κ^2) (refer to Preacher and Kelly, 2011) was calculated. The summary of the results for the mediation analyses are included in Table 4-14 below.

Table 4-14. Summary of mediation results

Mediation Model	Indirect Effect and BCa CI	Sobel Test (Z-value and significance)	Result	Effect size (κ^2)
Meaningful Purpose	$b=.241$, [0.02, 0.55]	$Z=2.28$, $p=.02$	Partial mediation supported	$\kappa^2= .19$, [.03, .36]
Common Goals	$b=.288$, [0.08,0.62]	$Z=3.11$, $p=.002$	Partial mediation supported	$\kappa^2= .24$, [.07,.41]
Working Approach	$b=.127$, [-0.02, 0.28]	$Z=1.46$, $p=.14$	Mediation NOT supported	
Mutual Accountability	$b=.283$, [0.13, 0.49]	$Z=3.64$, $p<.001$	Partial mediation supported	$\kappa^2= .27$, [.13, .42]

Limitations

Mediation is one of many ways that three variables could be tested. The choice was made here for its practical application motivation of seeking an intervention that might directly positively impact trust climate and therefore indirectly affect partnership performance. Future work should consider different potential relationships such as moderation in which trust climate may also modify the relationship of teaming to performance such that the relation of teaming and performance differs at different values of trust.

The non-experimental research design limits the researcher ability to establish causality of the relationships in the model. The analysis for this study can be treated as a preliminary step, evaluating the plausibility of the hypothesized causal relationships based on the non-experimental evidence in this single study. Future work might consider an experimental design for example considering a control group and a group for which a specific disciplinary action is put into place and testing the relationships in each group. Further one study in of itself is limited in results, future work involving replicating the study across different samples would increase confidence that positive results were not due to standard error estimates.

Regarding practical significance, it is difficult to judge practical differences in partnership performance due to the imprecise nature of the agreement scale used in data collection for the variables. While there are practical indications at the extremes of the scales (e.g. trust climate 0 is problematic lack

of trust and trust climate 7 indicating a high level), the numbers in between are highly subjective to interpretation.

Additional future work on the mediation models should include more variables in the mediation model to test more complex relationships. For example, trust and knowledge sharing, and trust and communication have a base of theoretical support for testing in future models of examining the role of trust in partnerships (Santoro and Saporito, 2003).

4.5 Quantitative Analysis Results Summary

To address the question about the role of trust in UIRP performance, the first question the researcher examined was: How does trust climate relate to UIRP performance? A Pearson correlation was performed to assess whether levels of partnership performance in UIRPs could be predicted from levels of trust climate obtained from self-reported questionnaire data from 78 academic and industry participants in UIRPs.

The correlation between trust climate and partnership performance was statistically significant, $r(78) = .62, p < .01$ (two-tailed). The R^2 was .375; thus about 37.5% of the variance in partnership performance could be predicted from levels of trust. In order to describe how well the partnership performance could be predicted from trust climate, a bivariate regression was performed. The regression equation for predicting partnership performance score from trust climate score was found to be $\text{Performance} = 1.262 + 0.820 * \text{TrustClimate}$.

The pattern of correlation is consistent with the possible existence of causal connection. Due to the non-experimental research design limits ability to infer a causal association. However, the positive relationship is consistent with previous findings and theories regarding trust and performance (e.g. Zaheer et al., 1998; Dirks and Ferrin, 2001).

RQ2: How does trust from academic participants compare with trust from industry participants?

The trust climate scores of academic participants were compared to the trust climate scores of industry participants and tested for significant differences (i.e. is there a statistically significant difference in the trust climate score of academics compared with the trust climate of industry participants?). The

results of an independent samples t-test indicated that the means did not differ significantly, $t(76) = -0.92, p = .361$, two-tailed. The mean trust climate score for the industry participants ($M = 5.28, SD = 0.68$) was not significantly different from the trust climate score for academic participants ($M = 5.43, SD = 0.66$).

RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?

Mediation analysis was performed in this study to explore interventions that might positively impact trust climate in a partnership and ultimately, positively impact partnership performance. Specifically, the variable trust climate is conceptualized as a mediating variable that is influenced by the predictor variables – the four teaming disciplines of operating with a meaningful purpose, following common goals, approaching work in an agreed upon manner, and joining in mutual accountability of partnership outcomes - and that influences the outcome variable of interest, partnership performance. The mediation analysis was performed using Baron and Kenny (1986) causal steps approach along with bootstrapped confidence intervals obtained utilizing procedures by Preacher and Hayes (2008) for the indirect effect *ab*.

Three of the four teaming discipline-trust climate mediation models - operating with a meaningful purpose, following common goals, and joining in mutual accountability of partnership outcomes - yielded results consistent with support for partial mediation. The fourth teaming discipline: approaching work in an agreed upon manner yielded a result that was not consistent for mediation. In the fourth case, there was not a significant path between trust climate and performance in this model.

In this study, the quantitative data provided evidence to support a positive relationship between trust climate and performance in university-industry research partnerships. These results were consistent with theories by other researchers in various organizational and inter-organizational settings (e.g. Dirks and Ferrin, 2001 and Zaheer et al. 1998). Despite the differences among academics and industry participants in partnerships with regard to the roles they might play, the data on their perceptions of trust climate in the partnerships did not exhibit significant statistical differences. Finally, in exploring possible

interventions for building trust in partnerships, mediation analysis results provided preliminary evidence that establishing a meaningful purpose for the partnership, following a common set of goals, and assuming mutual accountability for the outcomes of the partnership may influence the trust climate of a partnership and positively impact partnership performance.

Chapter 5: Qualitative Analysis Results

To investigate the role of trust in university-industry research partnerships from a qualitative perspective, the researcher followed a phenomenological approach for the study. Leedy and Ormrod (2009) define a phenomenological study as “a study that attempts to understand people’s perceptions, perspectives, and understandings of a particular situation” (p.141). In this study, the focus will be on understanding the academic and industry leadership perceptions of trust and partnership performance in three I/UCRC (Industry/University Cooperative Research Centers).

Interview data from the academic-industry leadership team members in each of the three Centers were collected and analyzed. Composite descriptions of trust and performance from participants’ leadership perspective were developed utilizing the synthesis of approaches from Creswell (2013), Leedy and Ormrod (2009), and Moustakas (1994), and as described in Section 3.4 above. This chapter presents the results of the analysis and the composite descriptions as an outcome of this phenomenological study. The specific steps for the process include: 1) Epoché 2) Participant descriptions 3) Horizontalization 4) Meaning unit clustering 5) Imaginative variation 6) Textural and structural descriptions- Composites and Participant summaries 7) Comprehensive description of the role of trust in UIRPs. To address the overarching research question: What is the role of trust with respect to UIRP performance, the results are presented in the context of the following research sub-questions:

RQ1: How does trust relate to UIRP performance?

RQ2: How does trust from academic participants compare with trust from industry participants?

RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?

5.1 Phenomenological Data Analysis Results

5.1.1 Epoché

The process of epoché (Husserl, 1931) involves an intentional separation of the researcher's personal experiences with a phenomenon of interest from the collection and analysis of the study. Moustakas (1994) describes the epoché as “bracketing” an investigator's experiences in order to approach the study of a phenomenon with a fresh perspective. By incorporating this process, the phenomenological study places greater focus on the experiences of the participants and less on the interpretations of the researcher (Creswell, 2013; Moustakas, 1994). The basis of the epoché for the researcher in this study come from her personal experiences participating in a UIRP similar to the ones investigated in this study. The written account which follows is a description of her experiences which are bracketed from this phenomenological study of the role of trust in UIRPs.

The researcher participated in a similar type of university-industry research partnership as an administrator with rich interactions with academic and industry participants observing the dynamics of the Center Director's long term relationships enduring through transitions and growth of the center. Specific observations included a sense of loyalty of industry members to the Center Director in particular; and a general willingness to work together to focus on fundamental research related to all of the companies in the Center. Even in the presence of some competitors, the research was fundamental and pre-competitive such that the relationships continued to be beneficial to participating organizations. Industry members were also very interested and insistent upon quality in the management and administration of the Center and highly valued well organized meetings with sufficient times to interact with one another informally and formally. Their general willingness to share resources and knowledge for the sake of fundamental research problem solving was a potential indicator of a positive trust climate within the Center that helped the Center to maintain a positive performance status.

Additionally, the researcher had an opportunity to attend a nationwide meeting with Center Directors from all of the Centers who participate in this particular partnering program in U.S. The researcher observed that the Centers that were identified and presented as “top performers” repeatedly

referred to their synergistic academic-industry relationships and specifically citing trust as a critical factor in their high performance success. This potentially biased the researcher toward positive expectation of observing trust as important and critical in this study. Additionally, the quantitative analysis that the researcher completed also supported this positive expectations of trust in the partnerships and further reinforced the potential bias.

In order to mitigate this potential bias, the researcher was careful to seek and note evidence from dialogue with the leaders that contrasted this expectation. One example was in carefully phrasing questions to give participants an opportunity to share both positive and negative aspects of trust rather than leading them into a discussion with trust as a positive and critical factor in UIRP performance. Also, in the peer examination, the researcher explained to the examiner how the bracketing was maintained throughout the analysis process by following a systematic procedure focused on interpreting meaning directly from the participants' statements without adding personal meaning to the statements for the analysis. Finally, the member checking process by the participants also validated the interpretation of their statements as accurate reflections to their unique, personal experiences.

5.1.2 Participant Descriptions

There were a total of six participants in the study. Below is a brief, paraphrased description of each participant which they shared in the initial warm up question portion of the interviews:

Center A, Industry Leader – P1 served as a technical adviser to the Center, representing the interests of his company. He inherited his leadership position from a predecessor in his company who left the position with the company.

Center A, Academic Leader – P2 was recruited to the center as a young faculty member with aligned research interests. He later became the Center Director through IAB appointment after the departure of his predecessor. As a leader, he assumed responsibility of executing the vision of service to industry as well as bringing the different academic and industry interests together.

Understanding what industry needs and how academe works and bringing the parties together so

that they work together productively, describe an overarching picture of his stated role in leadership of the Center.

Center B, Industry Leader – P3 has had relationships with industry-university cooperatives established over decades. The organization in the form of the Center was new, but the relationships had already been established and P3 was invested in the relationships. P3 was asked by the Center Director if he would lead the Industry Advisory Board. He stated that one of his primary responsibilities was to coordinate the process of voting for research project funding allocations – to determine which projects received funding support. He mentioned the importance of getting discussions going and that he was good at reaching consensus and that coordinating was easy for him.

Center B, Academic Leader – P4 is a Center Director who was a founder of the Center. He commented that all of the universities had confidence that he would maintain the Center's interest as central rather than his own personal career interests. He had already led cooperatives, so, there was rapport with members already established. The difference in the Center was that there was potentially a deeper level of collaboration available once companies worked beyond their closest university in their region and conducted work across regions and disciplines. His role with the Center was strictly administrative at the time of the interview and his responsibilities included conducting the annual advisory board meetings, overseeing university reporting to NSF, and coordinating voting on funding allocations for projects. He was also responsible for some publicity, but not formal recruiting that was done at the university levels.

Center C, Industry Leader – P5 was the head of a research and development group at his company who was seeking university partners to address a specific problem at the time. In the midst of his search, he met a site director who introduced the Center to him. His company saw the potential value and joined the Center. As he learned more about the Center and had the opportunity to interact with the Center Director, he was eventually asked by the Center Director to be the IAB Chair.

Center C, Academic Leader - P6 was appointed to a chaired faculty position at a university and a condition of the position included leading this Center. He found the Center director position to be differently rewarding than typical faculty duties in that the faculty involved in the Center choose to be part of a collaborative organization. As Center Director, P6 had no official authority over the people so the entire focus is on emphasizing mutual benefits and helping people work together and essentially encouraging them into productive behavior. He felt his job leading the Center was to form the right system and nurture the right culture with proper incentives so that people naturally do what ultimately benefits the Center – a challenging undertaking. He saw the opportunity in running the Center as an opportunity to “run his own ship his own way.”

Table 5-1. Leadership participant center entrance overview

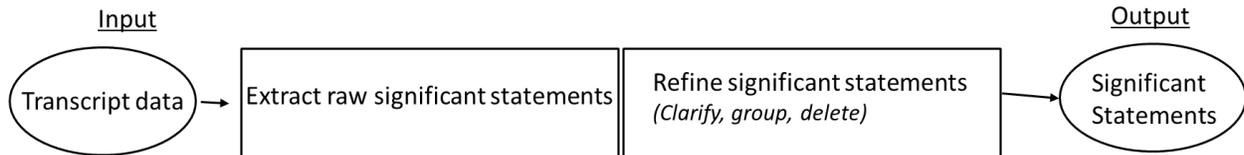
Participant	Center Status upon Entrance	Center Entrance Scenario
P1	Joined existing Center	Represented his company as technical adviser for the Center
P2	Joined newly formed Center	Was recruited for research interests aligned with the Center
P3	Center Founder	The formal center was established to encompass the existing academic-industry cooperative (co-op) program relationships
P4	Center Founder	Previously led a co-op program; led negotiations proposing a four-university center with NSF
P5	Joined existing Center	R&D leader at his company seeking technical advice who found a university site director who introduced him to the Center
P6	Joined existing Center	Faculty member at the lead university in the Center who accepted the faculty position with an expectation to fulfill the Center Director role

5.1.3 Procedural Results

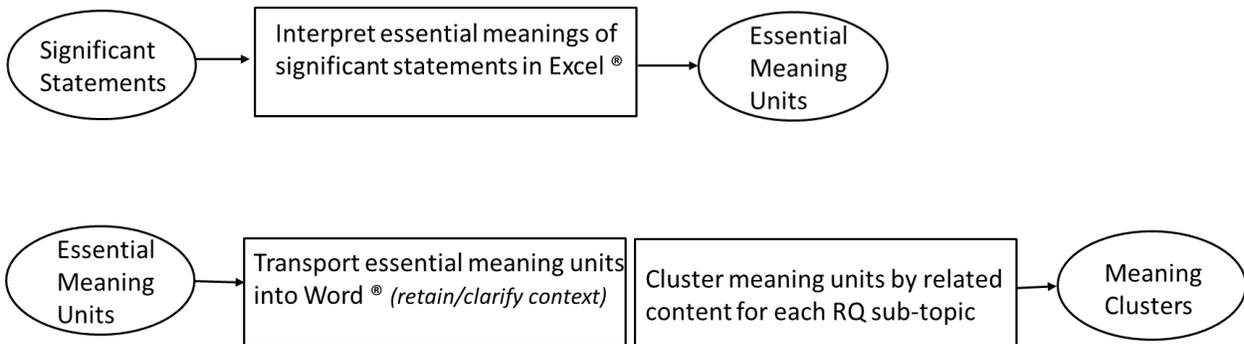
The following Figure (5-1) depicts the flow of each of the procedures involved in this phenomenological analysis.

Figure 5-1. Procedural diagrams for the phenomenological analysis

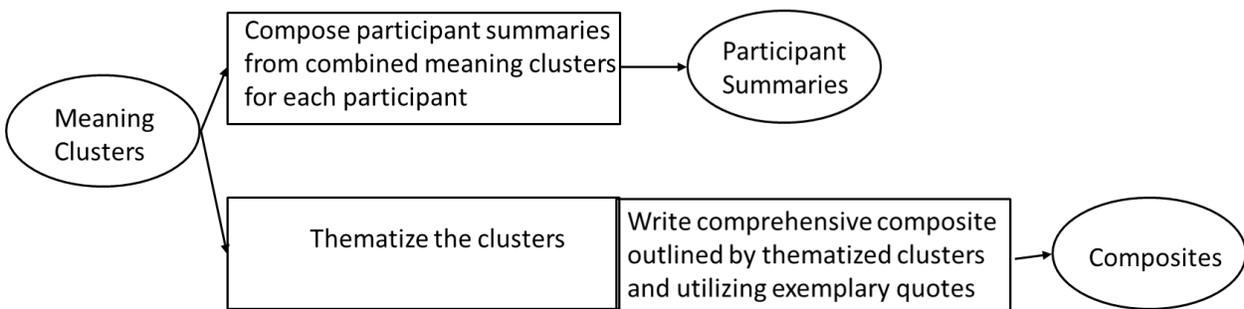
Horizontalization



Meaning Clustering



Imaginative Variation



Horizontalization

Approximately 1100 raw text segments were extracted from the six verbatim transcriptions of the interviews conducted with the academic and industry leaders utilizing Atlas.ti® software. Moustakas (1994) used the term “significant statements” as a descriptor for the statements that were relevant to a set of research topics addressed. The raw text segments were grouped according to the research sub-question

topics: trust related to performance, academic and industry trust differences, and actions for building and managing trust in UIRPs. With redundant material removed 357 relevant statements were categorized as “significant statements” and included in the analysis for this study. A peer examination was conducted for credibility of the clarifications, grouping, and deletions of the statements for relevance and accuracy. Table 5-2 below gives examples of some verbatim transcript extractions that the researcher refined into “significant statements” for analyzing in the study in the horizontalization process.

Table 5-2 Horizontalization process samples

Interview Topic	Participant	Original Extraction(s)	Refining Action	Significant Statement
Center Performance Assessment	P1	<i>Uh, unfortunately, the Center has not been able to attract membership from a broader type of corporation.</i>	Minor Clarification	Unfortunately, the Center has not been able to attract membership from a broader type of corporation.
Actions Managing Trust	P6	<i>Those are things I think you have to do to make sure that the companies not only you know, see that and don't get concerns related to trust that you're misallocating funds</i>	Major Clarification	[The financial aspects] are things I think you have to make sure that the companies not only see, but that they don't get concerns related to trust that you're (academia) is misallocating funds.
Trust with respect to partnership performance	P3	<i>(1) So, in my case, in most of industry case, we know a lot of these folks, (2) so it's not like we just grabbed a bunch of scientists off the street and started doing anything (3) so trust and mutual respect and relationships were there when this center actually started, (4) so that just kind of makes it easier.</i>	Grouping	So... in most of industry case, we know a lot of these folks, so it's not like we just grabbed a bunch of scientists off the street and started doing anything... so trust and mutual respect and relationships were there when this center actually started, so that just kind of makes it easier.
Center Performance Factors	P5	<i>In other words, we were developing a tool to basically allocate the right size of tanks...</i>	Deletion	

Units of Meaning

Once the statements were selected and refined for inclusion in the analysis, the significant statements were formulated into meaning units. Table 5-3 gives an example of some significant statements and their formulated meaning units.

Table 5-3 Meaning units formulated from significant statements

Participant	Significant Statement	Formulated Meaning Unit
P2	There you have to trust that the advisory board as a whole can handle the influence of new people and that the new people, their interests may deviate significantly and it could cause a huge change in the research agenda, right in the middle of the effort.	Trust advisory board to remain steady even with disruptive representative exchanges.
P1	Our consortium differs from other consortia in that some of [my company's] competitors are members, so we have to be a little circumspect about what we say at these meetings	Industry competitors are involved in the consortium, so they have to be circumspect with sharing information
P3	The leadership of the program from [Center Director] is a really good one. ...he's always had a good link to industry and I've known him since he started with the faculty at [University] so I mean, that's kind of an underpinning of the whole program	Long term relationship with academic leader and industry partners underpins the program [the Center]

In the process of transferring the meaning units from Excel ® to Word ® for the remaining analyses, the researcher edited statements to achieve a contextual clarity necessary for effectively clustering the meaning units in the next procedure in the analysis.

Meaning Clusters – Imaginative Variation

Once the meaning units were clarified and transferred from Excel ®, two processes were conducted. First, the meaning units remained grouped by participant, in order to compose the participant summaries that were verified through member checking by the participants. Second, the statements were

thematically clustered independently of the participant labels in the process of meaning clustering in order to develop the composites of the themes from the combined participant perspectives. Moustakas (1994) refers to this analysis procedure for considering the various perspectives of the participants as “imaginative variation.” An example of two thematic clusters and their associated meaning units is presented in Table 5-4 below.

Table 5-4 Samples from meaning unit clustering

<p><i>Cluster: Industry and Academic “natural” distrust</i></p> <ul style="list-style-type: none"> -Industry naturally questions the intentions of the faculty (<i>question faculty motives</i>) -Natural lack of industry not trusting faculty due to faculty independence -Suspicion is natural tendency of industry toward faculty they don’t know -Natural tendency of distrust from both industry and academe -Trust is not natural for academics due to competition for research funding. -Mutual Distrust attributed to different operational environments
<p><i>Cluster: Honest/Transparent Discussion</i></p> <ul style="list-style-type: none"> -Directors mutually respect each other; Discussions frank [respect and open communication] -Complete transparency with updates of Center decision making -Consistency in transparency has built trust over time -Sharing confidential information between research teams and member organizations -Speaking freely about the membership agreement and mutual understanding long term -Speaking accurately with companies and research teams about expectations within the formal agreement

The thematic meaning clusters were summarized and combined into composite descriptions for each of the three sub-question topics. The three composite descriptions are presented below in Section 5.1.4. A final composite, addressing the overarching research question, describing the role of trust in UIRP performance, was the outcome of the analysis and is presented below in Section 5.1.5.

5.1.4 Composite Descriptions

RQ1: Composite for Trust and Performance

During the interviews, the participants shared various experiences either in the form of examples when they felt trust played a factor in center performance or other experiences that described their general notion of how trust works in their center. Additionally, some participants shared situations that were explicitly described as “not trust” but something else that might be related to or even perceived as trust. The composites below were paraphrased meaning units that were clustered by related topics and inclusive of the perspectives of the six participants.

Ability to have challenging discussions

One cluster of relevant meaning units related to the notion of an environment where participants could discuss and address difficult concerns and work through conflict. The description “challenging” in this context describes discussions that were critical, opposing, frank, or transparent interactions. In the centers, through these challenging discussions, participants addressed and worked through conflict situations to get work accomplished effectively.

P1 shared an experience when his research team at his company presented some work for consideration in the center and some of the analysis was completed incorrectly. In this scenario, P1 asserted that there was enough trust built into the relationship that the researchers who noticed the mistake spoke up right away and then the groups worked together to complete a correct analysis. P1 spoke of the work being submitted at a date past the original deadline, but with the joint problem solving, the outcome was still of high quality.

Another example provided by P1 displays how even a minority voice is valued and considered in the context of the center. He shared a story of an investment direction that the majority of the center members were interested in pursuing, but that a smaller minority was adamant about not pursuing. The concerns of the minority were considered and the decision was made in their favor with the outcome positive.

P3 spoke of the mutual respect that the site directors have for one another. He explains that the discussions among and between them could be frank, but they were characterized by a respectful openness. P5 generally spoke of opportunities to raise concerns and share multiple perspectives on Center issues in IAB meetings. He also generally spoke of the director's ability to involve the right people in problems and how the director openly shared difficulties and details thereof that concern the Center operations. P6 spoke of the ability of members to address issues as they arise, especially in terms of formal agreements. He shared an example of an intellectual property (IP) concern that one company saw value in some software and was interested in keeping it proprietary for themselves. However, this industry member had to be reminded of the expectations as laid out in the formal agreement that shares access to such IP with Center members.

Finally, another general experience noted by some participants was the honesty and transparency in the interactions in the Center. P5 spoke of the Center Director's complete transparency with sharing updates of Center decision making. The transparency was observed in the context of difficulties as well as times of reporting results of group decisions. P5 added that the consistency in transparency has built trust over time. P6 spoke of the sharing of confidential information between the research teams and the member organizations. The membership agreement scenario mentioned above in working through conflict was also applicable in this context in which there was transparency about what would be tolerated and what would not be in terms of honoring the membership agreement.

Mutual Responsibility/Accountability

The concept of mutual responsibility and accountability was mentioned as well when speaking of experiences of trust affecting the performance. In the scenario described by P1 above, a result was a quality work product from both academic researchers and industry researchers working together to amend the problem that led to a quality work product. Also, at the closure of the experience of deciding to adhere to a minority consideration, all members were mutually accountable for the decision to not expend the resources. P3 also shared an example of people deciding to go forth with a project with some reservations and even disagreement, but in the end, their mindset is that everyone accepts the success or

failure of a project. In spite of how the decisions come to be, the participants conveyed a sense of mutual accountability with outcomes.

Being proactive and setting an overall tone for mutual accountability was an approach described by P5. The example he shared about experiencing trust with respect to performance involved the Center Director including P5 in the vision forming of the Center through participating in a leadership retreat. P5 explained that the Director clearly valued input from industry even to the point of involving them in the Center [research] roadmap.

One practical example of mutual accountability in constant practice mentioned by P5 was in the form of shared responsibility in organizing the IAB meetings. Both academic and industry leadership contribute to the logistics of the meeting and are jointly invested and responsible for the success of the meetings. P5 also mentioned experiences in which his company included faculty researchers in the process of formally reporting to his company on behalf of the Center. He also stated that it was generally undesirable to have academic researchers work separately from industry reinforcing the concept of an expectation of joint responsibility for performance in the Center.

P6 also shared a formal mechanism that enables the Center university sites to share contacts and negotiation progress in order to combine forces in recruiting industry members. P6 spoke of the characteristic of the mechanism as representative of an integrated organization. According to P6, without this particular formal mechanism for sharing recruiting information the mistakes in recruiting could hinder the “integrated organization” pitch that was pivotal in drawing members to the Center. P6 spoke of the tool as a way to support each other and indirectly, mutually account for membership recruitment.

Leadership Credibility

P2 shared the perspective that generally academic site directors trusted the judgment of their industry advisory board to create the research agenda. He believes the trustworthiness between industry and academe had been reinforced through positive performance results over time. P2 further explained that academics trust that industry looks out for the Center as a whole when considering the research agenda and even further considered the limitations of academic researchers’ scope (e.g. practical

limitations of time). Further P2 shared a confidence in the technical expertise of the industry members in the Center.

P4 shared his experience when he was a new leader and gained the trust over a period of about three years of the industry members through learning about the field and how to manage relationships with industry. He specifically mentioned that there were a few members who were loyal to him as the leader who remained during a time when many members decided to discontinue participation in the previous industry university cooperative experience – that predated the Center. He shared that when he was able to visit the various sites and enjoy greater interaction with cooperative participants, the cooperative thrived. However, he had one year in which he had some career transitions and was unable to be as interactive and that was a point where the remaining participants decided to end their first cooperative model. In describing his experience in the formation of the Center, P4 cites his credibility in “...working for the common good [of the group of participants] and not just [his] own good...” as a pivotal part in the success of beginning the new Center. P4 explains he was able to work with each of the site directors to establish trust upon entering the Center endeavor.

When asked about trust and performance, P6 shared his experience making sure that potential conflict of interest does not hinder trust and thereby performance particularly through hindering membership recruitment efforts. P6 had a dual role as director of the Center and a director for a site so there was a potential conflict of interest in recruiting members to the Center as a whole and not just his site. In addition to avoiding personally opportunistic behavior, he shared that he also had to be careful to not show favoritism toward any particular site in directing new members. He cited the formal mechanism they have for membership recruitment beneficial “to police” and help all of the directors remain transparent in their membership recruitment efforts.

Long term relationships

P3 and P4 were leaders of a center that had established relationships of over thirty years. They explained that there had been long term working relationships with trust and mutual respect between scientists and industry who were also in the Center. P3 specifically assessed the relationships to be

healthy at the center, site, and project team levels. He described the long term relationships, specifically between the Center Director and industry partners, as an “underpinning [of] the program [the Center].”

P5 also spoke from the perspective of performance resulting from the process of building trust over time. He attributed the relationships developed over time to helping connect a student with industry. He gave a specific example in which a student was hired to work for his company. While the student went through the formal process for applying, P5 believed the process went smoother due to the already existing relationship between his company and the Center. Finally, P2 also stated that the best way to develop trust was cultivation of relationships over time. He further explained that, like in the partnership, working together toward a common goal builds trust naturally over time through engagement.

Turnover

P2 spoke of the occurrence of industry representative changeover as situation that is disruptive to trust building efforts. He explained that it results in a loss of institutional memory and is disruptive to the foundation of mutual understanding and introduces a need to revert back in the relationship process and “...bring the whole group back to a common level.” He further explained that the academics trusted the industry advisory board to “...handle the influence of new people...” and manage these representative exchanges as they occurred to ensure that the Center adhered to a set research agenda.

P2 also shared an experience regarding a relationship external to the Center with his university administration misunderstanding how the Center operates with respect to membership agreements. The administrator attempted to alter the text of an established membership agreement. P2 shared this as an experience that introduced concern about the level of trust he was able to have with the administration.

Deeper engagement across organizations beyond partnership

P5 expended time describing the importance of mutually deep engagement opportunities with his company and his university site counterpart. He had good experiences sharing the academic researchers’ impact of the work with company management with a high level of visibility in his home company. He actively involved researchers in the updates and reporting efforts about the Center to the company and at

the executive level management in the company. He said he felt that this visibility helped increase academic trust of industry by valuing the research conducted. Additionally, he was apparently influenced by a visit to his university site where he was able to see the labs and have discussions beyond the project level. One indirect outcome of this visit was a hiring of one student from the university into P5's company which P5 attributes the ease of the hire to the trusting relationship between the organizations by way of their participation in the Center.

Trust affecting Membership Retention as performance

P6 and P4 both referred to trust as a factor in retaining members in the Center. P4 gave a direct example in which the members of the Center trusted in the Center Director as a leader, developed a sense of loyalty, and remained part of the Center even as other members left. P6 explained an indirect relation of trust with relating to performance in that "...lots of aspects of trust play into...everything working well and keeping people coming back to the Center...at least two aspects of performance." P6 explained that the formal mechanism to facilitate sharing information for membership recruiting still required a sense of trust among site directors to use and to be transparent in their negotiations.

RQ2: Composite for Differences in Academic and Industry Member Trust

There were some participants who felt there was no difference in trust among academic and industry participants. P4 explained that there were no fundamental differences in the trust between academic and industry members because "people are people" (P4). He further explains that there are differences in the roles that academic and industry members play in these partnerships. Industry members have corporate role with a business and/or technical agenda associated with their company and academia are largely "free agents" (P4). P3 stated that he also felt that there was no difference. The other participants described their perceptions of differences in trust which are paraphrased below.

Trust in the midst of competition

P6 asserted that industry people trust each other more than the academics trust each other. He referred to the fact that there are no direct industry competitors in his Center so "...they all trust each

other in the sense that they don't rely on each other..." P1 recalled his experience in previous research consortiums where he was freer to share information due to the absence of competitors in the Center. He explained that, however, in this Center he had "...to be a little circumspect about what [they] say at these meetings..." due to the fact that there were direct competitors for industry in the Center.

P6 explains that academics in the Center have "a little bit of competition among them" for securing research funds. He refers to the similar research interests among academic participants that leads to potential competition over intellectual property and the research funding sources for proposals. In summary, the competitive environment among academics who are participating in a center which is established around common research areas may make it more difficult for academics to trust each other than for industry members without competitors in some centers.

Tendency to distrust due to differing work cultural norms

P2 referred to a "natural tendency" of academic and industry members to distrust each other because, "...they operate in such different environments." P2 commented that industry members "naturally... question the intentions of faculty...if they're really there to serve the industry or...to serve their own purposes..." P2 explained that, in his opinion, faculty are perceived by industry as being very independent. P4 described faculty as operating "by and large as free agents" who are more concerned with their personal career advancement than an overall organizational advancement – different from industry. Additionally, P5 shared that industry members question faculty's "ability to follow and respect milestones and a schedule" – an industry cultural norm. P6 referred to NDAs (non-disclosure agreements) and explained that NDAs as formal mechanisms do not guarantee sharing of industry members with academe. P6 observed that there is still "guardedness" by industry toward academe. P2 perceived that academics lacked trust in industry members proposing meaningful work for projects. He also commented, that, in general, faculty "...are not used to taking directions from industry..."

Differences in trust can be overcome by engaging in the Center

In spite of the potential differences in academic and industry culture that impacts trust within them, P2 was hopeful in explaining that by coming together as in these partnerships and learning about

each other “...the two groups...could develop a sense of trust.” P4 offered from his experience that faculty “...have learned over time that they...need to keep the [industry] members happy and keep trust levels high...for their research program to succeed.”

RQ3: Composite for Actions Managing Trust

In response to the inquiry for actions that are practiced or could be practiced within the Center to maintain trust, some responses were directly implementable, continuous tasks, and, then, some were long term actions to foster an environment conducive to building and maintaining trust. Respondents also alluded to both formal and informal means of interactions that were believed to positively affect trust in the Center. Also, several respondents shared practices that hinder trust building. There was an overall tone for addressing the needs of the Center members – particularly the needs of industry. Finally, there was a group of responses clustered that focused on maintaining an overall climate of trust long term.

Continuous actions to maintain trust

Some directly implementable practices or customs within the Center that were helpful in building and maintaining trust can be listed as follows: frequent updates on projects, Industry Advisory Board meetings twice per year (required), and research updates via phone conference calls. P1 offered that within the last 12 months, his center had implemented more frequent updates on projects. He described their previous situation as one in which the industry members were uninformed until the very end of projects and the industry members perceived a “take it or leave it” sense from faculty as a result of having no industry involvement throughout. However, he said, with the new process trust can be built in the interim since industry members could present suggestions and interact actively throughout the project. Also, faculty did not have to struggle and wait for the end, but they had access to industry support sooner as concerns arose. Due to the new reporting structure, P1 said that industry members felt more at ease relying on faculty to adhere to project objectives.

P5 and P2 also mentioned frequent interactions with site directors through monthly phone conference calls with university site directors. P5 said he made it a priority to be involved in these calls.

Also, both P5 and P4 referred to the importance of face-to face interactions as time and resources allowed. The formal mechanism mentioned by all participants and required by NSF, is the Industry Advisory Board meeting, which occurs twice per year. P1, in fact, mentioned that it was within the business meeting at this formal setting that the IAB voiced their concerns about not having enough interaction and the recently implemented project updating schedule was designed to address the industry concern.

Within these formal meetings of the IAB, leaders also planned opportunities for informal interaction: adequate breaks, poster sessions, evening social activities, etc. P4, in particular described these interactions as opportunities to seek ideas and suggestions for improving the Center and also to gauge members' satisfaction with the Center. He explains, that the conversations reiterated that the members are integrated into the "communication pipeline" and that their ideas are respected and further that people cared about the concerns that were important to them. P2 explicitly cited similarly informal conversational opportunities as mechanisms for cultivating trust in partnership relationships.

Another item that was relevant to concrete, implementable action was simply to conduct quality research. P3 explained that high quality research, as measured by peer-reviewed publications, confirmed the credibility of the scientists that helps maintain trust. Another action described by P5 included following through with concerns that have been raised. He gave the example of setting up action items after a meeting and also maintaining meeting notes. He elaborated by stating that following up on action items through a good feedback communication loop was very important.

Finally, financial transparency was a priority for P6. He mentioned that sharing both pooled research budgets and operational budgets at the IAB meetings was an NSF best practice which was implemented in his center. He expressed his belief that being forthcoming and transparent with financial reporting averted potential concerns about financial misconduct. P1 shared a different approach from the industry perspective of simply trusting that the financial investments were returned by way of quality research outcomes.

Practices and customs for maintaining trust long term

P1 shared that there was not currently any industry monitoring of academic expenditures on research projects. He explained that industry had no reason to doubt the academic stewardship of finances so the custom they maintained in their Center excluded formal auditing of research expenditures. P3 spoke of the consistent practice of reaching consensus and moving on during decision making concerned with planning projects in alignment with the overall research agenda.

P4 maintained a focus in the Center on meeting the various needs of industry members over time. The needs of different companies in the Center could be divergent, so the Center Director tried to make sure that over time everyone had some specific needs that were met to maintain a belief that the Center was including their company's interests in the whole picture of the Center's interests.

P5 and P6 emphasized a practice of complete and open sharing of information as a top priority. P5 explained that information should flow seamlessly between the industry advisory board and the university sites. P5 and P6 summarized, in agreement, that open, upfront communication and transparency were critical for building and maintaining trust in their Center.

P4 emphasized a need to be attuned and responsive to the needs of the industry members. He explained that like any other situation, "...you have to talk to people...and ask them what it is they need or want from a situation..." He further explained that it's important to understand the motives for those needs and find an empathetic position – to "...get in their shoes..." P4 used an analogy of a successful negotiation in an enterprise that only happens through accounting for all players' needs as a similar example for the negotiation of needs of industry that was necessary for the cooperative research experience to be successful. Additionally, he referred to the formal annual meeting as a place to specifically voice concerns or satisfaction with the Center's progress. Similar to the example previously shared by P1 regarding the industry concern for insufficient engagement with academic participants, P4 had an ongoing concern that industry members vocalized some disillusionment with their investment and their expectations in terms of collaborative research. P4 intended to have more frank conversations with

the academics and even introduce some requirements in order to address this need. He articulated his anticipation that this responsive action will lead to more industry trust.

Awareness and mitigation of trust hindering practices

In considering what actions were taken to build trust, several leaders also mentioned the opposite consideration and referred to practices that hindered trust. As P1 mentioned the academic participants possessing independent financial managing practices, he also mentioned that monitoring them and holding them accountable to industry level of fiduciary standards would have been onerous for them and so they forewent them and chose to trust. P3 spoke of the inevitability of conflict from the frustrations of various members that was not a trust issue alone, but could indirectly affect trust if it was not dealt with prudently. P4 explained further that people were not always forthcoming with their real feelings and by not talking and addressing their feelings, the chances of “finding common ground” and therefore building trust would have been reduced.

P2 referred to IAB turnover as a disruption to trust building. He explained that whenever there was a new member, the current industry members had to rebuild previously established trust. P2 further explained that the key to mitigating this was consistent interaction to cultivate relationships and to anticipate and absorb the potentially negative effects of turnover.

Similarly, when P4 was explaining the need to understand and meet the needs of members in the Center, he also mentioned the negative perspective that if someone always lost or did not have their needs consistently met, they were not going to trust that the Center was looking out for their interests and would likely not continue their membership. P4 mentioned the challenge of having a large center to run and the difficulty in maintaining one-on-one relationships. His previous center was smaller and he could visit sites and retain one-on-one relationships with site directors as another way of being aware of meeting members' needs.

Finally, P5 and P6 emphasized transparency and openness in communication as key to building trust but they also further explained that transparency and openness were important to avoid concerns and deflect ideas of “misallocating funds” that could lead to an overall sense of distrust.

5.1.5 Final Phenomenological Description: The Role of Trust in UIRPs

The final procedure in this phenomenological study involved the researcher interpreting the “essence” of the phenomenon focusing on the common themes of the participants in the form of a descriptive passage (Creswell, 2013). In addressing the overarching research question, “What is the role of trust in UIRP performance?” the leaders’ lived experiences indicated that:

- 1) Trust directly and indirectly enables positive performance behaviors and outcomes in UIRPs, and
- 2) Trust requires intentional, two-fold management which includes practicing behaviors that develop trust and mitigating circumstances that hinder trust.

Table 5-5 below maps themes from the composites above into the categories of the final comprehensive description.

Table 5-5: Categorical mapping of thematic clusters

Trust directly and indirectly enables positive performance behaviors and outcomes:	
Ability to initiate challenging discussions	
Transparent/open information sharing	
Ability to efficiently recruit and retain membership	
Positive research performance outcomes	
Trust requires intentional, two-fold management:	
<u>Build and maintain trust through:</u>	<u>Mitigate threats to trust such as:</u>
Long term relationships	Academia and Industry differences
Consistent, interactive engagement	Competitive Environment
Being responsive and meeting needs	Representative Turnover
Deeper levels of engagement	
Transparent/open information sharing	

Trust directly and indirectly enables positive performance behaviors and outcomes

The experiences shared by the leaders indicated that trust plays an enabling role in UIRP performance. They described trust as enabling positive behaviors like having candid and pointed conversations. P1 describes a sufficient level of trust in the partnerships, by which academic and industry participants were able to initiate challenging discussions, address concerns, and constructively work through conflict toward positive outcomes. The situation of an academic researcher group challenging an industry research team on an analysis and the situation of industry “complaining” about being ill-informed about project progress were both shared by P1 in the context of the trust they had among members, that enabled them to have candid conversations. For example, he shared:

“...there was enough trust...that when we were challenged, we went back, ... and looked at the analyses themselves and found the problem there and redid them.... ultimately they were correct because of the trust that we had between the various parties accepting that they were free to challenge us and that we would be responsive to that challenge.” (P1)

P4 explained that if some tough conversations do not happen where a leader gains understanding of the needs of members, that the “...chances of finding common ground are vastly reduced...” He was planning test this principle and rely on the foundation of trust in his center to enable to him to make a demand for greater collaborative proposals. P5 also referred to trust as enabling the Center Director to share information, including potential difficulties and challenges facing the Center:

“I think there was a complete transparency when it came to updating us ...[our Director] was very good at sharing information with the industry advisory board and reporting progress, identifying difficulties, potential difficulties down the road ...I think to me those are good examples of trust and building that trust over the years.”

Trust was also described as an enabler of membership recruitment and retention. At the formation of his center, the potential site directors trusted that P4 would look out for their interests and not just his own. Later as the Center was going through a time of attrition, P4 shared how some members of his Center members trusted in him and remained with the Center during a time of attrition “...out of trust

loyalty to [him].” P6 shared a statement that could serve as a summary for the enabling property of trust to with respect to performance: “...there’s a lot of aspects of trust that play into at least everything working well and keeping people coming back to the Center which working well and coming back to the Center are probably at least two aspects of performance.”

P2 described the role of trust in the Industry Advisory Board as enabling beneficial research agendas with high quality research results:

“I have had a great deal of trust in the technical expertise of the advisory board and that trust has worked well for me. I could easily go off and study different topics that are not quite in alignment and if I did that of course the industry members would leave, but staying within their guides and trusting their understanding of critical details has been very fruitful for me...”

P1 shared that the academic researchers were spared an onerous task of meeting industry standards of financial reporting because of industry sponsors’ choice to trust in their stewardship:

“...it is evidence of a level of trust because I think meeting standards would be onerous, definitely onerous for companies, ...and they’d be onerous for professors, because they are pretty demanding standards, but I am sure the membership, so the corporate members all believe that the PIs are using the finances prudently or appropriately and nobody is taking vacations to Hawaii or anything like that as a result of getting a grant from the Center. So there’s a level of trust that the money is being spent properly.”

The leaders’ expressed experiences of trust enabling behaviors that positively affect partnership performance.

Trust requires intentional, two-fold management

Building and Maintaining Trust

In addition to sharing experiences about how trust related to performance, the participants were asked to describe actions they practice in their centers that they attribute to building and maintaining trust in the partnerships. P2 and P3 agreed that the development of long term relationships were essential to

building trust. P3 spoke of how the relationships that were already present at the formation of the center and therefore trust was also already present:

“...most of the scientists that work with this program have been long time colleagues of mine... So there’s none of these scientists that I don’t trust... so trust and mutual respect and relationship were there when this center actually started...”

P2 viewed the trust building process as a natural consequence of people who are engaged in work toward a common goal:

“...what I’ve observed the best way to develop trust is just a cultivation of relationships over time. So with time as the same folks are working together towards a common goal, I find, I observe that trust builds naturally with engagement, with a continued relationship”

P4 as well emphasized the importance of consistent engagement as an ongoing process to maintain trust in the Center. He shared the following story where he realized that his active engagement made a difference in sustaining a previous version of the center:

“I made a habit during all those years of visiting every company, individually, on their site for at least a day... developed personal relationships with those people – got to know those companies and could at least try to be helpful in their individual programs...And in fact the last year that that program was going ... I did not have an opportunity to visit them on site because I had other duties and when we all got together, just that one year of absence, we all agreed then that it was time to end that program. So, you know to me that pointed out the importance of the personal relationships...”

P5 shared the importance of striving for deeper levels of engagement and shared the following ways his company did so with increasing the academic partners’ visibility in his company:

“I think there was a really good sharing of the impact of the work and involving [University] in some of the update reports and involving them in some of the discussions with [my Company] management....I think that again is an example of how you build trust within the framework of a

project. Making sure you give the right level of visibility and also you share information accordingly.”

P5 also shared how impactful it was for him as an industry advisor to be invited to participate in the vision formation of the center through attending a leadership retreat with the academic leaders:

“...the way I look at it...it’s really the fact that [the Director] thought it was important for the industry advisory board to be represented at this meeting. Right there it sent me a very strong message that,...[the Director] was very serious about making sure the IAB was involved and [the Director] was very serious in involving the IAB in the definition in the vision for [the center]....”

The invitation to the retreat was viewed as an extraordinary level of involvement that P5 shared as an example of trust in action in his center.

P4 shared the importance of making a habit to understand and meet members’ needs as a method for maintaining trust in the center:

“...that’s where the trust really comes in. If someone loses every time, they’re not going to have trust. But if people get to win sometimes, ...then they will hang in there and have trust that this [Center participation] is a worthwhile endeavor and they should keep supporting it because maybe next time they’ll get exactly what they need.”

At the same time, P4 understood that it was also critical that academics be responsive to the needs of industry to build trust. He shared about a change that he was going to require for more collaborative proposals among the academic researchers:

“And frankly, I think, if we can start to make a real push in this direction, we’re gonna earn a lot more trust of the IAB as well. Because I’ve heard from a number of them that ‘when we pulled this thing together, ...it sounded so great...but wouldn’t it be great if we could really do some of this more collaborative research?’”

Transparency and openness with information sharing were critical to maintaining trust in a center. P5 attests:

“I think first and foremost, you know, complete and open sharing of information...I think having that open communication is absolutely critical and is a key part of the trust.”

Trust could be established through long term investments in relationships over time and it could also be built and nurtured in partnerships through both specific consistent engagement practices like regular project updates. Additionally, trust could be deepened through more intimate levels of engagement.

Mitigate threats to trust

There were some factors and situations that emerged in the conversations with leaders that they perceived as hindering to building trust. P2 spoke of the natural tendencies of both academe and industry to distrust each other based on their respectively different environments:

“...I think there’s a natural tendency of both groups, scientists in industry and scientists in academia to have some degree of distrust because they understand that they operate in such different environments... And then it takes interaction and cultivation of these two groups when they come together to learn about each other and to learn to develop a sense of trust.”

It was interesting that P2 added to this explanation of a hindrance an assurance that it could be overcome by interaction and cultivation – the same concepts others highlighted as methods for building and maintain trust above.

Another factor that may have been true in some partnerships was a competitive environment. While competition was possible with industry members, it more likely to occur among academics in this partnership context. In describing the differences in industry trust and academic trust, P6 explained:

“I think industry people... don’t tend to have direct competitors in our Center and so...I think they all trust each other in the sense that they don’t rely on each other...” [But,] “...there’s a little bit of competition among [academic researchers] for funds and there’s a little of competition overall in terms of the intellectual property idea space, so, yeah, I think the industry people probably trust each other more than the academics do.”

P1 corroborated the notion that the presence of competitors made it more difficult to openly share information than when competitors were not present:

“Where our consortium differs from other consortia that I’ve actually participated in is some of [our] competitors are members, right, so we have to be a little circumspect about what we say at these meetings,”...compared with Centers without competitors...you could be freer about talking about the impact of any particular piece of work on your own business because you knew that none of your competitors were there.”

P6 shared a situation related to membership recruitment that might hinder trust. He shared the situation in the context of sharing a mechanism to mitigate the effects of the competition and encourage collaboration with member recruiting:

“So, you know, there has to be a lot of trust in each other that we’re not going to try to steal companies that sign up at one school and try to bring them to another school so you have to police that and we do that through our mechanism... to make sure that other sites are aware...and that there’s not an issue of people running into each other or competing against each other when they should be collaborating.”

In this case, there was not a direct relation with trust being hindered by competition, rather, one could have observed the property of trust again as an enabler in that while competition could hinder collaboration, trust could enable collaboration.

Another situation that occurred in partnerships was industry membership representative turnover. P2 explained that the turnover itself was “not a trust issue” for academics, but that the turnover situation could be disruptive to in-progress trust building practices:

“For instance if one company changes their representatives that they’ve sent. And that can be disruptive because you have to bring the whole group back to a common level. That’s not really a trust issue. There you have to trust that the advisory board as a whole can handle the influence of new people and that the new people, their interests may deviate significantly. And it could cause a huge change in the research agenda, right in the middle of the effort, and you have to trust that the advisory board recognizes this...”

Continuing the conversation, P2 made a more direct link of turnover to trust and offered a method to again mitigate the effects turnovers may have on trust:

“...And in that regard, the turnover of the industry advisory board members is very important. Because if there is a sudden turnover then you have to start all over again- build trust with company. So perhaps a key element is just consistent interaction, cultivation of relationship over time. And trying to anticipate and absorb the negative effects of turnover on the industry advisory board.”

Again, even in discussing a potential hindrance of trust, the leaders were hopeful about the method of relationship cultivation in particular to be helpful in overcoming negative effects of the hindrances.

P5 used the phrase “trust but verify” to explain the importance of following through with intentions by warning that if one did not follow up and take action on intentions, then trust could be lost:

“...we use the expression “trust, but verify”... Verify that when we say we’re going to do something that something actually ends up happening. There needs to be that follow up that is actually critical in a Center... ‘Cause if you keep raising issues and if there is no follow up behind that, very quickly you are going to lose that trust...”

P6 described ways that he was proactive as a leader by being personally transparent and fostering transparent practices throughout the partnership organizational environment. He specifically described how transparency made a difference in the Center’s effective membership recruitment:

“You know, we’ve never had any kind of misunderstandings along those lines [member recruiting overreach resulting in confusion and potential member recruit loss] and I think part of that is that we try to be as open and as visible as possible on the directors’ side. So I do think that there are some instances in that regard where we’ve had a particular company that we’ve recruited from a bunch of different angles and that’s worked out okay and not get us into trouble and I think the visibility and how up front we are about it probably makes the biggest difference.”

P6 also shared an example with regards to financial management of projects. Being proactively transparent could alleviate concerns of misallocation which could arise if industry members were not given adequate information:

“... being transparent with regard to the financial aspects...Those are things I think you have to do to make sure that the companies not only you know, see that and don't get concerns related to trust that you're misallocating funds...”

The leaders shared methods ways that trust could be hindered. Their responses remained optimistic in terms of the methods to build trust being useful in mitigating the effects of the situations and factors might hinder trust building efforts.

Trust has the role of enabling behaviors that positively affect partnership performance. The leaders of the centers provided examples of behaviors attributed to building and maintaining trust directly and indirectly and also on a continual basis. Also leaders were aware of the need to mitigating affecting of situations that might hinder trust and even to combat the effects with the same methods used to build and maintain trust. The academic and industry leaders were able to articulate ways that they were intentional about building trust and that it had been beneficial for them to trust in each other.

5.2 Trustworthiness

Peer Examination

The researcher conducted two peer examination sessions with a colleague familiar with qualitative research in the Engineering Education Department. In the first session the researcher presented the logistical procedures of horizontalization that included acquiring the significant statements from the transcripts and transferring and organizing the data from Atlas TI ® into an Excel ® file for further analysis. The researcher presented then explained the process of developing meaning units and gave some examples of the preliminary clustering categories. Then the researcher also presented the participant summaries that were developed from the meaning units and were subsequently presented to the interview participants for member checking. The examiner judged the procedures to be sound and

well documented. The examiner assisted the researcher in delineating the procedures that conclude with composite descriptions from the procedures that concluded with member checking. The researcher and peer examiner scheduled to meet one more time to examine the final composites and to examine the audit trail for the qualitative analysis.

Prior to the second peer examination meeting, the researcher asked the examiner to read over the qualitative results dissertation chapter draft and shared access to the analysis documents so that the examiner can assess how well the trail for the analysis could be audited. Upon reviewing the material, in the follow up meeting, the examiner provided critical feedback notes and suggestions to the researcher. A summary of the feedback and the researcher's response were:

Feedback: The examiner was unclear about how the researcher actually formulated the meaning units from the significant statements. She was unclear of what criteria the researcher used to determine whether or not there was a complete meaning unit for clustering.

Response: The researcher first realized that the labels of the inputs and products of each step in the phenomenological procedures were not consistently labeled. After clarifying and reconciling the input and product labels, the researcher explained that in the process of transferring the meaning units from Excel ® to Word ® in preparation for clustering, the researcher had the need to contextually clarify the meaning units in order to cluster the meanings effectively. Therefore, the following suggestion was made and then implemented to address this feedback: Consider constructing a diagram so that a reader can better see the entire flow of the practical steps, inputs, and products for the phenomenological analysis.

The diagram is reflected above in Figure 5-1.

The minutes from the peer examination meetings are included below in Appendix I.

Member Checking

The researcher attempted to contact the six interview participants in order to conduct a member check of the interview data analysis. Five out of the six participants were contacted via email. The sixth had an invalid email and the researcher received a “message failed” notice. The researcher shared the summary with the other five participants and requested their feedback regarding the accuracy, clarity, and confidentiality of their statements. The researcher allowed two weeks for participants to respond with their feedback with a reminder after one week.

All five of the participants responded within the allotted timeframe. Three participants were very pleased with the accuracy and had no edits. The other two respondents had a few clarifications of their personal descriptions and provided minor corrections. The member checked, corrected participant summaries are included in Appendix J below.

5.3 Qualitative Analysis Summary

A phenomenological approach was taken in this study of trust in partnership performance from leadership perspective. In this case, the data included voices of both academic and industry participants in UIRPs that sets this study apart from most previous studies in this context (one notable exception is Mora-Valentin, Montoro-Sanchez, and Guerras-Martin, 2004). The experiences of the leaders indicated that trust directly and indirectly enables positive performance behaviors and outcomes in UIRPs, and that trust requires an intentional, two-fold management process that includes practicing behaviors that develop trust and mitigating circumstances that hinder trust. The leaders consistently shared that “because of trust...” they were able to openly share information and to build relationships. These two activities are critical performance components of maintaining a healthy, long term collaborative research partnership.

Chapter 6: Merged Results and Conclusions

The purpose of this dissertation research was to conduct an empirical investigation of the role of trust in university-industry research partnership performance. The convergent parallel mixed methods research design was utilized in order to more holistically describe the role of trust by combining quantitative and qualitative methods of inquiry. This concluding chapter presents the results of corroborating the findings from the independently conducted quantitative and qualitative studies and delivering a holistic description of the role trust plays in UIRP performance. The chapter begins with summaries of the quantitative and qualitative studies, then presents a merged interpretive discussion of the findings from both. The chapter concludes with specific recommended guidelines for building trust in UIRPs, limitations of this study, and future work.

The overarching question for this research was:

What is the role of trust with respect to university-industry research partnership performance?

The related sub-questions that were addressed:

RQ1: How does trust relate to UIRP performance?

RQ2: How does trust from academic participants compare with trust from industry participants?

RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?

Table 6-1. Summarizing results from each study in terms of RQs

Research Questions	Quantitative Study	Qualitative Study
RQ1: How does trust relate to UIRP performance?	The correlation analysis between trust climate and partnership performance resulted in a statistically significant, positive relationship, $r(78) = .62, p < .01$ (two-tailed)	Trust enables partnership participants to initiate difficult discussions/concerns and work through conflict. Trust also enables participants to efficiently recruit/retain membership. The quality of communication and membership retention are two key aspects of UIRP performance.
RQ2: How does trust from academic participants compare with trust from industry participants?	The results of an independent samples t-test indicated that the means did not differ significantly, $t(76) = -0.92, p = .361$, two-tailed. The mean trust climate scores: Industry ($M = 5.28, SD = 0.68$) Academic ($M = 5.43, SD = 0.66$)	Mixed results: Most agreed there is no fundamental difference between trust, but, some leaders attributed the perceived differences to the diverse roles played by academic and industry participants. Some also attributed to the differences to the different environments that industry and academe tend to operate.
RQ3: What collective action might partnership participants take to build and maintain high levels of trust and performance?	Three of the four teaming discipline-trust climate mediation models - operating with a meaningful purpose, following common goals, and joining in mutual accountability of partnership outcomes - yielded results consistent with support for partial mediation.	In order to build and maintain trust, the leaders recommended focusing on: <ul style="list-style-type: none"> - Cultivating long term relationships through consistent interaction and deeper levels engagement. - Being responsive and meeting needs of participants - Being transparent and practicing openly sharing information

6.1 Quantitative Study Results Summary

The correlation analysis between trust climate and partnership performance was conducted and yielded a statistically significant, positive relationship, $r(78) = .62, p < .01$ (two-tailed). In comparing the trust climate scores for industry and academic participants, the results of an independent samples t-test indicated that the means did not differ significantly, $t(76) = -0.92, p = .361$, two-tailed. The mean trust climate score for the industry participants ($M=5.28, SD=0.68$) was not significantly different from the trust climate score for academic participants ($M=5.43, SD=0.66$). Finally, mediation analysis was performed in this study to explore interventions which might positively impact trust climate in a partnership and ultimately, positively impact partnership performance. Three of the four teaming discipline-trust climate mediation models - operating with a meaningful purpose, following common goals, and joining in mutual accountability of partnership outcomes - yielded results consistent with support for partial mediation. The fourth teaming discipline, approaching work in an agreed upon manner, yielded a result that was not consistent for mediation.

6.2 Qualitative Study Results Summary

Trust enabled certain behaviors that directly related two aspects of partnership performance – quality communication and membership recruitment and retention. There was a mixed response regarding the differences in academic and industry trust. Some leaders felt there was no difference, but attributed behaviors that might look different to the tendencies of academe and industry to operate in certain roles related to their different respective normal operational environments. Finally, the leaders shared a variety of methods they practice in their centers for building and maintaining trust. The most prevalent practices were: focusing on cultivating long term relationships through consistent interaction and deeper levels of engagement; being responsive to meeting the needs of the industry members; and practicing transparency and openness with sharing information. The experiences of the leaders indicated that trust directly and indirectly enables positive performance behaviors and outcomes in UIRPs, and that trust requires an intentional, two-fold management process that includes practicing behaviors that develop trust and mitigating circumstances that hinder trust.

6.3 Merged Interpretive Discussion

While the scores utilized in assessing the trust climate in the Center were limited in ability to quantify the level of trust climate descriptively, it could be reasonable that on a 7- point interval scale, where 0 represents the lowest level of trust and 7 represents the highest level of trust, that an average trust climate score over 5 would indicate a relatively high level of trust and high performance. This was the case for all of the centers in the quantitative portion of this study. This finding was corroborated in the qualitative section in that everyone described positive levels of trust and had positive assessments of performance.

In the quantitative study, there were no significant differences in the trust climate scores between academic participants and industry participants. A limitation became apparent while interpreting the phrasing of this question by a leader during his interview. The researcher failed to specify the trustors and trustees when asking this question and P6 made it clear that it could be interpreted as trust among industry members compared with trust among academic participants as well as it could have meant academics trust of industry members or industry members' trust of academic participants and he responded to both situations. P3 and P4 asserted that there was no difference fundamentally, and P3 further explained that trust may look different due to the different roles that academics play in the partnership.

In the quantitative study, the actions tested toward building trust were limited to four actions associated with teaming discipline. Three of the four models supported partial trust mediation between the action and partnership performance. There were four other actions which emerged from the qualitative analysis and these are presented in conjunction with the teaming discipline actions in a set of seven empirically-based guidelines for building trust to positively impact UIRP performance:

- 1) Agree upon and commit to a meaningful purpose.** The mediation analysis yielded results to support that trust climate partially mediated the relationship between partnership participants' development of and commitment to a meaningful purpose, and partnership performance. The

indirect effect of having a meaningful purpose on partnership performance through trust climate was significant, $b=.241$, BCa CI [0.02, 0.55]. The effect size, $\kappa^2= .19$, [.03, .36] represented a relatively (L M S) effect. Katzenbach and Smith (1993) explained that when teams expend effort and focus on shaping a purpose that is meaningful, they develop momentum in the process to perform in a unified strategic direction. When asked about the purpose, there was general agreement among the leaders of the UIRPs in this study that the purpose of the centers was to partner academia and industry in conducting fundamental research to enhance or sustain their respective scientific area. The agreement by the leaders along with the positive indications of trust and performance in the centers qualitatively corroborate the positive relationships indicated in the mediation analysis.

- 2) **Set common goals to accomplish the purpose the partners have agreed upon.** The mediation analysis yielded results to support trust climate was partially mediating the relationship between establishing common goals and partnership performance. The indirect effect of establishing common goals on partnership performance through trust climate was significant, $b=.288$, [0.08, 0.62]. The effect size, $\kappa^2= .24$, [.07, .41] represented a relatively (L M S) effect. According to Katzenbach and Smith (1993) teams should derive specific and measurable goals from the broadly defined common purpose. P4 emphasized the importance of seeking commonly important goals in prioritizing the Center's research activities. He explained that this action involved understanding the needs of members and that the action was a way to build trust.
- 3) **Assume mutual accountability for accomplishing the common goals.** The mediation analysis yielded results to support that trust climate was partially mediated the relationship between assuming mutual accountability for accomplishing the partnership goals and partnership performance. The indirect effect of assuming mutual accountability on partnership performance through trust climate was significant, $b=.283$, [0.13, 0.49]. The effect size, $\kappa^2= .27$, [.13, .42] represented a relatively (L M S) effect. Katzenbach and Smith (1993) described mutual accountability as a promise among team participants to hold themselves accountable for the

team's goals. According to Katzenbach and Smith (1993) this promise underpins the team's trust and commitment that are accepted as two critical aspects of teams. In UIRPs, the leaders described their intention to be mutually accountable for the research outcomes. One specific example was in the experience of P1, when academic researchers vocalized a challenge of some work that was conducted incorrectly by his company. He concluded his account of the story by illuminating that the academic and industry partners assumed accountability of the quality of the research and worked together to correct the problem. P1 shared this experience in response to a question about how he has seen trust has affect performance in the partnership.

- 4) **Establish and retain trustworthy leaders.** Trust in leadership was found to be a valuable basis to build inter-organizational trust in UIRPs. P3 and P4 in particular emphasized that their center was founded because members trusted in the leader. P6 was a leader who exemplified transparency and openness and was essentially proactively exhibiting his trustworthiness. These academic leaders' counterpart industry advisors noted that leadership trustworthiness was a pivotal trait with respect to the high levels of trust and performance they experienced throughout their partnerships. P3 described a prevalence of healthy relationships based on trust "[...from the director level] down through the team level."
- 5) **Establish formal and informal communication processes.** For formal communications, members should agree on the frequency and the modes of communication that will work best for their center. Leaders P2 and P5 articulated that regularly reporting on projects at a scheduled frequency with a formal milestone reporting mechanism was helpful in building trust throughout the project experience. Additionally, P4 in particular emphasized the need to schedule informal interactions to regularly gauge how the members felt about the Center and to reinforce their sense of inclusion in the Center through connecting with leaders informally. He explained that these offline conversations that occurred in informal settings were helpful for better understanding the needs of members in order to develop research agendas to meet their needs and ultimately build trust that enabled retention.

- 6) **Prioritize meeting the needs of industry members consistently.** When the process is in place for communication to flow, and then the leaders understand the needs, it is important to meet the needs consistently. As P4 explained, if the needs are met, then the members will trust that their interests are valuable in the Center, but if someone has needs that are consistently not met, then they will lose trust that the Center has their best interest as a priority. P5 described the formal process used in his center to ensure the needs discussed at meetings were translated into action items and then followed upon. He labeled the situation "...trust but verify..." and described the academic leader, P6, as an exemplary practitioner of this principle. P5 explained that P6 made sure that there were specific actions developed to address the needs of members and then these actions were documented and tracked to ensure that tasks associated with the action are implemented.
- 7) **Beware and plan to mitigate inhibitors of trust.** One theme that surprisingly emerged as a hindrance in a "collaborative" research partnership was a competitive environment. When competition among participants was a factor, sharing information became a risk that some were unwilling to take (P1). P6 described a formal mechanism for sharing information about membership recruiting that is perceived as a collaborative tool for academic researchers who may otherwise "compete" for members. Additionally, P6 specifically referred to his active transparency, especially in financial reporting, to be open so that he alleviated notions of distrust that could arise when information is seemingly withheld.

Also, while there were no specific solutions discussed, P2 referred to industry representative turnover as a disruption to trust building and described the notion that the industry advisory board had to be ready to bring new people into the center and re-establish common ground to ensure that they were also in agreement with an ongoing research agenda. There was an awareness and an intention to mitigate the potential hindrance

It is interesting that an "agreed upon work approach" wasn't supported in the mediation model; however, working together effectively was unanimously mentioned by leaders for what makes a center

successful. When leaders were asked what makes a UIRP successful most of them alluded in some way to the ability to leverage the complementarity of academe and industry:

“It’s really maintaining a high level of engagement [between academe and industry] throughout the project.” (P5)

“I think that the two sides bring very complementary assets to the table...you need a critical mass on both sides... a critical mass of university people, faculty and graduate students, that are engaged in the work and doing a lot of the work.” (P4)

“I need answers and they need research projects... if we can clearly identify the kind of questions we have in industry and let the scientist know and jointly kind of develop research projects...then they’re working on a credible effort and it’s something that I can use.” (P3)

“... the two organizations bring a great deal of valuable information to the other and it’s complimentary. So groups lack the information that the other one has, so when they come together it is very powerful if they work together effectively.” (P2)

Summarizing the leaders’ responses, success comes with effectively working well together and leveraging the complementarity of academics who desire rich research proposal ideas and bring a set of foundational knowledge and skills and industry who desire fundamental research and bring resources to accomplish the work. These empirically based guidelines are based on experiences of leaders of successful UIRPs. Their experiences indicated that by engaging one another and learning about one another through frequent interactions, they were able to cultivate trust-based relationships that are contributing to their respective partnership performance success.

Insight: Overall what is the role of trust in UIRP performance?

Foundational Role

Trust plays a foundational role in UIRPs. As the leaders explained, the relationships in the centers are based on trust - among participants and also, trust in the leadership - that underpin the centers. Inter-organizational trust can be considered constitutive of an inter-organizational network (Sydow, 1998). According to structuration theory (Giddens, 1990) trust can be both a medium and an outcome. Considering these theories in light of the UIRPs in this study, trust can be both initially present and built over time. However, there are different ways that is present as a medium and as an outcome. For example, P3 and P4 described their center as one that came into being because the potential members had trust in a leader. This leadership trust served as a foundation for the inter-organizational trust that developed over time in the context of engaging through the partnership. The relationship of trust as both medium and outcome is supported in this study, but there should be a distinction between the forms that trust assumed as a medium and outcome.

Transactional Role

Arrow (1974) specifically described trust operating as a “lubricant.” In this dissertation study, there was a significant positive relationship between trust and performance and there was also thematic support of the relations between trust and different aspects of collaborative performance in the accounts from the leaders. Revisiting trust’s enabling property in UIRPs, trust enables transactional flow – it enables flow of communication and enables knowledge sharing that are essential operational components in UIRPs. As P6 explained, “lots of aspects of trust...play into at least everything working well...” Trust in UIRPs plays a role in enabling collaborative transactions.

Reinforcing Role

In this dissertation study, trust climate was conceptualized and tested as a predictor variable for an outcome variable of partnership performance. There was a significant and positive relationship that means causality could be possible, but the relationship could also be one that is reinforcing: trust positively affects performance that reinforces a foundation of trust that enables more positive performance. Consider the findings as explained by P1 who explained that regular reporting practices can build trust and at the same time because of the level of trust they had, the members had challenging discussions. In this example, there was action that built trust and that principal amount of trust enabled positive performance action. Another consideration is that P2 perceived that trust was developed through interaction over time and P3 perceived that long term relationships had a wealth of trust that enabled effective interactions. In UIRPs, over time an atmosphere of openness where members can freely share information can begin with relationships where members share, but with this reinforcing characteristic, members can also begin to share and thereby build trust based relationships.

Returning to the operational definition of trust used in this dissertation study: "...the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control the other party" (Mayer, Davis, and Schoorman, 1995, p. 712), in UIRPs, vulnerability happens when information is shared across organizations. In the reinforcing role, trust essentially allows "safe space" in which members may be willing to be vulnerable in sharing information openly and enabling knowledge to flow effectively that relates to positive performance that was related to increased trust (P2).

6.4 Future work

Extensions to other types of partnerships

In this dissertation study, the perspective of improving partnership performance stemmed from the individual level with a focus on the socio-relational mechanism of trust. Therefore, the research

findings are transferable to many types of inter-organizational alliances in which academic persons interact closely with industry persons in related public and private partnership endeavors across many disciplines (e.g. construction management, healthcare). While this dissertation study was designed to investigate long-term university-industry collaborative research partnerships, there is a myriad of ways that academe and industry partner and collaborate. An ontological study of the various organizational structures might be a useful tool for researchers in academic-industry partnering to be able to clearly distinguish what components of partnerships are “universal” and what parts are unique. Universal topics can be studied with the aim to generalize broadly impactful findings while unique topics can be useful in improving and contributing to specific types of UIRPs. Additionally, this dissertation study was limited to an American perspective of partnerships. Future studies may consider an international comparison of university-industry alliances (e.g. Mora-Valentin et al., 2004; Eom and Lee, 2010; and Giuliani and Arza, 2009). Further, both academic institutions and industry organizations are diverse regarding size and resources, so future work should also consider how the heterogeneity of the organizations affects meeting the needs to adequately build trust in partnerships.

Considering Trust along with Distrust

This dissertation study focused on trust and how it works productively in partnerships, rather than what trust is essentially. An interesting extension would be to investigate how the participants perceive what the construct of trust is, rather than what it does. A study with this focus would more easily lend to a discussion of distrust alongside trust that is another consideration in this organizational context. In this study, the researcher referred to ways that trust is hindered from developing, but did not explore situations in which distrust might be destructive and how it may occur simultaneously and could be explored conjunctively (e.g. Kramer 1999; Bigley and Pearce 1998). Investigating this could generate valuable insight with implications for how trust and distrust could be perceived and measured.

Develop and test other plausible models

Two limitations of this dissertation study design were that it was cross-sectional and observational. These characteristics limit the ability of the researcher to infer causality. Future work might include a longitudinal study to investigate the potential causal relationships between trust and performance. “Also, UIRP stakeholders should be cognizant of the needs of both industry and academe that are subject to change over time and make sure that the purpose, goals, and work practices of the partnership continue to align with the potential changes that happen in organizations over time.”

Additionally, this dissertation study tested one type of mediation model. Future studies might consider expanding the model to include factors such as knowledge sharing and communication which emerged as important themes related to trust and performance in the qualitative analysis of this study. Continual developments in statistical software enable testing more complex models more easily. Future work should also consider Stakeholders in UIRPs. Additionally, both academic institutions and industry organizations are diverse regarding size and resources, so future work should also consider how the heterogeneity of the organizations affects meeting the needs to adequately build trust in partnerships.”

6.5 Conclusion

One interesting comment from an expert in the validation study was that the level of trust in UIRPs should not matter in technological commercialization:

“While trust is important, it is simply one factor in achieving the goal of successfully commercializing a technology. The aim is to achieve that goal regardless of the level of trust (or despite the level of trust).” - Expert Panelist 5

The researcher would argue that, while it may be true that the goal of successful commercialization might be achieved with or without trust, the goal might not be achieved as efficiently or sustainably. Further, in this dissertation study, the focus has been on long-term partnerships with goals that are broader than the singular aim of commercializing technology.

The relational aspects of inter-organizational partnerships have been largely neglected in empirical studies, but anecdotally critical to organizational and inter-organizational performance success. This study served as an empirical investigation of the role of trust from a relational perspective in the context of UIRP performance. The findings align with previous studies of the importance of inter-organizational trust in partnerships (e.g. Zaheer et al., 1998; Santoro and Saporito, 2003; Bruneel et al., 2010). These studies left future researchers to investigate why trust matters and how it might be managed in an inter-organizational context.

The current study adopted a relational perspective for investigating methods by which industry and university partners might strengthen the connection points between them and reduce barriers to joining through focusing on the role trust plays in UIRP performance. The study implies that if the partnership participants intentionally implement a two-fold management strategy for trust: building trust through regular interactions and meaningful engagement and mitigating factors that hinder trust, then participants can be confident that they are strengthening the connection points between them and positively impacting the innovation ecosystem in the U.S.

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Appendix A – Informed Consent and Questionnaire Items

Opening Page:

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants in Research Projects Involving Human Subjects

Title of Project:

The Role of Trust in University-Industry Research Partnership Performance

Investigator: Lynette Wilcox, Industry and Systems Engineering Graduate Student

Advisors: Brian M. Kleiner, PhD., Lisa D. McNair, PhD.

PURPOSE OF PROJECT

The purpose of this research is to examine the relationship between trust, teaming discipline, and performance in university-industry research partnerships.

PROCEDURES

You will be asked to complete a secure, online questionnaire. You will be asked to read and agree to the informed consent form for this study. Once the informed consent form is completed, you will be directed to a questionnaire that will ask information about trust, teaming discipline, and performance in your experience as a participant in a university-industry research partnership. Additionally some general questions regarding your partnership affiliation will be included. It is expected that completion of the questionnaire will take approximately 20 minutes.

RISKS

Participation in this project does not put you at more than daily risk.

BENEFITS

Your participation in this study is voluntary. It will help gain an understanding of the relationship between trust, teaming discipline, and performance. It is expected that understanding this relationship will help improve relationships, and thus performance, in university-industry research partnerships.

CONFIDENTIALITY

The results of this research will be kept strictly confidential. The questionnaire will be anonymous including only a code to identify the partnership group. Data will be stored securely

and will be made available only in the context of research publications and discussion. No reference will be made in oral or written reports, which could link you to the data, nor will you ever be identified as a participant in this project.

FREEDOM TO WITHDRAW

You are free to withdraw from this study at any time without penalty.

APPROVAL OF THE RESEARCH

This research has been approved by the Institutional Review Board for research projects involving human participants at Virginia Polytechnic Institute and State University. A copy of this form will be provided to you.

PARTICIPANTS' RESPONSIBILITIES

It is important that you keep the activities and information discussed confidential, since others will be participating in the research.

CONTACT

If you have questions at any time about the project or the procedures, you may contact:

Lead Investigator:	Lynette Wilcox Graduate Student, Grado Department of Industry and Systems Engineering Email: lywilcox@vt.edu Phone: _____
Faculty Advisors:	Dr. Brian M. Kleiner Professor, Grado Department of Industry and Systems Engineering Email: bkleiner@vt.edu Phone: (540) 231-4926
	Dr. Lisa McNair Professor, Department of Engineering Education Email: lmcnair@vt.edu Phone: (540) 231-1144

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant have been violated during the course of this project, you may contact Dr. David Moore, Chair of the Institutional Review Board Research Division at 540-231-4991.

PARTICIPANT'S PERMISSION

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

CLICK "I agree" button [must agree before accessing the survey]

Beginning of Survey:

Consider what level of your university-industry partnership interactions most influence your perceptions of trust - for example, Center level, site level, or project team level. Please respond to the questions based on your experiences with academic and industry members at this level."

Which one of the following best describes your role in the partnership?

- **University/Academic Participant (non-student)** who works directly with an industry/government member participant in a research partnership

- **Industry/Government Member Participant** who works directly with a university/academic participant in a research partnership

- **Student Participant**

Please indicate your level of agreement with the following statements:							
TRUST							
Propensity to trust	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
1. Most people in this partnership do not hesitate to help a person in need.							
2. In this partnership most people speak out for what they believe in.							
3. In this partnership most people stand behind their convictions.							
4. The typical person in this partnership is sincerely concerned about the problems of others.							
5. Most people will act as "Good Samaritans" if given the opportunity.							
6. People usually tell the truth, even when they know they will be better off by lying.							
Perceived trustworthiness	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
7. In this partnership people can rely on each other.							
8. We have complete confidence in each other's ability to perform tasks.							
9. In this partnership people will keep their word.							
10. There are some hidden agendas in this partnership. (r)							

11. Some people in this partnership often try to get out of previous commitments. (r)							
12. In this partnership people look for each other's interests honestly.							
Cooperative behaviors	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
13. In this partnership we work in a climate of cooperation.							
14. In this partnership we discuss and deal with issues or problems openly.							
15. While taking a decision we take each other's opinion into consideration.							
16. Some people hold back relevant information in this partnership. (r)							
17. In this partnership people minimize what they tell about themselves. (r)							
18. Most people in this partnership are open to advice and help from others.							
Monitoring behaviors	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
19. In this partnership people watch each other very closely.							
20. In this partnership people check whether others keep their promises.							
21. In this partnership most people tend to keep each other's work under surveillance.							
TEAMING DISCIPLINE	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
Truly meaningful purpose							

22. In this partnership, we have a broad, meaningful purpose that all members aspire to.							
23. The purpose of the partnership constitutes a broader, deeper aspiration than just near-term goals.							
24. The partnership's purpose is a broader organizational purpose. (r)							
25. The partnership's purpose is just one individual's purpose (e.g., the leader) (r)							
26. All members of the partnership understand the purpose the same way.							
27. All members of the partnership articulate the purpose the same way.							
28. Members define the purpose vigorously in discussions with outsiders.							
29. Members frequently refer to the purpose.							
30. Members frequently explore the implications of the purpose.							
31. The purpose contains themes that are particularly meaningful.							
32. The purpose contains themes that are memorable.							
33. Members feel the purpose is important.							
Specific goal or goals	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
34. In this partnership, we have a specific set of partnership goals that members have agreed upon.							
35. The partnership goals are broader organizational goals.							
36. The partnership goals are just one individuals's goals (e.g. the leader's).							
37. The partnership goals are clear.							
38. The partnership goals are simple.							
39. The partnership goals are measurable.							
40. The partnership goals are realistic as well as ambitious.							

41. The partnership goals allow small wins along the way.							
42. The partnership goals call for a concrete set of partnership work-products.							
43. The partnership goals relative importance is clear to all members.							
44. The priority of partnership goals is clear to all members.							
45. All members agree with the goals.							
46. All members agree with the relative importance of the goals.							
47. All members agree with the way in which goal achievement will be measured.							
48. All members articulate the goals in the same way.							
Clear working approach	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
49. In this partnership, we have a clearly understood and commonly agreed upon working approach.							
50. There is a concrete working approach.							
51. There is a clear working approach.							
52. The working approach is really understood by all members of the partnership.							
53. The working approach is agreed to by all members of the partnership.							
54. The working approach will result in achievement of the objectives.							
55. The working approach will capitalize on the skills of all members.							
56. The working approach will enhance the skills of all members.							
57. The working approach is consistent with other demands on the members.							
58. The working approach requires all members to contribute equivalent amounts of real work.							

59. The working approach provides for open interaction.							
60. The working approach provides for fact-based problem solving.							
61. The working approach provides for results-based evaluation.							
62. All members of the partnership articulate the approach in the same way.							
63. The working approach provides for modification over time.							
64. The working approach provides for improvement over time.							
65. Fresh input and perspectives are systematically sought and added to the working approach.							
Sense of mutual accountability	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
66. In this partnership, we are individually and mutually accountable for the partnership's collective results.							
67. I am individually accountable for the partnership's purpose.							
68. I am jointly accountable for the partnership's purpose.							
69. I am individually accountable for the partnership's goals.							
70. I am jointly accountable for the partnership's goals.							
71. I am individually accountable for the partnership's approach.							
72. I am jointly accountable for the partnership's approach.							
73. I am individually accountable for the partnership's work-products.							
74. I am jointly accountable for the partnership's work-products.							
75. The partnership can measure progress against specific goals.							
76. The partnership measures progress against specific goals.							
77. All members feel responsible for all measures.							

78. The partnership members are clear on what they are individually responsible for.							
79. The partnership members are clear on what they are jointly responsible for.							
80. There is a sense that “only the partnership can fail.”							
PERFORMANCE	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
81. Partnership members meet or exceed productivity requirements.							
82. Partnership members are committed to producing quality work.							
83. Partnership members have successfully implemented ideas to reduce costs.							
84. Generally speaking, partnership members are very satisfied with their work.							
In the time of your experience with the partnership, how satisfied are you with the following:	Completely Dissatisfied	Mostly Dissatisfied	Somewhat Dissatisfied	Neither satisfied nor dissatisfied	Somewhat Satisfied	Mostly Satisfied	Completely Satisfied
85. Timeliness of results							
86. Knowledge sharing							
87. Return on investment							
88. Overall Performance							

Appendix B – Invitation Letter to Experts

Dear (*Expert Name*):

I hope this letter finds you well. My name is Lynette Wilcox (*or, As you may recall*), I am working to complete my doctoral program requirements in Industry and Systems at Virginia Tech. My dissertation, entitled “The Role of Trust in University-Industry Research Partnership Performance,” is a study designed to examine the relationships between the variables trust, teaming discipline, and performance in university-industry research partnerships. I have arrived at the time of my dissertation study where I am preparing to collect data through a survey protocol and I am seeking expert participation in my preliminary questionnaire validation process.

Based on your experience working with UIRPs, I have identified you as an expert and I am asking for your participation in this preliminary phase of my research study. I plan to invite academic and industry participants in university-industry research partnerships (UIRPs) to respond to a questionnaire containing statements about trust, teaming discipline, and performance based on their experiences as participants in UIRPs. Before administering the questionnaire to them, I would like to perform a content validity assessment utilizing feedback from experiential experts in UIRPs, such as you.

In this phase of the study, you will be asked to assess the relevance of each item of a questionnaire to the context of university-industry research partnerships. Each item includes a scale rating for relevance and a space where you may provide comments and offer clarifying or rewording suggestions, if you feel so inclined. Please do not respond to the items as a participant, only utilize the response options to indicate a level of relevance for each item in the context of UIRPs. The questionnaire validation survey is administered online utilizing a secure website. Upon clicking on the link provided, you will be directed to an informed consent form. Once you acknowledge reading and receipt of the form, you will be directed to the questionnaire validation survey. I anticipate the process will take approximately 30-45 minutes.

The results of this research will be kept strictly confidential. Your responses will remain strictly confidential. Data will be stored securely and will be made available only in the context of research publications and discussion. No reference will be made in oral or written reports, which could link you to the data, nor will you ever be identified as a participant in this project.

Your participation is voluntary. If you would like to participate, please click on the link below, read and acknowledge receipt of the informed consent and participate. Please submit your response no later than (*insert date 7-10 days after this invitation*). Please utilize the following participant to log in: “Expert code”

Expert Validation Questionnaire: https://www._____

If you have any questions now or at any time during the survey, you may contact me, Lynette Wilcox, at lywilcox@vt.edu.

Sincerely,

Lynette F. Wilcox, M.S.
Doctoral Candidate, Industry and Systems Engineering, Virginia Tech
Email: lywilcox@vt.edu Phone: _____

Appendix C – Expert Validation Informed Consent form and Protocol

Opening Page:

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY Informed Consent for Participants in Research Projects Involving Human Subjects

Title of Project:

The Role of Trust in University-Industry Research Partnership Performance

Investigator: Lynette Wilcox, Industry and Systems Engineering Graduate Student

Advisors: Brian M. Kleiner, PhD., Lisa D. McNair, PhD.

PURPOSE OF PROJECT

The purpose of this research is to examine the relationship between trust, teaming discipline, and performance in university-industry research partnerships. This phase of the project involves an expert validation process of the content of the questionnaire.

PROCEDURES

You will receive an email invitation and will be asked to complete a secure, online questionnaire. You will be asked to read and agree to the informed consent form for this study. Once the informed consent form is completed, you will be directed to a questionnaire where you will be asked to assess the relevance of each item of the questionnaire to the context of university-industry research partnerships. You may also provide comments on each item as you feel so inclined. The expected completion time for the assessment of the questionnaire is approximately 30-45 minutes.

RISKS

Participation in this project does not put you at more than daily risk.

BENEFITS

Your participation in this study is voluntary. It will help validate an instrument that will be used to gain an understanding of the relationship between trust, teaming discipline, and performance. It is expected that understanding this relationship will help improve relationships, and thus performance, in university-industry research partnerships.

CONFIDENTIALITY

The results of this research will be kept strictly confidential. Your responses will remain strictly confidential. Data will be stored securely and will be made available only in the context of research publications and discussion. No reference will be made in oral or written reports, which could link you to the data, nor will you ever be identified as a participant in this project.

FREEDOM TO WITHDRAW

You are free to withdraw from this study at any time without penalty.

APPROVAL OF THE RESEARCH

This research has been approved by the Institutional Review Board for research projects involving human participants at Virginia Polytechnic Institute and State University. A copy of this form will be provided to you.

PARTICIPANTS’ RESPONSIBILITIES

It is important that you keep the activities and information discussed confidential, since others will be participating in the research.

CONTACT

If you have questions at any time about the project or the procedures, you may contact:

Lead Investigator:	Lynette Wilcox Graduate Student, Grado Department of Industry and Systems Engineering Email: lywilcox@vt.edu Phone: _____
Faculty Advisors:	Dr. Brian M. Kleiner Professor, Grado Department of Industry and Systems Engineering Email: bkleiner@vt.edu Phone: (540) 231-4926
	Dr. Lisa McNair Professor, Department of Engineering Education Email: lmcnair@vt.edu Phone: (540) 231-1144

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant have been violated during the course of this project, you may contact Dr. David Moore, Chair of the Institutional Review Board Research Division at 540-231-4991.

PARTICIPANT’S PERMISSION

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

CLICK “I agree” button [must agree before accessing the survey]

Beginning of Survey:

Instructions:

- Please select a level of relevance for each item to the context of university-industry research partnerships.

- Please do not respond as a participant, but please assign a level of relevance for each item to university-industry research partnership participants.

(For questions 1- 80, participants will be asked to give a level of agreement on a 7 point scale from “Strongly Agree to Strongly Disagree.” For questions 81-88, participants as asked to give a level of satisfaction on a 7 point scale from “Completely Dissatisfied to Completely Satisfied”)

Please indicate your level of agreement with the following statements:					
TRUST					
Propensity to trust	Not Relevant	Somewhat Relevant	Quite Relevant	Highly Relevant	Comments
1. Most people in this team do not hesitate to help a person in need.					
2. In this team most people speak out for what they believe in.					
3. In this team most people stand behind their convictions.					
4. The typical person in this team is sincerely concerned about the problems of others.					
5. Most people will act as “Good Samaritans” if given the opportunity.					
6. People usually tell the truth, even when they know they will be better off by lying.					
Perceived trustworthiness	Not Relevant	Somewhat Relevant	Quite Relevant	Highly Relevant	Comments
7. In this team people can rely on each other.					
8. We have complete confidence in each other’s ability to perform tasks.					
9. In this team people will keep their word.					
10. There are some hidden agendas in this team. (r)					
11. Some people in this team often try to get out of previous commitments. (r)					
12. In this team people look for each other’s interests honestly.					
Cooperative behaviors	Not Relevant	Somewhat Relevant	Quite Relevant	Highly Relevant	Comments

13. In this team we work in a climate of cooperation.					
14. In this team we discuss and deal with issues or problems openly.					
15. While taking a decision we take each other's opinion into consideration.					
16. Some people hold back relevant information in this team. (r)					
17. In this team people minimize what they tell about themselves. (r)					
18. Most people in this team are open to advice and help from others.					
Monitoring behaviors	Not Relevant	Somewhat Relevant	Quite Relevant	Highly Relevant	Comments
19. In this team people watch each other very closely.					
20. In this team people check whether others keep their promises.					
21. In this team most people tend to keep each other's work under surveillance.					
TEAMING	Not Relevant	Somewhat Relevant	Quite Relevant	Highly Relevant	Comments
Truly meaningful purpose					
22. In this team, we have a broad, meaningful purpose that all members aspire to.					
23. The purpose of the team constitutes a broader, deeper aspiration than just near-term goals.					
24. The team's purpose is a broader organizational purpose. (r)					
25. The team's purpose is just one individual's purpose (e.g., the leader) (r)					
26. All members of the team understand the purpose the same way.					
27. All members of the team articulate the purpose the same way.					
28. Members define the purpose vigorously in discussions with outsiders.					
29. Members frequently refer to the purpose.					
30. Members frequently explore the implications of the purpose.					
31. The purpose contains themes that are particularly meaningful.					

32. The purpose contains themes that are memorable.					
33. Members feel the purpose is important.					
Specific goal or goals	Not Relevant	Somewhat Relevant	Quite Relevant	Highly Relevant	Comments
34. In this team, we have a specific set of team goals that members have agreed upon.					
35. The team goals are broader organizational goals.					
36. The team goals are just one individuals' goals (e.g. the leader's).					
37. The team goals are clear.					
38. The team goals are simple.					
39. The team goals are measurable.					
40. The team goals are realistic as well as ambitious.					
41. The team goals allow small wins along the way.					
42. The team goals call for a concrete set of team work-products.					
43. The team goals relative importance is clear to all members.					
44. The priority of team goals is clear to all members.					
45. All members agree with the goals.					
46. All members agree with the relative importance of the goals.					
47. All members agree with the way in which goal achievement will be measured.					
48. All members articulate the goals in the same way.					
Clear working approach	Not Relevant	Somewhat Relevant	Quite Relevant	Highly Relevant	Comments
49. In this team, we have a clearly understood and commonly agreed upon working approach.					
50. There is a concrete working approach.					
51. There is a clear working approach.					
52. The working approach is really understood by all members of the team.					
53. The working approach is agreed to by all members of the team.					
54. The working approach will result in achievement of the objectives.					

55. The working approach will capitalize on the skills of all members.					
56. The working approach will enhance the skills of all members.					
57. The working approach is consistent with other demands on the members.					
58. The working approach requires all members to contribute equivalent amounts of real work.					
59. The working approach provides for open interaction.					
60. The working approach provides for fact-based problem solving.					
61. The working approach provides for results-based evaluation.					
62. All members of the team articulate the approach in the same way.					
63. The working approach provides for modification over time.					
64. The working approach provides for improvement over time.					
65. Fresh input and perspectives are systematically sought and added to the working approach.					
Sense of mutual accountability	Not Relevant	Somewhat Relevant	Quite Relevant	Highly Relevant	Comments
66. In this team, we are individually and mutually accountable for the team's collective results.					
67. I am individually accountable for the team's purpose.					
68. I am jointly accountable for the team's purpose.					
69. I am individually accountable for the team's goals.					
70. I am jointly accountable for the team's goals.					
71. I am individually accountable for the team's approach.					
72. I am jointly accountable for the team's approach.					
73. I am individually accountable for the team's work-products.					
74. I am jointly accountable for the team's work-products.					
75. The team can measure progress against specific goals.					
76. The team measures progress against specific goals.					

77. All members feel responsible for all measures.					
78. The team members are clear on what they are individually responsible for.					
79. The team members are clear on what they are jointly responsible for.					
80. There is a sense that “only the team can fail.”					
PERFORMANCE	Not Relevant	Somewhat Relevant	Quite Relevant	Highly Relevant	Comments
81. Team members meet or exceed productivity requirements.					
82. Team members are committed to producing quality work.					
83. Team members have successfully implemented ideas to reduce costs.					
84. Generally speaking, team members are very satisfied with their work.					
In the time of your experience with the team, how satisfied are you with the following:	Not Relevant	Somewhat Relevant	Quite Relevant	Highly Relevant	Comments
85. Timeliness of results					
86. Knowledge sharing					
87. Return on investment					
88. Overall Performance					

-Please comment on the length of the survey (e.g. too short or too long)

-Please share any concerns you may have about the functionality of accessing and completing this online questionnaire.

-Please comment on the clarity of the questions. Feel free to utilize specific question numbers to refer to items which should be clarified or removed.

Thank you for your completing the survey!

Appendix D – Invitation Letter to Director

Greetings [Director Name]

My name is Lynette Wilcox and I am a doctoral candidate in Industry and Systems Engineering at Virginia Tech. I am currently conducting a doctoral dissertation study on the topic of trust within university-industry research partnerships (UIRPs). I have come to the point of gathering participants for my study and I would like to invite you and the members of your organization to participate in the survey study I am conducting.

The purpose of the research is to examine the relationship between trust, teaming discipline, and performance in UIRPs. Your organization contains many active UIRPs and therefore your input is vital to this study. Overall, the work for my dissertation is addressing a deficit in empirical studies conducted on UIRPs as a whole. Your participation contributes to a great need for university-industry relations across many industry sectors to be continuously improved.

The steps of the study involve distributing an email invitation which contains a link to a secure, online questionnaire I have developed. Potential respondents will be asked to read and acknowledge receipt of an informed consent form which will appear before beginning questionnaire. The questionnaire completion time is approximately 20 to 30 minutes and respondents will be given a two-week period to respond to the survey.

Respondents' individual identities will remain anonymous – no personal identifying information will be collected in this study. However, respondents will be asked to identify their partnership affiliation within the organization. Individual responses will be aggregated in groups determined by these partnership affiliations and they will be coded and will remain confidential. Also, participants will be asked to identify themselves as either an industry or academic participant. No other demographic data will be requested.

If you would like to participate, I will follow up with you via telephone or email to discuss the logistics of distributing the link to the questionnaire among the members of your organization. Specifically, I would like to know if you prefer to share contacts with me so that I can communicate directly with potential respondents, or if you would prefer that I share the study materials for you to share internally (thereby retaining contact information).

My research has been approved by the Institution Review Board for research projects involving human participants at Virginia Polytechnic Institute and State University (#13-184). I have attached a copy of the informed consent below.

Thank you for your consideration. Please contact me at the email or phone number below if you have any questions about my dissertation study. I look forward to speaking with you in the very near future.

Sincerely,

Lynette F. Wilcox, M.S.
Doctoral Candidate, Industry and Systems Engineering, Virginia Tech
Email: lywilcox@vt.edu Phone: _____
Mailing Address: 565 Whittemore Hall (0118)
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

Appendix E – Invitation Letter and Informed Consent Form to Participants

Greetings:

My name is Lynette Wilcox and I am a doctoral candidate in Industry and Systems Engineering at Virginia Tech. I am currently conducting a doctoral dissertation study on the topic of trust within university-industry research partnerships (UIRPs). I have come to the point of gathering participants for my study and I would like to invite to participate in the survey study I am conducting.

Your participation is requested because you are an active member in a UIRP whose input is vital to this study. Included below is a link to a secure, online questionnaire. When you click on the link to you will be asked to read and acknowledge receipt of an informed consent form which will appear before beginning questionnaire. You will be asked to respond to statements about trust, teaming discipline, and performance based on your experience as a participant in a UIRP. The questionnaire completion time is approximately 20 to 30 minutes and your response must be submitted no later than (*insert date two weeks from the invitation*).

Your individual identity will remain anonymous – no personal identifying information will be collected in this study. However, you will be asked to identify your partnership affiliation within (*insert organization*). Individual responses will be aggregated in groups determined by these partnership affiliations and they will be coded and will remain confidential. Also, you will be asked to identify yourself as either an industry or academic participant. No other demographic data will be requested.

Your participation is voluntary. You may read the informed consent and participate in the study by clicking on the link below:

https://www._____

If you have any questions now or at any time during the survey, you may contact me, Lynette Wilcox, at lywilcox@vt.edu.

Sincerely,

Lynette F. Wilcox, M.S.
Doctoral Candidate, Industry and Systems Engineering, Virginia Tech
Email: lywilcox@vt.edu Phone: _____

Opening Page:

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants in Research Projects Involving Human Subjects

Title of Project:

The Role of Trust in University-Industry Research Partnership Performance

Investigator: Lynette Wilcox, Industry and Systems Engineering Graduate Student

Advisors: Brian M. Kleiner, PhD., Lisa D. McNair, PhD.

PURPOSE OF PROJECT

The purpose of this research is to examine the relationship between trust, teaming discipline, and performance in university-industry research partnerships.

PROCEDURES

You will be asked to complete a secure, online questionnaire. You will be asked to read and agree to the informed consent form for this study. Once the informed consent form is completed, you will be directed to a questionnaire that will ask information about trust, teaming discipline, and performance in your experience as a participant in a university-industry research partnership. Additionally some general questions regarding your partnership affiliation will be included. It is expected that completion of the questionnaire will take approximately 20 minutes.

RISKS

Participation in this project does not put you at more than daily risk.

BENEFITS

Your participation in this study is voluntary. It will help gain an understanding of the relationship between trust, teaming discipline, and performance. It is expected that understanding this relationship will help improve relationships, and thus performance, in university-industry research partnerships.

CONFIDENTIALITY

The results of this research will be kept strictly confidential. The questionnaire will be anonymous including only a code to identify the partnership group. Data will be stored securely and will be made available only in the context of research publications and discussion. No

reference will be made in oral or written reports, which could link you to the data, nor will you ever be identified as a participant in this project.

FREEDOM TO WITHDRAW

You are free to withdraw from this study at any time without penalty.

APPROVAL OF THE RESEARCH

This research has been approved by the Institutional Review Board for research projects involving human participants at Virginia Polytechnic Institute and State University. A copy of this form will be provided to you.

PARTICIPANTS' RESPONSIBILITIES

It is important that you keep the activities and information discussed confidential, since others will be participating in the research.

CONTACT

If you have questions at any time about the project or the procedures, you may contact:

Lead Investigator:	Lynette Wilcox Graduate Student, Grado Department of Industry and Systems Engineering Email: lywilcox@vt.edu Phone: _____
Faculty Advisors:	Dr. Brian M. Kleiner Professor, Grado Department of Industry and Systems Engineering Email: bkleiner@vt.edu Phone: (540) 231-4926
	Dr. Lisa McNair Professor, Department of Engineering Education Email: lmcnair@vt.edu Phone: (540) 231-1144

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant have been violated during the course of this project, you may contact Dr. David Moore, Chair of the Institutional Review Board Research Division at 540-231-4991.

PARTICIPANT'S PERMISSION

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

CLICK "I agree" button [must agree before accessing the survey]

Appendix F – Informed Consent and Interview Protocol
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
Informed Consent for Participants in Research Projects Involving Human Subjects

Title of Project:

The Role of Trust in University-Industry Research Partnership Performance

Investigator: Lynette Wilcox, Industry and Systems Engineering Graduate Student

Advisors: Brian M. Kleiner, PhD., Lisa D. McNair, PhD.

PURPOSE OF PROJECT

The purpose of this research is to examine the relationship between trust, teaming discipline, and performance in university-industry research partnerships. This phase of the project involves a telephone interview to address completeness of research questions and to gain clarity on the concepts of trust and performance directly from leadership participants in a university-industry research partnership.

PROCEDURES

You will be asked to read and agree to the informed consent form for this study. Once the informed consent form is completed, the researcher will start recording. The researcher will ask you a few questions about trust and performance in university-industry research partnerships. Also, the researcher will ask for suggested research directions of university-industry research partnerships based on your experiences. You may also provide general comments to conclude the interview. The expected completion time for the interview is approximately 30-45 minutes.

RISKS

Participation in this project does not put you at more than daily risk.

BENEFITS

Your participation in this study is voluntary. It will help to gain an understanding of the relationship between trust, teaming discipline, and performance and to refine research directions for university-industry research partnerships. It is expected that understanding the variables' relationships will help improve partnership relationships, and thus performance, in university-industry research partnerships.

CONFIDENTIALITY

The results of this research will be kept strictly confidential. Your responses will remain strictly confidential. Data will be stored securely and will be made available only in the context of research publications and discussion. No reference will be made in oral or written reports, which could link you to the data, nor will you ever be identified as a participant in this project.

FREEDOM TO WITHDRAW

You are free to withdraw from this study at any time without penalty.

APPROVAL OF THE RESEARCH

This research has been approved by the Institutional Review Board for research projects involving human participants at Virginia Polytechnic Institute and State University. A copy of this form will be provided to you.

PARTICIPANTS' RESPONSIBILITIES

It is important that you keep the activities and information discussed confidential, since others will be participating in the research.

PARTICIPANT'S PERMISSION

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

Signature: _____ **Date:** _____

Printed Name: _____

CONTACT

If you have questions at any time about the project or the procedures, you may contact:

Lead Investigator:	Lynette Wilcox Graduate Student, Grado Department of Industry and Systems Engineering Email: lywilcox@vt.edu Phone: _____
Faculty Advisors:	Dr. Brian M. Kleiner Professor, Grado Department of Industry and Systems Engineering Email: bkleiner@vt.edu Phone: (540) 231-4926
	Dr. Lisa McNair Professor, Department of Engineering Education Email: lmcnair@vt.edu Phone: (540) 231-1144

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant have been violated during the course of this project, you may contact Dr. David Moore, Chair of the Institutional Review Board Research Division at 540-231-4991.

DATE:

TIME:

LOCATION:

PARTICIPANT #:

INTERVIEWER:

Interviewer Introduction: The purpose of this research is to investigate the role trust plays in the performance of university-industry research partnerships. There are no “right or wrong” responses. When answering these questions, please be as honest as possible so that the researcher can make the best recommendations for understanding and improving university-industry research partnerships. Let’s begin.

Warm up Question 1:

Approximately how long have you worked with the Center?

Probe: What are your responsibilities with the Center (both prescribed and assumed)?

Probe: What do you enjoy about participating in the Center?

Question 2: How would you describe the performance of the Center?

Probe: How does the past performance compare to current performance?

Probe: What factors do you consider in describing performance? What aspects do you consider when you gauge a level of performance?

Probe: What performance topics do you feel are most important to report back to your “home” or “primary” organization?

Question 3: What role do you feel trust plays in Center performance?

Probe: How does trust matter at different levels (Center, site, team)?

Question 4: What actions/best practices are performed in the Center to build/maintain trust?

Probe: How might this action impact performance of the Center?

Probe: How much effort is expended to improve or maintain relationships between academe and industry? Please describe actions in terms of which individuals/groups/organizations?

Question 5: Is there evidence of a difference of trust levels between industry members and academic participants?

Probe a: If so, what do you think causes the difference?

Probe b: If not, what do you think keeps the levels even?

Question 6: In general, what factors contribute to the success of university-industry research partnerships?

Probe: Which of these factors are critical?

Probe: In measuring success, what are some areas should researchers and practitioners focus on?

Question 7: Do you have any closing comments?

(If yes, Probe: Please share them. If no: conclude the interview)

Interviewer Conclusion: This concludes the interview. Thank you for your time and honest responses.

Appendix G - Quantitative Analysis SPSS Output Tables

Descriptive Statistics

	Mean	Std. Deviation	N
PerformAvgScore	5.6624	.88445	78
TrustAvgScore	5.3690	.66819	78

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
TrustAvgScore	.066	78	.200*	.993	78	.934

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PerformAvgScore	.133	78	.002	.919	78	.000

a. Lilliefors Significance Correction

TRUST and PERFORMANCE REGRESSION ANALYSIS

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.619 ^a	.383	.375	.69901	1.976

a. Predictors: (Constant), TrustAvgScore

b. Dependent Variable: PerformAvgScore

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.099	1	23.099	47.275	.000 ^b
	Residual	37.134	76	.489		
	Total	60.233	77			

a. Dependent Variable: PerformAvgScore

b. Predictors: (Constant), TrustAvgScore

Bootstrap for Coefficients

Model	B	Bootstrap ^a				
		Bias	Std. Error	Sig. (2-tailed)	BCa 95% Confidence Interval	
					Lower	Upper
1 (Constant)	1.262	.007	.781	.104	-0.264	2.813
TrustAvgScore	.820	.000	.139	.001	.539	1.090

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Casewise Diagnostics^a

Case Number	Std. Residual	PerformAvgScore	Predicted Value	Residual
7	-3.140	3.56	5.7503	-2.19471
20	-3.810	2.11	4.7745	-2.66334

a. Dependent Variable: PerformAvgScore

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	4.2280	6.9993	5.6624	.54771	78
Std. Predicted Value	-2.619	2.441	.000	1.000	78
Standard Error of Predicted Value	.079	.223	.107	.034	78
Adjusted Predicted Value	4.2917	6.9992	5.6647	.54714	78
Residual	-2.66334	1.29475	.00000	.69445	78
Std. Residual	-3.810	1.852	.000	.993	78
Stud. Residual	-3.903	1.864	-.002	1.008	78
Deleted Residual	-2.79455	1.31184	-.00235	.71471	78
Stud. Deleted Residual	-4.336	1.896	-.011	1.046	78
Mahal. Distance	.000	6.859	.987	1.450	78
Cook's Distance	.000	.375	.015	.046	78
Centered Leverage Value	.000	.089	.013	.019	78

a. Dependent Variable: PerformAvgScore

For RQ1: T-Test

Group Statistics

	Q2	N	Mean	Std. Deviation	Std. Error Mean
TrustAvgScore	1	31	5.2833	.68090	.12229
	2	47	5.4255	.66090	.09640

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
								Lower	Upper	
TrustAvgScore Equal variances assumed	.027	.869	-.919	76	.361	-.14228	.15476	-.45051	.16595	
TrustAvgScore Equal variances not assumed			-.914	63.003	.364	-.14228	.15572	-.45346	.16891	

Appendix H - RQ3 Mediation Analysis Details

PATH a
 Path b
 Path c
 Path c'
 Path ab
 Sobel
 κ²

Run MATRIX procedure:

***** PROCESS Procedure for SPSS Release 2.12.1 *****

Written by Andrew F. Hayes, Ph.D. www.afhayes.com
 Documentation available in Hayes (2013). www.guilford.com/p/hayes3

Model = 4
 Y = PerformA
 X = TDPurpos
 M = TrustAvg

Sample size
 78

Outcome: TrustAvg

Model Summary

R	R-sq	MSE	F	df1	df2	p
.7189	.5168	.2186	81.2868	1.0000	76.0000	.0000

Model

	coeff	se	t	p
constant	1.9144	.3868	4.9493	.0000
TDPurpos	.6469	.0718	9.0159	.0000

Covariance matrix of regression parameter estimates

	constant	TDPurpos
constant	.1496	-.0275
TDPurpos	-.0275	.0051

Outcome: PerformA

Model Summary

R	R-sq	MSE	F	df1	df2	p
.7003	.4904	.4093	36.0879	2.0000	75.0000	.0000

Model

	coeff	se	t	p
constant	.6727	.6086	1.1053	.2726
TrustAvg	.3721	.1570	2.3706	.0203
TDPurpos	.5603	.1412	3.9668	.0002

Covariance matrix of regression parameter estimates

	constant	TrustAvg	TDPurpos
constant	.3704	-.0472	-.0210
TrustAvg	-.0472	.0246	-.0159
TDPurpos	-.0210	-.0159	.0199

***** TOTAL EFFECT MODEL *****

Outcome: PerformA

Model Summary

R	R-sq	MSE	F	df1	df2	p
.6725	.4522	.4341	62.7425	1.0000	76.0000	.0000

Model

	coeff	se	t	p
constant	1.3850	.5451	2.5407	.0131
TDPurpos	.8010	.1011	7.9210	.0000

Covariance matrix of regression parameter estimates

	constant	TDPurpos
constant	.2972	-.0546
TDPurpos	-.0546	.0102

***** TOTAL, DIRECT, AND INDIRECT EFFECTS *****

Total effect of X on Y

Effect	SE	t	p
.8010	.1011	7.9210	.0000

Direct effect of X on Y

Effect	SE	t	p
.5603	.1412	3.9668	.0002

Indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2407	.1365	.0216	.5562

Partially standardized indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2722	.1435	.0264	.5843

Completely standardized indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2021	.1056	.0201	.4248

Ratio of indirect to total effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.3005	.1741	.0261	.6873

Ratio of indirect to direct effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.4296	.6696	.0268	2.1983

R-squared mediation effect size (R-sq_med)

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.3453	.0727	.2137	.5070

Preacher and Kelley (2011) Kappa-squared

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.1903	.0835	.0311	.3570

Normal theory tests for indirect effect

Effect	se	Z	p
.2407	.1056	2.2796	.0226

***** ANALYSIS NOTES AND WARNINGS *****

Number of bootstrap samples for bias corrected bootstrap confidence intervals:
1000

Level of confidence for all confidence intervals in output:
95.00

----- END MATRIX -----

Run MATRIX procedure:

***** PROCESS Procedure for SPSS Release 2.12.1 *****

Written by Andrew F. Hayes, Ph.D. www.afhayes.com
Documentation available in Hayes (2013). www.guilford.com/p/hayes3

Model = 4
Y = PerformA
X = TDGoal
M = TrustAvg

Sample size
78

Outcome: TrustAvg

Model Summary

R	R-sq	MSE	F	df1	df2	p
.6564	.4309	.2575	57.5371	1.0000	76.0000	.0000

Model

	coeff	se	t	p
constant	2.4009	.3955	6.0705	.0000
TDGoal	.5595	.0738	7.5853	.0000

Covariance matrix of regression parameter estimates

	constant	TDGoal
constant	.1564	-.0289
TDGoal	-.0289	.0054

Outcome: PerformA

Model Summary

R	R-sq	MSE	F	df1	df2	p
.6738	.4540	.4385	31.1822	2.0000	75.0000	.0000

Model

	coeff	se	t	p
constant	.7967	.6290	1.2668	.2092
TrustAvg	.5139	.1497	3.4325	.0010
TDGoal	.3972	.1276	3.1123	.0026

Covariance matrix of regression parameter estimates

	constant	TrustAvg	TDGoal
constant	.3956	-.0538	-.0191
TrustAvg	-.0538	.0224	-.0125
TDGoal	-.0191	-.0125	.0163

***** TOTAL EFFECT MODEL *****

Outcome: PerformA

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.6068	.3682	.5007	44.2977	1.0000	76.0000	.0000

Model

	coeff	se	t	p
constant	2.0304	.5515	3.6813	.0004
TDGoal	.6847	.1029	6.6557	.0000

Covariance matrix of regression parameter estimates

	constant	TDGoal
constant	.3042	-.0561
TDGoal	-.0561	.0106

***** TOTAL, DIRECT, AND INDIRECT EFFECTS *****

Total effect of X on Y

Effect	SE	t	p
.6847	.1029	6.6557	.0000

Direct effect of X on Y

Effect	SE	t	p
.3972	.1276	3.1123	.0026

Indirect effect of X on Y

Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2875	.1269	.0778

Partially standardized indirect effect of X on Y

Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.3251	.1249	.0902

Completely standardized indirect effect of X on Y

Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2548	.0995	.0779

Ratio of indirect to total effect of X on Y

Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.4199	.1933	.0966

Ratio of indirect to direct effect of X on Y

Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.7239	21.9695	.1001

R-squared mediation effect size (R-sq_med)

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2977	.0811	.1547	.4807

Preacher and Kelley (2011) Kappa-squared

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2419	.0827	.0689	.4065

Normal theory tests for indirect effect

Effect	se	Z	p
.2875	.0926	3.1049	.0019

***** ANALYSIS NOTES AND WARNINGS *****

Number of bootstrap samples for bias corrected bootstrap confidence intervals:
1000

Level of confidence for all confidence intervals in output:
95.00

----- END MATRIX -----

Run MATRIX procedure:

***** PROCESS Procedure for SPSS Release 2.12.1 *****

Written by Andrew F. Hayes, Ph.D. www.afhayes.com
Documentation available in Hayes (2013). www.guilford.com/p/hayes3

Model = 4
Y = PerformA
X = TDApproa
M = TrustAvg

Sample size
78

Outcome: TrustAvg

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.7323	.5363	.2097	87.9108	1.0000	76.0000	.0000

Model

	coeff	se	t	p
constant	2.2997	.3314	6.9385	.0000
TDApproa	.5759	.0614	9.3761	.0000

Covariance matrix of regression parameter estimates

	constant	TDApproa
constant	.1099	-.0201

TDApproa -.0201 .0038

Outcome: PerformA

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.7485	.5602	.3532	47.7722	2.0000	75.0000	.0000

Model

	coeff	se	t	p
constant	1.0498	.5497	1.9098	.0600
TrustAvg	.2212	.1488	1.4861	.1415
TDApproa	.6426	.1171	5.4902	.0000

Covariance matrix of regression parameter estimates

	constant	TrustAvg	TDApproa
constant	.3021	-.0510	-.0045
TrustAvg	-.0510	.0222	-.0128
TDApproa	-.0045	-.0128	.0137

***** TOTAL EFFECT MODEL *****

Outcome: PerformA

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.7398	.5473	.3588	91.8752	1.0000	76.0000	.0000

Model

	coeff	se	t	p
constant	1.5585	.4335	3.5952	.0006
TDApproa	.7700	.0803	9.5852	.0000

Covariance matrix of regression parameter estimates

	constant	TDApproa
constant	.1879	-.0344
TDApproa	-.0344	.0065

***** TOTAL, DIRECT, AND INDIRECT EFFECTS *****

Total effect of X on Y

Effect	SE	t	p
.7700	.0803	9.5852	.0000

Direct effect of X on Y

Effect	SE	t	p
.6426	.1171	5.4902	.0000

Indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.1274	.0763	-.0204	.2795

Partially standardized indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.1440	.0866	-.0304	.3125

Completely standardized indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.1224	.0736	-.0237	.2607

Ratio of indirect to total effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.1654	.0987	-.0307	.3521

Ratio of indirect to direct effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.1982	.1494	-.0298	.5435

R-squared mediation effect size (R-sq_med)

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.3705	.0825	.2004	.5186

Preacher and Kelley (2011) Kappa-squared

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.1256	.0684	.0116	.2645

Normal theory tests for indirect effect

Effect	se	Z	p
.1274	.0873	1.4597	.1444

***** ANALYSIS NOTES AND WARNINGS *****

Number of bootstrap samples for bias corrected bootstrap confidence intervals:

1000

Level of confidence for all confidence intervals in output:

95.00

----- END MATRIX -----

Run MATRIX procedure:

***** PROCESS Procedure for SPSS Release 2.12.1 *****

Written by Andrew F. Hayes, Ph.D. www.afhayes.com
 Documentation available in Hayes (2013). www.guilford.com/p/hayes3

Model = 4
 Y = PerformA
 X = TDaccoun
 M = TrustAvg

Sample size
 78

Outcome: TrustAvg

Model Summary

R	R-sq	MSE	F	df1	df2	p
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.5769 .3328 .3018 37.9064 1.0000 76.0000 .0000

Model

	coeff	se	t	p
constant	3.2282	.3532	9.1394	.0000
TDAccoun	.4319	.0701	6.1568	.0000

Covariance matrix of regression parameter estimates

	constant	TDAccoun
constant	.1248	-.0244
TDAccoun	-.0244	.0049

Outcome: PerformA

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.6440	.4148	.4700	26.5778	2.0000	75.0000	.0000

Model

	coeff	se	t	p
constant	1.0856	.6386	1.7000	.0933
TrustAvg	.6543	.1431	4.5713	.0000
TDAccoun	.2146	.1072	2.0023	.0489

Covariance matrix of regression parameter estimates

	constant	TrustAvg	TDAccoun
constant	.4078	-.0661	-.0094
TrustAvg	-.0661	.0205	-.0088
TDAccoun	-.0094	-.0088	.0115

***** TOTAL EFFECT MODEL *****

Outcome: PerformA

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.5017	.2517	.5930	25.5656	1.0000	76.0000	.0000

Model

	coeff	se	t	p
constant	3.1980	.4951	6.4589	.0000
TDAccoun	.4972	.0983	5.0562	.0000

Covariance matrix of regression parameter estimates

	constant	TDAccoun
constant	.2452	-.0479
TDAccoun	-.0479	.0097

***** TOTAL, DIRECT, AND INDIRECT EFFECTS *****

Total effect of X on Y

Effect	SE	t	p
.4972	.0983	5.0562	.0000

Direct effect of X on Y

Effect	SE	t	p
.2146	.1072	2.0023	.0489

Indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2826	.0939	.1323	.4856

Partially standardized indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.3195	.0906	.1540	.5122

Completely standardized indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2852	.0815	.1428	.4690

Ratio of indirect to total effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.5684	.1908	.2611	.9961

Ratio of indirect to direct effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	1.3170	12.2472	.3145	21.6229

R-squared mediation effect size (R-sq_med)

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2204	.0651	.1121	.3843

Preacher and Kelley (2011) Kappa-squared

	Effect	Boot SE	BootLLCI	BootULCI
TrustAvg	.2720	.0728	.1345	.4195

Normal theory tests for indirect effect

	Effect	se	Z	p
	.2826	.0776	3.6394	.0003

***** ANALYSIS NOTES AND WARNINGS *****

Number of bootstrap samples for bias corrected bootstrap confidence intervals:
1000

Level of confidence for all confidence intervals in output:
95.00

----- END MATRIX -----

Appendix I - Peer Examination Meetings Minutes

Peer Examination Meeting Minutes:

Meeting 1: Thursday, December 17, 2015 at 10:00am in 542 Whittemore Hall

Data Preparation:

Audio recordings transcribed by researcher.

Transcriptions edited to remove explicitly identifying information (Personal and Institutional names).

On a secondary round verifying transcriptions, other descriptively identifying quotes were marked to be considered for removal in the next round of significant statement identification.

“Cleaned” transcripts were uploaded into Atlas TI[®] for extracting significant statements

Significant Statements beginning Phenomenological Process:

1100 statements extracted from the original transcripts. Careful to break down each into singular “relevant/significant” statements.

-It was tough to categorize statements in ATLAS TI[®] and it was going to be difficult to ascribe meaning units to statements, so the data was exported from ATLAS TI[®] into Excel[®]

Meaning Units: Grouped, clarified, deleted raw significant statements from quotes.

Sorted statements and summarized statements focusing on essential meanings of statements relevant to trust and performance. Some statements were too “finely parsed” and were re-grouped together. Others were full of “filler” verbal communication “ums, ‘you know’, etc.” so those were edited to retain meaning of the statements.

After clarifying the statements, meaning units were interpreted first in EXCEL and then transferred into Word[®] for clustering.

Participant Summaries individually written from essential meaning unit/statements to tell each participant’s story in the context of the research sub-questions. These will be sent to members for “member checking”

Still need to do:

Next steps:

Cluster essential meanings

Identify themes between clusters and use these as an outline for a composite.

Examiner suggestions:

Document the steps – perhaps in a diagram so the examiner can follow the procedures.

Peer Examination meeting 2
11:40am 1-25-2016 565 Whittemore Hall

Prior to the meeting the researcher asked the examiner to read through the Chapter and gave the examiner access to the documents used in the analysis for the composites.

She provided the following feedback:

1. I really like how you describe the steps that you take to describe your qualitative data analysis. The steps are easy to follow and it seems logical as to how you moved throughout the analysis process.
2. I'm a little confused about how you actually clustered the significant statements to form the meaning clusters. How did you determine which statements needed to be clustered together? How did you know when a cluster was a completed cluster?
3. I can see the relationship between your Significant Statements and your Meaning Clusters. You may want to talk about how these statements were also categorized before they were clustered based on the sheets in your excel file. Then you can talk about how the meaning clusters incorporated all of these categories. – I just see that you have the Thematizing Concepts document which is very helpful! I did not see you talk about that in the dissertation document.[C1]
4. Did you create the meaning clusters for each participant individually?

[C1]These two basically go together. I was just having a bit of a time figuring how what information was coming from where.

Responses to Questions 2 and 3:

Initially the statements were grouped according to research sub-questions and maintained participant labels. In order to cluster by content, the researcher de-identified the statements and grouped strictly by content agreement.

Meaning units separated by participants and sub-questions. Then clustered meaning units into similar content clusters.

Suggestion by Examiner:

- Clearly document the trail of interpretation...diagram would be helpful for steps.
- Also reconcile what the statements/units/clusters are called at each stage.

Researcher Explanation

Meaning units for clustering were cleaned in transferring the statements from Excel to Word. Some interpretation and contextual descriptions were added for clarity of the statements in the transfer as well.

Examiner Suggestion:

Pull from a participant transcript and show its process through to the composite...
For example... Use the diagram... and each unit show it in each stage to follow it through....
helpful for clarity.

Appendix J - Interview Participant Summaries

Participant 1 – Industry Advisory board chairperson for (Small, newest) I/UCRC

Background

Center A, Industry Leader – P1 serves as a technical adviser to the Center, representing the interests of his company. He inherited his leadership position as Industry Advisory Board (IAB) Chair from a predecessor in his company who left the position with the company.

Trust and Performance

Overall, P1 believes that his company sets objectives that the Center meets. There has been some membership decline which has been attributed to the housing market. He also notes that there is a limited type of membership and while there is ample fundamental research in one area, there is a lacking of fundamental research in a different area which might be attractive to a different type of company which might also benefit from Center membership. He felt that the academics have a good, balanced participation among the partner universities.

In considering how trust might relate to performance in the Center in some way, P1 shared an example of academic and industry members facing the problem of an incorrect analysis made by his company's research group during a joint research effort with a partner university. P1 shares that the mistake was exposed professionally and respectfully. Further both the academic and industry researchers worked together to amend the problem.

P1 shared a second example where an individual company representative was adamantly against a research investment decision. In this case, the voice of the minority member was valued and respected. The majority heard out the concerns and decided not to make the investment after all. There was mutual accountability in deciding to accept the minority advice not to expend the resources in the area and in hindsight, P1 has seen that the decision was a prudent one.

The strength of their trust can be sensed through open communication of the problem and even deeper with academics assuming joint responsibility for solving the problem. There was a climate in place such that honest and respectful dialogue arose from both situations. In the first, honesty paid off and trust remained intact even in the face of a mistake which could have impacted credibility of the parties involved. In the second, the fact that the minority decision prevailed exhibits a sense of trust that the individual member felt comfortable enough to speak up and that his concern would be heard and considered. The mutual accountability for the decisions in both situations ultimately lead to positive outcomes.

Academic v. Industry Trust

P1 believes that trust is apparent between academia and industry throughout the Center. However, because there are industry member competitors involved in the Center, there is some caution exercised in sharing information. P1 recalls that this was not the case in a previous partnership experience where there were no competitors – everyone could more freely in share information.

Actions managing trust important in the Center

P1 mentions that a process that allows for more frequent updates on projects was instated within the last 12 months of the interview. Previously there was an approval by the IAB and then the project would start and end without any interim reporting. Industry members felt uninformed and excluded in the

process and progress of the research being conducted by industry. However, with the new process in place, industry members can present suggestions and interact actively throughout the project which is a way trust is built between academia and industry. Also P1 mentioned that the process is helpful so that faculty and students do not have to struggle and wait until the end to call on industry for support. As a result of the interim reporting, industry members are more at ease relying on faculty to adhere to project objectives.

The formal process of reporting came about as a result of industry member unsatisfactory feedback at an IAB meeting. In response, academic partners agreed to a formal process in which academics hold phone conferences to communicate project progress anywhere from once per month to once per quarter.

P1 also offers an example of trust in relation to financing projects in the Center. He observes that there is currently very minimal monitoring of academia over how project resources are expended. Industry members have had no reason to doubt the academic stewardship practices over the finances and they believe that everyone is prudent with them stating, "...nobody is taking vacations to Hawaii or anything..." Overall industry has a high level of trust in the financial stewardship of projects by academic researchers.

Successful Center perspective

P1 believes that academe and industry each bring their own strengths to the partnership and neither tries to encroach upon the territory of the other. P1 describes a successful academic partnership as one in which: academic partners conduct fundamental research that industry couldn't do on their own; graduate students finish degrees and remain working in the research area of the Center; and, the consortium is recognized as valuable in a "University's eyes" – the Center's value extends beyond the immediate academic researchers in the Center to the university affiliated administrators.

Participant2 – Academic Faculty, Center Director for (small, newest) I/UCRC

Background

P2 was recruited to the center (11 years before Center had I/UCRC status) as a young faculty with research interests aligned with those of the Center. He later became the Center Director (5 years before Center had I/UCRC status) through Industry Advisory Board appointment after the departure of his predecessor. As a leader, he assumes responsibility of executing the vision of service to industry as well as bringing the different academic and industry interests together. Understanding what industry needs and how academe works and bringing the parties together so that they work together productively describe an overarching picture of his stated role in leadership of the Center.

Trust and Performance

P2 assesses performance as good overall and that industry members "get their money's worth." He alludes to some differential performance at the project level – "some go well, others not so well." However, P2 clarifies that the problems with project performance are more attributable to logistical and procedural challenges in running the Center rather than any ability or effort affecting the quality of the

research. Also, as this is a fairly young Center, there are still some changes going as the processes for running the Center are under constant revision to ensure that industry members' needs are being met.

Regarding how trust may relate to performance, P2 begins by sharing that academic leaders trust the judgment of the industry advisory board to set the research agenda. This credibility has been validated by fruitful Center performance results over time. Academics trust that the industry members are looking out for the Center interests and not just those of their own companies. Academics also trust that industry understands that there are limitations, in terms of research scope, of the Center. Academia has confidence in the technical expertise of the industry members as well. P2 concludes that, even with academic freedoms, the choice to align with industry in this case has been a fruitful experience.

P2 shares an example of changing of company representatives between IAB meetings as a situation that can be disruptive to the foundation of mutual understanding. In these situations, there is a loss of institutional memory and it introduces a new need to re-establish common ground in the essentially new relationship. P2 asserts that this situation itself is "...not really a trust issue," however, trust becomes a factor in believing that the advisory board can manage the disruption of a new person with potentially new interests and can incorporate their interests into the agenda being mindful of efforts already in progress that are affected by deviations in the agenda. As a general rule, academics trust industry to remain steady in managing representative exchanges due to a mutual awareness that potential conflict can arise and affect trust. Also, academics trust that industry will stay true to a holistic Center research perspective. P2 has been pleased with the IAB in these situations.

Overall P2 cannot think of a situation in where mistrust impeded Center activity or performance. However, P2 cites one example where a newly appointed university administrator introduced some angst when they attempted to alter an already established membership agreement. The situation introduced a concern about trust between P2 and the university administration more than concerns about trust within the Center.

Academic v. Industry Trust

P2 believes that there are "certainly" differences in trust between industry members and academic participants. He refers to a natural lacking of industry trust in faculty due to the independent nature of a faculty position. Industry naturally questions whether faculty motives such that they are really there to "serve the industry" or "serve themselves." Industry is also concerned that faculty won't take direction from industry. Academics also may feel that industry might not propose meaningful work. P2 feels there is a natural mistrust from both industry and academe which can be attributed to their different norms of operational environments. P2 is hopeful, however, that by coming together and learning about each other - as in a partnership such as this- they can develop a mutual sense of trust.

Action Managing Trust

P2 believes the best way to develop trust is through cultivating relationships over time and that working together toward a common goal builds trust naturally. He refers again to the industry advisory board turnover as disruptive to trust building; "...because if there is a sudden turnover then you have to start all over again building trust with that company." However, in managing these situations, the key is

consistent interaction with the new person and also to anticipate and absorb potentially negative effects of industry member turnover.

P2 lists some formal processes in place for these consistent interactions: IAB meetings twice per year and the regular research update conference phone calls. Some informal practices are private conversations which occur before or after public interactions at IAB meetings. Informal social activities are planned as part of these meetings as well and are viewed as a critical informal mechanism for cultivating trust in partnership relations.

Successful UIRP

Industry brings pressing issues – pertinent topics - that serve as a rich source of research inspiration for academic researchers. Industry gains the most recent analytical methods; cutting edge theory and understanding of significant research trends from the academic researchers. P2 asserts that the complementary work described here can be very powerful – if industry and academia work together effectively.

P2 states that the principle measure of success is the number of industry members. High investments indicate that industry values the efforts of the academics and is a mark of a successful partnership. P2 explains that membership is either growing, static, or declining...stable or growing membership would indicate success.

Participant3 – Industry Advisory Board Chairperson large, older I/UCRC

Background

P3 has had relationships with industry-university cooperatives which have been established over decades. The organization in the form of the Center is new, but the relationships had long been established and P3 was invested in the relationships. P3 was asked by the Center Director if he would lead the Industry Advisory Board. He stated that one of his primary responsibilities is to coordinate project voting. He mentions the importance of getting discussions going and that he is good at reaching consensus and that coordinating is easy for him.

Trust and Performance

P3 describes the performance of the center as “very good.” He says that the faculty develop clear projects, keep to their guidelines, stay within their budgets, and disseminate their results. Projects result in outcomes that are desirable most times and that both positive and negative results both help advance the science and are therefore useful and productive. P3 explains that it is advantageous to have broader access to academic researchers to address tough problems collaboratively and conduct research that would not have happened outside of the context of the center. The broader academic research collaboration is positive for performance.

Regarding trust, P3 begins explaining the nature of the relationships that exist in the Center. The relationships between the scientists and industry have been established a long time, roughly 30 years. Directors mutually respect each other. The discussions can be frank due to the mutual respect and open communication norms of the directors. Healthy relationships exist at the Center, site, and project level “[...from the director level] down to the team level.” P3 observes that the long term relationships

between academic leader and partners underpins the program. The director has always had good links to industry. Financial investments for the Center are different than those of the co-ops in that this time the focus for the Center is for exploratory, fundamental research as opposed to direct application to specific problems in certain co-ops.

Academic-Industry Trust

“There is no difference.”

Action Managing Trust

High quality research outcomes, as measured by rigorous, peer-reviewed publications confirm scientists’ credibility and efficient stewardship of investments in conducting the research, subsequently, help maintain trust. P3 explains that industry representatives rely on faculty who are working on projects to speak up and communicate issues in projects which might require redirection. Industry trusts that the academics will remain open with project concerns. Trust is currently perceived as prevalent throughout the Center. P3 had a hard time thinking of an area where trust is lacking. He mentions that inevitably someone will be frustrated and there will be some conflict, but it isn’t necessarily a trust issue... it could just be “stubbornness.” But even in this the participants reach consensus and move on.

Successful UIRP

P3 succinctly explains “Industry needs answers and academics need research projects.” Academia and industry have to match up problems with abilities to do the research. Industry involvement keeps projects practical. Additionally, if industry keeps coming back, that marks success. If it didn’t work, they would drop out and not continue to participate. P3 summarizes that scientific collaboration benefits industry and academe and it is “...a worthy investment.”

Participant4 - Academic Faculty, Center Director for very large sized, long established I/UCRC

Background

P4 is a Center Director who was a founder of the Center. All of the universities had confidence that he would keep the Center’s interest at heart rather than his own personal career interests. He had already lead cooperatives so, there was a wealth of rapport with industry members already established. The difference in the Center is that there is a potential for a deeper level of collaboration once companies collaborate beyond their closest university in their region and conduct work across regions and disciplines. His current role with the Center is strictly administrative and his responsibilities include conducting the annual advisory board meetings, overseeing university reporting to NSF and coordinating voting on funding allocations for projects. He is also responsible for some Center publicity efforts, but not formal recruiting which is done at the university levels. P4 states the purpose of the Center is to bring together industry members and university scientists across the country to solve problems with interdisciplinary approaches; and, also to provide graduate students with industry relevant, cutting-edged scientific training.

Trust and Performance

P4 lacked practical experience in his research area, so he took specific effort to be careful to not overstep authoritative boundaries in telling industry what they should be doing. However, he gained the trust over

the few years by learning more about the field from an industry standpoint and interacting with the industry members and he happily reports that no members left the program due to dissatisfaction with the program. P4 made a habit during these years to visit every company on their site in order to develop personal relationships with these people and getting to know the needs of the companies and the individual co-op programs. As the program was winding down with membership declining due to a market upheaval, there were a few companies who remained part of the program seemingly out of loyalty to the P4 as the leader. When P4 assumed a role in his university where he ended up being largely absent in just one year of personal career changing, everybody agreed that it was time to end the program. This pointed out the importance of personal relationships and the members' trust in his motives to serve their needs.

P4 provides another example from the Center formation and explicitly asserts that the Center formation was built on trust. There was an issue of mistrust between some of the universities who were desiring to form a Center and an antagonist needed to be removed from the situation. The removal of the antagonist by P4 validated the remaining member's trust in P4 to be an impartial leader and the center was ably built on a solid trusting relational foundation.

Academic v. Industry Trust

P4 believes that fundamentally there is no difference in academic versus industry trust. He explains that people are people, they just play different roles. Industry members have a corporate role with a business and/or technical agenda. Further, the value systems for academe and industry are different. For industry members, it is important to convey to their home organization that the Center membership is valuable and that their company is a critical part of the Center. This is unlike faculty who are largely free agents and not as concerned about their organizational advancement. Faculty are individually motivated to form strong research programs and train graduate students. In the context of the Center, however, faculty have learned over time that to have a successful research program in the Center, they must keep industry members happy and trust high between them. P4 summarizes that the fundamental dynamics for trust in academics and industry are the same, industry members and academic participants just play different roles.

Action Managing Trust

P4 states that it is critically important to understand the needs and desires of people in any situation. At an interpersonal level, one needs to understand the motives for others' needs to find an empathetic position and "get in their shoes." It's also important to recognize that people are not always forthcoming with their actual feelings and by not talking openly, the chances of finding common ground necessary for building trust are reduced.

At an organizational level a successful negotiation in an enterprise only happens through accounting for all players' needs. P4 likened a Center cooperative to an enterprise which must have a same accounting of needs to be successful. Specifically, sometimes many companies voice many different needs. Since the Center can't do everything, leaders have to learn what is most important to each of them and then somehow bring these needs together. When prioritizing the Center's activities it's important to seek commonly important goals and over time to make sure that everyone has had some needs met at some

point. Trust is cultivated in meeting these needs. If someone loses all the time, they're not going to trust that the Center is looking out for their interests and therefore won't see the Center membership as a worthwhile endeavor. However, those that win feel considered, heard, acknowledged as valuable, and trust that the Center is a worthwhile endeavor. The atmosphere of the center should be one in which participants have faith that they will win sometimes if they keep supporting the effort.

The formal IAB meetings are purposefully designed with high levels of informal interaction time. There are adequate breaks and poster sessions for conversational times during the day and there are also evening social engagement activities. The informal interactions offer opportunities for leaders and members to converse about how the members' experiences in the Center are going and to gauge satisfaction. These interactions are also opportunities to seek ideas and suggestions for Center improvement. The interactions convey that the members are integrated into the communication pipeline for the Center and that their ideas are respected and Center leadership care about what is important to them. There are also formal business meeting interactions at the IAB meetings where industry can voice their concerns and or satisfaction with the Center's progress. Both the informal and formal mechanisms contribute to open communication that is essential for maintaining trust in partnerships.

In the context of this large center, it is difficult to maintain one-on-one relationships as opposed to in small co-ops like the P4 had previously run. There are relationships that have remained strong and have lasted many years. However, face-to-face is so important that P4 plans to begin visiting some member and university sites again to connect in a more personal way to continue building internal trust within the Center.

A concluding example is the context for which P4 as Center Director is currently encouraging faculty to collaborate on proposals using what he describes as "a soft sell" approach, but anticipating that more frank talks are becoming necessary in order to get the desired outcome. P4 is becoming insistent upon the collaborative proposals due the fact that the current method of proposals is not allowing industry members to reap the full benefit of being in a collaborative research center. Industry has already vocalized some disillusionment with not getting all that they invested in and expected to reap in terms of fundamental, collaborative research, so P4 believes that addressing this need will lead to greater industry trust.

Successful UIRP

P4 believes that academia and industry bring complementary assets to the table. Academia contributes talented academic research scientists and graduate students who are potential employees for companies. Industry provide funding and often facilities to get research work done. Industry also brings a grounding in what research is most relevant to make a difference in the world. In order for this complementarity to work, there needs to be a critical mass of companies who are interested in the work and there needs to be a critical mass of academic faculty and students who are engaged in doing the work.

The different sides – academe and industry- have different measures of success. Companies anticipate research results that can be translated into actual practices that impact how they manage their business and make their companies more profitable. Academia measures success in graduate students trained, research dollars brought into their programs and high impact publications. Academe also receive

an intrinsic reward of seeing companies using research they developed and validating that the work they put in was indeed worthwhile.

P4 sees his Center as successful when observing active and vibrant participation by industry members, energetic and innovative research being conducted, and bright graduate students being attracted to the Center and succeeding in their careers.

Participant5 - Industry Advisory board chairperson for (Med; older) I/UCRC (no member check)

Background

P5 is the head of a research and development group at his company who was seeking university partners at the time for specific problem which they came across. He visited a university where a site director introduced the Center concept and the company saw the potential value and joined the Center. Engagement with the Center Director on a strategic level helped P5 to see what the Center stood for. As he learned more about the Center and had opportunity to interact with the director, he was eventually asked by the director to be the IAB chair. He firmly believes in the knowledge sharing mission of the Center and was also personally intrigued by the leadership ability of the Center Director at the time. P5 describes the purpose of the Center to develop the best practices through research and collaboration and to tackle some topics that have not been tackled before in the field with a balance of fundamental and applied research.

Trust and Performance

P5 characterizes the performance of the Center as “outstanding” in terms of how well defined, motivating, clearly articulated and presented the vision is for the Center. P5 referred to the level of authority and access that the academic leaders encouraged the industry members to have as an example of trust at work in the Center. The (Academic) Center Director included industry in the vision formation early through a retreat. Industry input was considered in the research roadmap. P5 seemed humbled at this level of involvement and saw it even as a privilege to be part of what academia does in setting the research roadmap and direction for the Center.

P5 also highlighted the shared responsibility for organizing the IAB meetings. There were opportunities to raise concerns share multiple perspectives on Center issues in the process of organizing the meetings. There was complete transparency with the updates regarding decision making on behalf of the Center. P5 noted that the Director involved the right people and openly shared difficulties he encountered. Progress was reported regularly through monthly updates and there has been a consistency in transparency which was built trust over time.

At the project level, P5 shares that trust exists between researchers and industry members through member companies including faculty researchers into their formal reporting to their companies. It was noted as an undesirable attribute for faculty researchers to work separately from industry and that it was particularly good to share the academic researcher’s impact of the work with the company management. P5 actively involved academic researchers with updates and reports to the company. In a particular example, a researcher presented directly to the company Vice President Research & Development - a very high level of visibility. This access to the highest levels of the organization is building trust by communicating a sense of importance. This communication of importance was reciprocated when P5 and his company visited the university and were welcomed at the department level with good face-to-face

dialog and discussions. P5 and his company members had opportunities to see the labs and opportunities for new discussions beyond the project at the time. A highly positive outcome of this particular visit was the hiring of a student to work for the company. There was trust built overtime between the university and company and while the student still went through the formal processes, the hiring was significantly easier due to the trust built through the long term relationship between the two organizations.

Academic Trust v. Industry Trust

In describing the potential difference in academic trust and industry trust, P5 directs attention to companies questioning academics' ability to respect milestones and to adhere to a schedule. Industry members pay attention to this. Participants in Industry- industry collaborations expect mutual respect of milestones and schedule; however, this is not currently the norm for academic-industry collaborations. P5 also mentions intellectual property (IP) issues briefly as a potential point of trust to consider differences, but with no further elaboration.

Actions Managing Trust

According to P5, complete and open sharing of information is of foremost importance. Information should also flow seamlessly from the IAB to the university sites. Open communication is key and a critical part of trust. P5 believes it is important to "Trust but verify" and describes the meaning in terms of following up on intended actions. If one says he/she is going to do something, then it should be verified that the action is indeed completed. The examples were simple and in terms of meetings in which one should create specific action items after a meeting. Within the Center, the Center Director was very good at following up on action items. Also, capturing meeting minutes was also another mechanism whereby one may verify explicit intentions aligned with actions. The follow up to addressing the issues is critical for trust and as well, on the flip side, continually raising issues that do not get addressed or followed up could lead to a loss of trust. Making sure there is a good feedback loop in communication process is important.

P5 also emphasizes an active presence is important for building trust. He made it a priority to participate in monthly conference phone calls with university site directors. Also, it was a priority for P5 to be present at the IAB meetings twice per year as much as possible. The face-to-face presence is an important action for building and maintaining relationships with Center members.

After the interview was conducted, P5 followed up with a message with an expansion of his perceptions of trust in University/industry relationships. He referred to an equation which he obtained from a leadership seminar:

$$\text{Trust} = (\text{credibility} + \text{reliability} + \text{intimacy}) / \text{Self-orientation}$$

He defined each of the variables as follows:

Credibility: expertise and fundamental knowledge for an academic also consider Quality of students as well; applied know-how...operational knowledge for a company.

Reliability: academic meeting deadlines and delivering results. For industry getting involved, following up and developing students

Intimacy: regularity of meetings, updates, communications, visibility, greater engagement in each other's organizations

Self-orientation (or lack that is desired) – all work together towards a common goal. Example in Center focusing on three points: 1) knowledge management, student investments, and increased collaboration and value for members.

P5 summarizes these elements were key in establishing trust in their Center's case.

Successful UIRP

P5 describes a successful UIRP as one in which universities deliver tangible, measurable results in a given timeframe and companies specify needs and projects and maintain actively engaged throughout the project. One example of a tangible measure of successful results is in terms of dollars savings for a company. This was particularly a high priority measure of success for his company.

P5 shares that there are also some intangible results which should be considered as measurements of success from a knowledge management and human capital perspectives. First, understanding the outcomes of a project and whether a company became more knowledgeable as a result of studying a certain research topic. This is related to a second measure from a human capital perspective of hiring a researcher who worked on a project which could be a way in which a company acquired knowledge. P5 alludes back to his personal company hiring a researcher as a win-win situation for all in that there is a mutual goal involving students that they be trained and hired and for researchers to remain contributors to the field.

Participant6 – Academic Center Director (med/mid) I/UCRC

Background

P6 was appointed to chaired faculty position at a university and a condition of the position included leading this Center. He found the Center director position to be differently rewarding than typical faculty duties in that the faculty involved in the Center choose to be part of a collaborative organization. As Center Director, P6 has no official authority over the people so the entire focus is on emphasizing mutual benefits and helping people work together and essentially encouraging them into productive behavior. He feels his job leading the Center is to form the right system and nurture the right culture with proper incentives so that people naturally do what ultimately benefits the Center – a challenging undertaking. He saw the opportunity in running the Center as an opportunity to “run his own ship his own way.”

P6 describes his responsibility as a leader as understanding the needs of the industry and making sure that faculty researchers who conduct the research understand these needs as well and are alert to what the industry members are trying to get in terms of value from participating in the Center. He makes sure that there is a foundation and infrastructure supportive of faculty-industry interactions and communications such that the needs of industry are met and value is created in the Center.

Trust and Performance

P6 first explicitly addressed the ambiguity in the term “performance” but previously in the interview provided some context from his leadership perspective of performance in the Center. Overall P6 was happy with the maturity of the Center – with how much companies in the Center are now thinking beyond project level work toward Center-wide benefits. He describes the challenge of companies in the Center originally focusing on what they can individually get out of a project growing in the Center to the point of realizing the holistic benefits of being part of a large collaborative effort. The evidence of this growth was seen in observing companies be more willing to invest specifically in operational funds for the Center and not just focus on a project investment.

While P6 described the performance of the center as great, he mentions that he is always concerned about membership retention which is a function of industry members getting value from the Center. From his leadership perspective, there is always a need for greater synergy and leveraging for the Center to be successful, but P6 does point out that it is continuously improving. P6 shared an example of seeing new interactions and companies thinking more broadly in successive IAB meetings as evidence of improving. Also, he shared that the industry members voted in such a way that they increased their membership fees in order to work on a project that was directly beneficial to the Center and indirectly beneficial to all of them. The industry members showed their willingness to invest in the Center beyond their project which is very positive for overall Center performance.

When he began sharing his experiences related to trust, P6 spoke of trust in the context of several different relationships within the Center. The first relationship was that of the site directors’ trust in the Center Director, P6. He shared an example of a potential conflict of interest in his dual position as the Center director and his own university’s site director. He had enough trust among the members that he would not “sell” his individual site to industry members over “selling” the entire Center to prospective members. P6 had to display impartiality toward the sites with directing new members to the Center. Otherwise, the resulting conflict would hinder information sharing that enables effective membership recruitment. Overall the members trusted the leader and believed he would not behave opportunistically with member recruitment.

Next P6 commented on the importance of site directors trusting in each other. He mentioned a specific communication tool as a formal mechanism they have for enabling information sharing during membership recruitment efforts. Universities can share membership contacts and negotiation progress with each other in an effort to try not to overreach each other and to try to maintain an overall collaborative environment rather than a competitive one. This tool has been used by other Centers and found valuable. It is a useful formal mechanism that represents an artifact of an integrated organization. Without it, mistakes in recruiting could hinder the “integrated” organization pitch to potential members. The mechanism enables sites to combine forces for recruiting and to share barriers to avoid repeating in recruiting. Overall, recruiting is more efficient with this sharing mechanism. The tool enables clearer communication to reduce misunderstandings between academics and industry and among academic leaders.

In the relationship between academic directors and industry members, P6 describes another aspect of trust is with regard to the formal legal agreements. There is the sharing of confidential information between research teams and member organizations on one hand and then there is the

honoring and understanding of the formal membership agreement. It is important to freely speak about the membership agreement and for both sides to have mutual understanding of the long term implications of the agreement. Speaking accurately for companies and research teams about expectations within the formal agreement. Members should address issues as they arise. P6 spoke about a recent example of a company perceiving some IP as valuable and wanted exclusive address; however, they were reminded of the agreement and the rights of other organizations in the Center. To discuss a potentially delicate issue in a holistic way requires trust between the parties involved.

Trust plays into many aspects of the Center working well and the members returning. The open, visible atmosphere set up front by the director also helps to reduce misunderstandings.

Academic Trust v. Industry Trust

P6 asserts that industry people trust each other more than the academics trust each other. This is probably due to the fact that there are no direct (industry) competitors in the Center. P6 further explains that industry also appreciates the interaction with peers and the sounding board of each other. He summarizes that essentially, they can trust each other because they don't rely on each other.

For academics, however, trust is not natural for them in the Center due to the competition for research funding. According to P6, academics compete for research territory through grant proposal space and industry membership funding. Academic collaboration also is not as high due to the research territory competition. There is also competition for IP idea space as well.

P6 does observe that faculty do have good relationships with high levels of trust with their industry partners. Different companies have different policies, but non-disclosure agreements (NDAs) are still required even with the high levels of trust. P6 notes that NDAs do not guarantee sharing, and that there is still guardedness around sharing information in research teams at times.

Action Managing Trust

P6 shared an example is an NSF best practice of sharing pooled research and operational funding budgets at the IAB meetings as an action for managing trust in the Center. According to P6, sharing the accounting of the budget and having financial transparency in research and operations is important for alleviating concerns and deflecting ideas of misallocating funds that would lead to an overall sense of distrust.

P6 further explains that transparency in finances also keeps industry members informed and credible with their home organizations. With the shared financial information, industry members can report the allocation of company funds in the Center and justify the spending back to their companies. Essentially,

the credibility is transferred through the member's ability to be aware of the Center happenings in their communications with their representing company.

The transparency about budgets and spending maintains trust and researchers can openly ask for the finances they need. P6 shares, for example, there was a small dip in membership which resulted in the need to increase the operations funding by \$1000 per member. There was a unanimous vote to go ahead with the decision. The upfront communication and transparency were key to having that open communication and building the trust through transparent financial stewardship.

Successful UIRP

P6 describes a successful UIRP as one in which academics see beyond epsilon value research – that is, marginal research that is not very far beyond an academic value. The collaboration with industry forces the academic research community to solve real problems, which is a good thing. Also, a successful UIRP will be successful educating students with industry contextual awareness that is not gained in a traditional classroom setting. Finally, UIRPs are successful when they transfer the research to use in industry. P6 estimates that the chances are high for many projects in the Center to change a practice or influence thinking in industry.