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The Effects of Relational and Social Behaviors Exhibited by Construction Project Team Members on Relationship Quality and Project Outcomes

James Ogechi Kereri

Louisiana State University and Agricultural and Mechanical College

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**THE EFFECTS OF RELATIONAL AND SOCIAL BEHAVIORS
EXHIBITED BY CONSTRUCTION PROJECT TEAM
MEMBERS ON RELATIONSHIP QUALITY AND PROJECT
OUTCOMES**

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Interdepartmental Program in Engineering Science

by

James Ogechi Kereri

B. CM., Jomo Kenyatta University of Agriculture and Technology, 2011

M.TM., Bowling Green State University, 2015

December 2020

To my mom, brothers, and sister:

You are amazing. Thank you for standing with me with your love and affection.

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TABLE OF CONTENTS

ACKNOWLEDGMENTS	iii
LIST OF TABLES	viii
LIST OF FIGURES	x
GLOSSARY	xi
ABSTRACT.....	xiv
CHAPTER 1. INTRODUCTION	1
1.1 Problem Statement	3
1.2 Goal and Objectives	3
1.3 Research Questions	4
1.4 Research Scope	4
1.5 Study Limitations	4
1.6 Dissertation Structure.....	5
CHAPTER 2. REVIEW OF RELATIONAL AND SOCIAL BEHAVIORS AND RELATIONSHIP QUALITY	7
2.1 Aim.....	7
2.2 Construction Project Teams	7
2.3 Social Networks	9
2.4 Social Networks and Construction Project Teams.....	10
2.5 Construction Project Team Behaviors	12
2.6 Collaborative Construction Project Teams	18
2.7 Relationship Quality	19
2.8 Chapter Summary.....	22
CHAPTER 3. RELATIONSHIP BETWEEN CONSTRUCTION PROJECT TEAM MEMBERS' RELATIONAL AND SOCIAL BEHAVIORS	24
3.1 Aim.....	24
3.2 Motivation.....	24
3.3 Methodology	26
3.4 Binomial Logistic Regression.....	35
3.5 Data Analysis and Results.....	40
3.6 Findings and Discussion	47

3.7 Chapter Summary.....	52
CHAPTER 4. RELATIONSHIP EMBEDDEDNESS IN CONSTRUCTION PROJECT TEAMS	
4.1 Aim.....	54
4.2 Motivation	54
4.3 Methodology	55
4.4 Multinomial Logistic Regression.....	60
4.5 Data Analysis and Results.....	64
4.6 Results and Discussion.....	67
4.7 Chapter Summary.....	76
CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS	
5.1 Introduction	78
5.2 Conclusions and Key Findings	79
5.3 Implications.....	82
5.4 Contributions.....	83
5.5 Future Research.....	83
APPENDIX I. SURVEY QUESTIONNAIRE (VERSION 1)	85
APPENDIX II. SURVEY QUESTIONNAIRE (VERSION 2).....	91
APPENDIX III. CASE STUDY QUESTIONNAIRE	101
APPENDIX IV. EXPERT INTERVIEW QUESTIONNAIRE	110
APPENDIX V: CODEBOOK.....	111
APPENDIX VI. QUESTIONNAIRE IMPROVEMENT SUGGESTIONS FROM EXPERT INTERVIEWS	112
APPENDIX VII. CASE STUDY INTERVIEW QUESTIONNAIRE	114
APPENDIX VIII: RELATIONAL TO SOCIAL BEHAVIOR (R,S) QUESTIONNAIRE MAPPING.....	115
APPENDIX IX. PERMISSION TO INCLUDE PUBLISHED MATERIAL	120

APPENDIX X. IRB EXEMPTION LETTER	121
REFERENCES	122
VITA	135

LIST OF TABLES

Table 2.1. Previous Research on Relational Behaviors	17
Table 2.2. Analysis of the Characteristics of Successful Teams	19
Table 3.1. Questionnaire Questions	28
Table 3.2. Expert Pilot Study Findings and Survey Question Revisions	31
Table 3.3. Absolute Frequencies for Relational and Social Behavior Data.....	34
Table 3.4. Binary Classifier Outcomes	39
Table 3.5. Respondents' Role and Work Experience	41
Table 3.6. Number of Years Worked Descriptive Statistics.....	41
Table 3.7. Fitted Models Parameter Estimates, Standard Errors, and p values	44
Table 3.8. Fitted Model Odds Ratios with Confidence Intervals and Predicted Probabilities	45
Table 3.9. Nagelkerke R-Squared Goodness-of-fit.....	46
Table 3.10. Prediction Models Internal Validation Metrics	46
Table 3.11. Significance Test Results for the Logistic Regression β_1 Coefficients	47
Table 4.1. Question Items in the Questionnaire.....	57
Table 4.2. REM Calculation Matrix	58
Table 4.3. Types of Validity and their Description	59
Table 4.4. Data Representing Relational to Social Behavior Pairs.....	59
Table 4.5. Absolute and Relative REM Frequencies for Each Relational Behavior	64
Table 4.6. Absolute and Relative Frequencies for RQ Variable Dimensions	65
Table 4.7. Absolute and Relative Frequencies for Project Outcome Variables.....	67
Table 4.8. Sensitivity, Specificity, and Accuracy Values for the Prediction Models.....	68
Table 4.9. Comparison Between Chapter 3 and Chapter 4 PPV and NPV Metrics	68
Table 4.10. Parameter Estimates, S.E., p value, OR and OR 95% CI for RQ Dimensions Models.....	69

Table 4.11. Parameter Estimates, S.E., p value, OR and OR 95% CI for Project Outcome Models.....	70
Table 5.1. Data Collection Tools by Objective.....	78

LIST OF FIGURES

Figure 3.1. Absolute Frequencies for Relational and Social Behavior Variables	35
Figure 3.2. Role of Respondents' Organization in the Project	42
Figure 3.3. Status for Projects Under Construction	43
Figure 4.1. REM Relative Frequencies for Each Relational Behavior	65
Figure 4.2. Relative Frequencies for Dimensions of RQ Variables	66
Figure 4.3. Relative Frequencies for Project Outcome Variables	67
Figure 4.4. Goodman-Kruskal Tau Matrix for RQ Dimensions and Project Outcomes.....	72
Figure 5.1. Research Methodology Process.....	78

GLOSSARY

Collaboration: “A creative process undertaken by two or more interested individuals, sharing their collective skills, expertise, understanding and knowledge (information) in an atmosphere of openness, honesty, trust and mutual respect, to jointly deliver the best solution that meets their common goal” Wilkinson, 2005, p. 2).

Communal relationships: “A relationship in which an interaction is governed primarily by consideration of the other’s needs and wishes” (American Psychological Association, 2020, para.1).

Exchange relationships: A relationship “in which the people involved are concerned mainly with receiving as much as they give” (American Psychological Association, 2020, para.1).

Fragmented relationships: A breakdown of project team member relationships.

Network embeddedness: The extent to which a team member is connected to other team members and how interconnected those team members are, in turn, to each other (Nahapiet & Ghoshal, 1998; Granovetter, 1992). The connections include both personal and impersonal relationships (Sporleder & Moss, 2002).

Project networks: The relatively organized set of relationships that an individual or group of team members have with others including contractual connections, and types and methods of communication (American Psychological Association, 2020, para.1).

Project party: A single entity (e.g., owner, contractor, design/engineer) integral to the delivery of a construction project composed of one or more persons.

Project team: An organized aggregation of individuals from all project parties who combine their individual inputs for the common pursuit of the project goals.

Project team member: An individual from the project team, irrespective of project party.

Relational behaviors: A team member's actions when subjected to some set of rules/standards/agreements which can either be formal or informal. Relational behaviors are representative of the interconnections between team members (Chinowsky et al., 2010).

Relationship: Connections between team members established by either a contract or as a result of continuing and often committed association between two or more team members (American Psychological Association, 2020, para. 1).

Relationship embeddedness: The extent of relationship interdependencies between two or more team members. Relationship embeddedness is a type of network embeddedness that specifically takes into account the interpersonal relationships that team members have with one another (Sporleder & Moss, 2002). According to Andersson et al. (2005), strong interdependence between member relationships suggests high level of embeddedness.

Relationship quality: The standard of evaluation (e.g., positive or negative, poor to excellent) of a relationship characterized by trust, conflict resolution, and knowledge transfer

Social behaviors: A team member's actions towards another as a result of their interaction and the responses they give in return. Social behaviors drive team relationships (Chinowsky et al., 2010).

Social networks: “Relatively organized set of relationships that an individual or group has with others, including types and methods of communication, patterns of liking and disliking, and the strength of interpersonal connections” (American Psychological Association, 2020, para.1)

Social network theory: A theory that conceptualizes the interaction of team members based upon their interconnectedness.

ABSTRACT

Relational and social behaviors of construction project team members explain team relationships. Whereas relational behaviors have often been studied in construction project team relationships, the current literature is deficient on the social behaviors. The literature review revealed seven relational behaviors (i.e., harmonization of conflict, propriety of means, restraint of power, reliance and expectation, contractual solidarity, flexibility, and reciprocity) and three social behaviors (i.e., past experience, benevolence, and integrity) commonly exhibited by construction project team members. Through a binomial logistic regression, research findings revealed that past experience was a significant ($p < 0.01$) predictor for five of the seven relational behaviors while benevolence and integrity were each significant ($p < 0.01$) predictors for three of the seven relational behaviors. Overall, out of the seven relational behaviors, only propriety of means is predicted by all the three social behaviors. Through multinomial regression, the results indicated that there is not enough evidence to show a relationship between the dimensions of relationship quality and project outcomes. However, there is a relationship between relationship embeddedness and project outcomes. Through internal and external validation, the prediction models performed well based on both positive predictive values and negative predictive values.

From a relationship management standpoint, this research introduces relational and social behaviors of team members as triggers of relationship embeddedness, and the potential influence on relationship quality and project outcomes. The results contribute to understanding the effect of social behaviors on the relational behaviors found in construction project teams where eleven statistically significant models that predict relational behaviors using the social behaviors were validated. The implication of this is that construction industry practitioners' efforts to create a more relational team can use these prediction models in predicting the relational aspects of the team.

CHAPTER 1. INTRODUCTION

Construction projects require completion of complex tasks by project team members drawn from multiple disciplines through contractual relationships between project parties. While contractual obligations outline party responsibilities, they are not necessarily effective in forming relationships and collaborations among team members to meet project schedule, cost and quality targets (Li et al., 2020; Yong & Rowlinson, 2012; Egan, 1998; AAA, 1994; Latham, 1994). Therefore, relational approaches (Macneil, 1974) such as partnering agreements and alternative project delivery methods (Zou et al., 2014) have recently been implemented to complement contracts in construction team formation (Adami et al., 2019). Individual behaviors of construction project team members inherently influence the quality of team relationships (Wambeke et al., 2012; Pryke, 2005; Pryke, 2004). Thus, relational approaches have the potential for team members to form stronger collaborative relationships, leading to improved relationship quality (RQ). Improved RQ may in turn foster deeper cooperation and collaboration (Memon et al., 2014), resulting in increased project performance (Jelodar et al., 2016; Chinowsky et al., 2010).

Fundamentals of relationship embeddedness stem from the study of social networks, explaining relational and social behaviors as key elements in initiating and maintaining sound relationships in project networks (Chinowsky et al., 2010). Previous construction research has identified relational behaviors as: 1) harmonization of conflict, R₁, 2) propriety of means, R₂, 3) restraint of power, R₃, 4) reliance and expectation, R₄, 5) contractual solidarity, R₅, 6) flexibility, R₆, and 7) reciprocity, R₇ (Ning et al., 2017; Harper et al., 2016; Macneil, 1980) and social behaviors as: 1) past experience, S₁, 2) benevolence, S₂, and 3) integrity, S₃ (Chinowsky et al., 2010; Rousseau et al., 1998). Project team member behaviors influence RQ (Wambeke et al., 2012; Pryke, 2005; Pryke, 2004); however, current construction literature focuses primarily on relational

behaviors in conceptualizing and modeling RQ while virtually ignoring social behaviors. It is important, therefore, to theoretically and empirically analyze team members' relational behaviors given the social behaviors within the team.

Construction project team members' relationships often start as arm's length relationships, which are not based on previous history or personal relationship considerations (Forsgren et al., 2005). Arm's length relationships are purely based on contractual agreements where project parties are expected to meet contract requirements according to the pre-specified terms and conditions (Hobbs & Andersen, 2001). With time and experience, team members develop embedded relationships (Andersson et al., 2005), which often offer a platform for improved RQ, which is characterized by trust, information transfer, and conflict resolution (Uzzi, 1997). RQ is a concept of interest in many industries beyond construction (Jelodar et al., 2016). Therefore, diverse definitions exist. However, RQ definition and assessment in the construction industry are in their early stages (Agustiawan et al., 2019). Current research in construction management (e.g., Iyiola & Rjoub, 2020; Lu & Guo, 2019; Jelodar et al., 2016; Williams et al., 2015; Leonidou et al., 2013; Ling et al., 2013) conceptualizes RQ as a high order construct consisting of several well-defined and distinguishable dimensions.

Research has shown that improved project outcomes, traditionally measured by tangible measures such as cost, schedule, safety, and quality (Ling & Bui, 2010), are achieved through sustained relationships between construction project team members (Gunhan, 2019; Ling & Bui, 2010; Liu & Walker, 1998). There is growing empirical evidence that RQ is linked to project performance. For instance, Jelodar et al. (2015), Williams et al. (2015), and Cook and Hancher (1990) showed an association between RQ, predominantly measured through the frequency of communication and conflict resolution, and construction project outcomes (i.e., cost, schedule,

quality, safety, owner satisfaction). Furthermore, RQ in these studies is based on relational contracting practices that are focused on relational behaviors, with minimal attention to the social behaviors (e.g., Jelodar et al., 2016; Zhang & Ng, 2013; Kumaraswamy et al., 2005).

1.1 Problem Statement

While current evidence in the literature show that both relational and social behaviors exhibited by team members are important in shaping team relationships, little attention has been given to the social behaviors. Consequently, there is not enough empirical evidence to determine team members' social behaviors. Furthermore, existing RQ models do not consider the relationship between relational and social behaviors exhibited by construction team members. Therefore, there exists a missing link between RQ defined in terms of relational and social behaviors and project outcomes.

1.2 Goal and Objectives

The goal of this dissertation research is to better understand the behaviors contributing to RQ and the impact of RQ on project outcomes. As a step towards addressing this goal, three specific objectives are identified:

1. Conduct an in-depth literature review and content analysis to identify social behaviors common in construction project teams.
2. Statistically model the relationship between construction project team members' relational and social behaviors as expressed through a national-level survey
3. Statistically model project outcomes and dimensions of RQ using a measure of relationship embeddedness based on case study data collected from transportation and wastewater projects.

1.3 Research Questions

In pursuit of meeting the objectives of this research, the specific research questions that will be explored in this dissertation are:

1. What are the social behaviors commonly exhibited by construction project team members?
2. What is the relationship between construction project team members' relational and social behaviors?
3. What is the relationship between relationship embeddedness and dimensions of RQ?
4. What is the relationship between relationship embeddedness and project outcomes?
5. What is the relationship between the dimensions of RQ and projects outcomes?

1.4 Research Scope

The data used for this dissertation research came from a United States national-level survey of construction decision makers (e.g., project engineers, project managers, design engineers, superintendents, contract administrators, estimators, schedulers, foremen, and operations and maintenance personnel) deployed by the author. For the case studies, the data were derived through case studies of publicly funded highway transportation and one wastewater projects.

1.5 Study Limitations

This research has several limitations, including:

- This research targeted the primary contracting parties as part of the construction project team, (i.e., the owner, contractor, design team, engineers, and subcontractors). However, the construction project team also includes non-construction professionals and suppliers beyond the primary contracting parties (e.g., material suppliers, technology support staff, and administrators), who were not considered in this study.

- The case studies were limited to infrastructure projects (water/wastewater and transportation projects) that were 60-100% completed. Projects from other construction sectors (e.g., commercial or residential) could provide additional data which may yield findings different from the findings of this research. Furthermore, the case study survey response samples were very small and should be considered a pilot study.
- This dissertation focuses solely on the extent to which embedded relationships are presented as products of the identified relational and social behaviors.
- This research identified a weakness with the questionnaire that was used because the responses were more inclined to elicit some choices. In as much as the authors hoped for conscientious responses, there was no way to know whether the respondents really understood or thoroughly read the questions before answering them. It is recommended that significant future research focus on data collection to confirm the data and findings of this dissertation.

Although several limitations exist in this research, they are acknowledged to serve as a starting point for future research in this topic.

1.6 Dissertation Structure

The dissertation is organized by research objectives and structured into chapters:

Chapter 2 provides an in-depth literature review and content analysis of the social network theory and construction project team literature. This chapter reviews the literature on construction project networks, provides a summary of the social factors that influence relationships in construction project teams, and reviews relational behaviors commonly exhibited by construction project team members. The comprehensive literature review and content analysis establishes the need for the current study.

Chapter 3 explores the relationship between relational and social behaviors exhibited by construction project team members in a construction project. This chapter is based on the review of literature and data collected through the use and distribution of a national-level survey. The participants were comprised of primary contracting parties that were part of a construction project team. Logistic regression modeling was used in the analysis.

Chapter 4 builds on the conceptual RQ model. Case study surveys and interviews using structured questionnaires with project team members, observations of the team in the field, and review of project documents were utilized. The data analysis utilized both qualitative and quantitative approaches. The qualitative approach used descriptive statistics to infer conclusions and trends within the cases, while the quantitative approach used multinomial logistic regression to investigate the relationship between fundamentals of relationship embeddedness, dimensions of RQ, and project outcomes.

Chapter 5 presents a summary of research findings, conclusions, implications, and areas for further study. The information provided in this chapter is composed of contributions to the overall body of knowledge and leads to further areas of research.

CHAPTER 2. REVIEW OF RELATIONAL AND SOCIAL BEHAVIORS AND RELATIONSHIP QUALITY

2.1 Aim

This chapter explores construction project networks and the social behaviors commonly exhibited by construction project team members. Relational behaviors commonly associated to construction collaborative teams and RQ modeling are also reviewed.

2.2 Construction Project Teams

The construction industry involves multiple contracted parties for the design and construction of projects. Project parties draw people from various disciplines with diverse expertise and specialties which then form the construction project team. The construction project team formed has a unique objective, composition, and method specific to the project at hand (Cornick & Mather, 1999). According to Salas et al., (1992), a team is “a distinguishable set of two or more people who interact dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform, and who have a limited life-span membership” (p. 4). Three main characteristics about teams emerge from this definition.

First, a team needs to have a common objective. However, it is often common that construction project team members do not share a common objective (Ju et al., 2017). In the construction industry, the objective of construction project teams is determined by the owner who has specific needs and mobilizes the required resources to meet those needs (Cornick & Mather, 1999). The owner then contracts a designer who is required to articulate the owner’s needs in a

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technically competent manner within the limitation of the owner's resources (Cornick & Mather, 1999). The project team implements the project design through to its successful completion taking into account project schedules, budget, and quality (Abdou, 1996). Efforts to create a common objective among construction project team members has been on the rise recently. However, the construction industry continues to engage subcontractors who do not necessarily share same values and objectives as the main contractor (Akintan & Morledge, 2013) and the engineers or architects (Emmitt & Gorse, 2006). Furthermore, the lack of a common objective among the diverse construction project team members has often been associated with the limited understanding of how one team member's behavior influences others on the team (Ju et al., 2017).

Second, project team members have specific roles. For example, architects have the role of designing the project and the spaces around them, while a construction superintendent has the role of overseeing the day to day operations of the construction site through coordination and supervision. Furthermore, multiple people may be assigned to the same roles, but these roles contribute collectively to the overall objective of the construction project. Additionally, roles in construction project teams are interdependent, where members of a team operate in connected roles (Kwofie et al., 2015). The defined and interconnected roles in construction project teams are very important because they define what is required from each team member, and who does what and when.

Third, the defining characteristic of a team is the interdependency of the interactions. Formal interactions are based on team member roles defined in contract documents signed by the project parties (e.g., a contractor will depend on the drawings from the architect/engineer to determine cost estimates and implementation on the site; a window installation subcontractor will depend on the masonry subcontractor to make window openings). Informally, team members

interact outside their roles, which can be within the workplace or outside work environments (e.g., sporting events, family interests). Therefore, relationships form as a result of people who have something in common coming together (e.g., friendships arising from a commonality, or relationships developing at places of work or as neighbors). As such, individuals who have comparable attributes or behaviors are classified together while those of dissimilar attributes are left out of the network, which can stretch team relationships.

2.3 Social Networks

From the perspective of social networks, construction project teams can be viewed as social groupings of individuals, who through their formal or informal interactions form a pattern of relationship networks (Zheng et al., 2016). Since these relationship networks are geared towards achieving the objectives of a specific construction project, they are often referred to as construction project networks and they operate with a relational approach that permits high-performance teams to emerge (Keast & Hampson, 2007). Wambeke et al. (2012) and Pryke (2005, 2004) attest to the fact that construction project team members act as points through which team relationships intersect to form a project network. Team members in project networks are free to use their personal connections to link together other team members to create a more collaborative team.

Personal connections refer to pre-existing relationships with others in the team. The potential of social networks to allow members to use personal connections differentiates project networks from teamwork (Triguero, 2018). Therefore, practices and processes that permit team members to socialize becomes essential. For example, team building activities and workshops can help team members familiarize themselves to one another and create personal relationships.

Collaborative relationships are essential in project networks for successful completion and performance of a construction project (Chinowsky et al., 2010). Research regarding construction

project networks is in the early stage, thus, the mechanisms by which construction networks form, the role/influence of each construction project team member in a network, and the social behaviors that influence team member interactions, are yet to be thoroughly investigated, even though these factors have a considerable impact on team performance.

According to Chinowsky et al. (2010), human behaviors (i.e. relational and social) are key to the establishment and maintenance of sound relationships in project networks. Substantial research has focused on relational behaviors in construction project team relationships (Harper et al., 2016). However, there is scant research regarding social behaviors in construction project networks. To address fragmented relationships in construction project teams, for example, it is argued in this chapter that the social construction of project networks should be addressed. The focus should be drawn to those social behaviors that will enhance trust, knowledge transfer, and joint problem solving (Uzzi, 1997), which have been identified as key RQ factors.

2.4 Social Networks and Construction Project Teams

Social network theory has been in use since it was first proposed by Moreno (1934). Moreno's major contribution to social network theory was the creation of sociometrics, a method in which networks are identified among groups. More authors have since contributed to social network theory studies, including Von Bertalanffy and Sutherland (1974), who established a general systems theory framework for analyzing networks. Also, Bonacich and Friedkin (1998) used the social network theory to define social influence and control of team members within a network setting. Over the years, the application of social network theory in various disciplines have been on the rise (Kereri & Harper, 2018).

The basic social structure elements are the connections among team members in a group, where the connections involve the exchange of valuable information and resources between the

members in a network (Aguilar-Raab et al., 2015). Furthermore, social network theory describes the social structure as a product to create conditions for the emergence of repeat relationships, as well as striking a balance between exchanges and team member expectations, based on networks of team member connections (Bernstein, 2015).

The concepts of social network theory have since been applied in the construction industry through the introduction and understanding of relational approaches. Specifically, the relational contract theory promoted by Mcneil (1980) that compared and contrasted relational and social behaviors. In relational contract theory, primary relationships in social networks are referred to as personal relationships, involving, among other factors, all the behaviors of individual team members (Mcneil, 1980). Moreover, relational approaches are not limited to solely relational contracts, but also the interpersonal relationships and interactions between team members. Therefore, team members are encouraged to adopt relational approaches in building interactions socially in a structured manner, without following subscribed legal mechanisms, to build trust and commitment towards achieving a common goal: construction project success (Memon et al., 2015).

A construction project brings together many individuals from diverse backgrounds who interact to form construction project networks. Uniquely, interactions in construction project networks are very dynamic, adapting to changes from members joining or leaving the network (Kereri & Harper, 2018). While studying social networks, Chinowsky et al., (2008), reaffirmed the nature of construction projects as unstable networks, due to the temporary status where parties come and go within a project, and tend to re-initiate with each new project. Therefore, understanding team member interactions and improving working relationships can influence project performance and success (Lin, 2015). As a construction project becomes more competitive and demanding in terms of risk and complexity, changing social order will always be found in the

construction project network (Aldrich & Kim, 2007). The social order defines how team members engage and interact with one another.

Chinowsky et al. (2008) proposed a construction social network model. The model links individual attributes and team member characteristics to team behaviors. The goal of the model is to establish high levels of trust and knowledge transfer, exchanged through collaboration among the team members. The underlying concept of the construction social network model is that by achieving high levels of trust and focusing on shared goals within a project network, the team will share information more and increase knowledge transfer, which then translates to high performance in projects. The model is a shift from the traditional measures of project success (i.e., time, cost, quality, productivity, and safety) to emerging issues such as societal and strategic concerns (Chinowsky et al., 2008).

2.5 Construction Project Team Behaviors

Individual construction project team members are expected to adopt and attain some level of relationship embeddedness when pursuing collaborative working relationship strategies. Both relational and social behaviors of individual team members have been associated with relationship embeddedness (Sven, 2004). Embedded relationships in project networks are exhibited when one team member holds a connection with two others who are not connected, the embedded team member acts as a “go-between,” hence tying them together (Chandler & Wieland, 2010). The go-between plays a crucial role in passing expectations from an embedded member to unconnected members. In construction project teams, go-betweens essentially break down contractual relationships for ease of information and resource flow, to more relationship based rather than transactional. The go-betweens link small groupings that exist within the network and break down hierarchy that exists within the team (Chandler & Wieland, 2010). In the process, a network is

formed, where members are exposed to team members' relational and social behaviors; thus, the network moves beyond individual concerns to those of the project.

2.5.1 Social Behaviors

Social behaviors have been described as the “what” that drives interpersonal relationships in a construction project network (Chinowsky et al., 2010). Social behaviors are those behaviors that influence or may be influenced by others at the point of interaction (McGlynn, 2012). In other words, the social behaviors of one member of a construction project team may influence the behaviors of others within the same team.

The study of social networks in construction is in its infancy at present. As such, a search of the literature in academic databases and construction journals provides limited published literature that focusses on specific social behaviors exhibited by construction project team members. A review of the literature found two papers that mention social behaviors exhibited by construction project team members. The first, Chinowsky et al. (2008) advanced the social network model based on human behavior (i.e., relational and social behaviors). However, it is difficult to separate the concepts of these two components from each other. For example, communication to pass information can constitute an exchange of knowledge. Furthermore, the author fails to describe the social behaviors exhibited by construction project team member.

The Chinowsky et al., (2008) model is anchored on the assertion that successful project networks are based on collaborative working relationships. The model seems to be an extension of relational trust first proposed by The Rousseau Trust Model (1998), that asserted that relationships depend on the trust levels that exist between team members. Relational trust is as a result of team members interacting with one another repeatedly over time (Rousseau et al., 1998). This trust depends on previous experiences with the other team member, also incorporating

benevolence and integrity. The Rousseau Trust Model (1998) advanced three factors as social behaviors exhibited by team members that represent the “what” of the exchange: 1) previous experiences, S_1 2) benevolence S_2 , and 3) integrity, S_3 . These social behaviors are described in the following three subsections.

2.5.1.1 Past experience, S_1

The previous experiences of team members who have worked together can influence how these members treat one another in a current project. For example, previous negative work experience may be damaging to relationships, thereby causing parties to lose trust in one another. On the other hand, a previous positive working experience may foster better relationships in a current project. As such, both positive and negative past experiences carry the potential of shaping individual behaviors of team members.

2.5.1.2 Benevolence, S_2

Benevolence refers to one’s concern for the well-being of others and to be generous or to show kindness to others. In construction project teams, a benevolent team member will show concern for the welfare of others by 1) showing consideration for the needs and interests of others; 2) acting in ways that will protect the interests of other team members; and 3) desisting from exploiting others within the team for the sake of self-interest (Mishra, 2012; McAllister, 1995). Further, benevolence encourages teams to develop social identity where members feel sense of belonging and value within the team (Dutton & Heaphy, 2003). Benevolence in a team can be exhibited through such behaviors as members being willing to meet, being compassionate to one another, willingness to act in good faith, and pooling resources.

2.5.1.3 Integrity, S₃

The construction industry demands that contractors complete the project on time, within a specified budget, and with the right quality, while at the same time generating profit. Integrity is defined as acting on accepted principles of right and wrong and being attentive to how one achieves results (Missimer et al., 2017). With competing interests in the industry, integrity is key to a cohesive, collaborative team. Integrity shapes how members will behave towards one another. Not only does integrity bring honesty to the construction project, but also the attribute tends to influence overall team behavior (Uzzi, 1997). Integrity in a construction project team can be exhibited in terms of the level of blame, following through on commitments, willingness to help others, and difficult situations are dealt with.

2.5.2 Relational Behaviors

Relational behaviors used in this dissertation are based on the relational contract theory advanced by Macneil (1980). Norms are expectations directed at those behaviors, which a partner in the exchange may show (Sven, 2004). Relational behaviors stem from two hypotheses: 1) relational contracts are essentially social and collaborative; and 2) contracts with substantial relational principles produce better project outcomes (El-Adaway et al., 2017). Therefore, every norm refers to the potential behavior of a project team member, and thus the relational contract theory norm framework may be used to structure research on relational behaviors (Sven, 2004).

Relational behaviors are well established in the literature as shared expectations or behaviors between project parties (El-Adaway et al., 2017; Diathesopoulos, 2012; Macneil, 1980). Relational behaviors exhibit a point of reference and establish standards to which parties are guided while executing specific tasks in a project. For better results in a project, the relational

behaviors of each team member must be acceptable to other team members: commitment to the team and the project is critical.

In the work by Macneil (1980), behaviors of contract parties do not necessarily depend on a form of project governance, but rather on the environment through which the relationship operates. To understand expected behaviors in relational approaches, Macneil (1980) developed nine primary social norms to guide behaviors of team members. Later, Macneil (1985) developed a tenth expected behavior while changing the label of one of the initial nine. These include R1) harmonization of conflict, R₁ 2) propriety of means, R₂ 3) restraint of power, R₃ 4) reliance and expectation, R₄ 5) contractual solidarity, R₅ 6) flexibility, R₆ 7) reciprocity, R₇ 8) planning implementation, 9) consent effectuation, and 10) role integrity.

Three of the ten behaviors are not commonly used in construction management research: planning implementation, consent effectuation, and role integrity. These are briefly defined but not discussed further. Planning implementation assumes investing in relationships between the project parties at the very start of the project (Prim-allaz & Perrien, 2010). This is not very common or widespread in construction unless it is for specifically formal partnering projects in the US or alliancing projects in Australia and New Zealand. Consent effectuation means agreeing to take other options at the expense of the contract whereas most parties in construction rely on contracts in their businesses (Faisol et al., 2005). This makes such a relational behavior uncommon in construction. Role integrity is a broad behavior, which mostly describes long-term behaviors specifically focusing on personal relationships. It is for this reason together with other existing literature that this dissertation identified integrity as a social behavior rather than a relational behavior. Therefore, these three behaviors were not studied further in this dissertation. Furthermore, this study considers behaviors that represent a reciprocal relationship between

members of a team. In other words, this research considers behaviors in which members return similar efforts in demeanor as their colleagues in the team.

The remaining seven commonly discussed behaviors have been identified through the review of literature (Table 2.1) and are defined following Table 2.1.

Table 2.1. Previous Research on Relational Behaviors

Author	Harmonization of conflict, R ₁	Propriety of means, R ₂	Restraint of power, R ₃	Reliance and expectation, R ₄	Contractual Solidarity, R ₅	Flexibility, R ₆	Reciprocity, R ₇
Thomas and Anderson, 1998						√	
Cannon et al., 2000	√					√	√
Cross et al., 2002		√	√			√	
Baiden et al., 2006					√	√	
Chinowsky et al., 2010				√		√	
Liu, 2010	√	√		√		√	
Xue et al., 2010	√		√		√	√	√
Alarcon, 2011		√		√		√	√
Bal et al., 2013	√	√	√	√	√	√	√
Ekberg-tamminen, 2013			√	√	√	√	
Palacios et al., 2013	√				√	√	√
Cao and Lumineau, 2015	√				√	√	
Handfield et al., 2015	√		√	√		√	
Lu et al., 2015		√			√	√	√
Harper et al., 2016	√	√	√	√	√	√	√
Williamson, 1975				√	√	√	√
Ning et al., 2017	√	√		√	√	√	

- Harmonization of conflict (R₁): In relational approaches, harmonization and conflict resolution is informal, flexible, and internal, because team members establish a distinct social order as an exchange becomes more relational (Kaufmann & Dant, 1992).
- Propriety of means (R₂): Requires that team members adhere to principles of division of responsibilities, together with contract terms and conditions. Team members are to be fair in their dealings through the principle of gain share and pain share, through risk and benefit sharing (Ning et al., 2013).

- Restraint of power (R₃): It is an expectation between team members that none of the project team members will apply their legitimate authority against any other member's interest (Kaufmann & Dant, 1992).
- Reliance and expectation (R₄): Team member relationships are based on the reliance (promise) that others will fulfill their part of the bargain. The expectations are anchored on the exchange of promises (Harper et al., 2016).
- Contractual Solidarity (R₅): Harmonious and peaceful state of a team that is able to preserve a relationship, especially in situations where one team member is faced with a difficult situation (Ning et al., 2017)
- Flexibility (R₆): Allows changes to occur in the environment to which the parties operate, or if the transaction exchanges between the parties are outdated, the flexibility of the team allows for termination and creation of appropriate exchanges (Macneil, 1985).
- Reciprocity (R₇): Refers to team members who treat one another as equals, and exchanges or transactions take place with these individuals being symmetrically placed. It can be said that reciprocity is a relation between individuals who mutually depend on each other's actions or influence (Macneil, 1985).

2.6 Collaborative Construction Project Teams

Researchers in construction and non-construction industries have considered the characteristics of successful teams. Table 2.2 presents findings of successful team characteristics, identified from the published studies reviewed. Problem solving, trust and commitment, effective/open communication, and previous experience were the most cited characteristics of successful teams. Indeed, these characteristics are associated to collaborative working relationships (Kereri, 2017), and are also associated with team member behaviors.

Table 2.2. Analysis of the Characteristics of Successful Teams

Characteristics of successful teams	Industry		No. of times the characteristic is cited in the literature	No. of studies the characteristic appeared
	Non-Construction	Construction		
Dispute resolution	√	√	83	22
Trust and commitment	√	√	77	19
Effective/open communication	√	√	57	14
Experience		√	47	8
Problem solving	√	√	45	10
Information exchange		√	23	7
Shared accountability	√	√	22	3
Shared leadership roles	√		21	7
Knowledge exchange	√	√	18	11
Reliance		√	17	5
Individual and mutual accountability	√	√	16	3
Performance measures	√		12	4
Team purpose	√		11	2
Collective work products/Shared goals	√	√	9	1
Pride		√	7	2
Values		√	6	3
Group culture	√		3	1
Independence		√	2	1

Team members who support one another and share information work collaboratively and freely to solve arising issues together (Kim & Nguyen, 2018). Relational approaches (e.g., project partnering or project alliances) aimed at collaborative teams bring together a number of organizations and individuals to work on a project; thus, the network pattern of the project team relationships will either facilitate or limit exchanges such as resources, knowledge sharing, and information exchange (Mickan & Rodger, 2000).

2.7 Relationship Quality

Relationship quality is a concept of interest in other industries beyond construction (Jelodar et al., 2016). Based on previous research, a common definition of RQ varies. For instance, Roberts et al. (2003) suggested a definition anchored on the properties presented by the attributes. Based on this concept, follow-up research has advanced on this argument and defined RQ as a high order-construct with several well defined and distinguishable attributes, that serve to evaluate positive

working relationships (Ashnai et al., 2016; Jelodar et al., 2015; Ashnai et al., 2009). This dissertation research extends this argument and identifies the dimensions of RQ together with other constructs associated with RQ.

2.7.1 Modeling Relationship Quality

Relationship embeddedness can be used to determine the quality of relationships in construction project teams. Embeddedness defines relationship ties through relational and social behaviors, which are reciprocal to one another in a team. However, previous RQ research is deficient in consideration of construction project team member relational and social behaviors. Since the concept of relationship embeddedness plays a key role in improving project outcomes, it is pivotal to consider the dimensions of RQ, as well as the mutual influence on project outcomes. This notion that relationship embeddedness contributes to project outcomes builds on the work completed by previous researchers who investigated project team relationships and project outcomes (e.g., El-adaway et al., 2017; Cacamis & El Asmar, 2014; Arya & Lin, 2007; Baiden et al., 2006; Bouchlaghem et al., 2004).

In construction social networks literature, some disagreements exist as to what attributes or combinations of attributes that can be used to evaluate RQ. Trust and satisfaction were stated as the main attributes associated with RQ in previous research (Jelodar et al., 2016). Currently, research on relationship embeddedness in construction project teams is limited, specifically on the attributes related to fundamentals of relationship embeddedness, dimensions of RQ, and project outcomes (Ashnai et al., 2016; Jelodar et al., 2016; Jelodar et al., 2015; Crosby et al., 1990).

2.7.1.1 Fundamentals of Relationship Embeddedness

Under the social network theory, one concept is that project team members engage and maintain relationships with an expectation of reward and that others in the team will reciprocate

(Hofer et al., 2009). Social network theory defines relationship embeddedness by relational and social behaviors. Therefore, team member relational and social behaviors form the basic building blocks for relationships to develop.

Lu and Guo (2019) investigated the effect of RQ in mediating relational behavior and concluded that RQ has an effect on relational behaviors, which in turn affect trust and information exchange. However, this study was limited to only three relational behaviors of flexibility, contractual solidarity, and harmonization of conflict. Another study by Rezvani et al. (2019), show a positive association between RQ and trust among team members. Construction project teams working in a collaborative project team environment is as a result of high levels of RQ.

2.7.1.2 Dimensions of Relationship Quality

Embedded relationships are used to explain construction project atmosphere. Project atmosphere is a manifestation of working relationships between team members and constitutes the dimensions of RQ. Several studies have been conducted to investigate team member relationships and RQ dimensions in many fields and disciplines. For instance, when parties interact over time, they develop higher levels of RQ and thus trust develops (Rezvani et al., 2019; Bond-Barnard et al., 2018; Santorella, 2017; Kereri, 2017; Uzzi, 1997), and team members more easily exchange information and transfer knowledge (Wu et al., 2017; Chinowsky et al., 2008; Emmitt & Gorse, 2006), and at the same time, solve conflicts jointly (Walker et al., 2017; Lavikka et al., 2015) or at the lowest level possible. On a positive note, this results in a collaborative project team with improved communication channels that reduce tension and allow free interaction among team members to perform their work better.

The project atmosphere attributes of trust, G_1 , conflict resolution, G_2 , and knowledge transfer, G_3 are used in this dissertation as dimensions of RQ. Trust is used to describe a situation

where each team member kept the project's best interests in mind. Conflict resolution represents situations where team members work out differences of opinion respectfully and jointly. Knowledge transfer describes situations where team members effectively share critical information with one another.

2.7.1.3 Project Outcomes

Traditionally, construction project performance is measured by cost, time, and quality. Cost performance is measured based on whether the project is completed over or under budget and expressed in cost growth terms. Project schedule performance is expressed in terms of schedule growth to ascertain whether the project was completed late or ahead of schedule. Quality is explained from a technical and workmanship perspective (Ling & Bui, 2010). As projects become more complex, more qualitative measures of construction success are identified, such as safety and customer satisfaction. Customer satisfaction is represented by owner and user perceptions of project performance, whereas safety is twofold from the work zone safety and user safety perspectives. For this study and the conceptual framework, project outcomes are measured in terms of budget, schedule, and quality objectives, as well as the functionality of the completed project.

2.8 Chapter Summary

Through a comprehensive literature review and content analysis, this chapter reflects on construction project teams from a relational approach perspective. In relational approach to construction project management, both relational and social behaviors of individual team members have been associated with relationship embeddedness. Therefore, in order to achieve collaborative working relationships, individual construction project team members are expected to adopt and attain some level of relationship embeddedness.

In summary, this chapter finds that:

- Social behaviors commonly found in the literature related to construction project teams are past experience, S_1 , benevolence, S_2 , and integrity, S_3 .
- Relational behaviors found in the literature related to construction project teams are harmonization of conflict, R_1 , propriety of means, R_2 , restraint of power, R_3 , reliance and expectation, R_4 , contractual solidarity, R_5 , flexibility, R_6 , and reciprocity, R_7 .

CHAPTER 3. RELATIONSHIP BETWEEN CONSTRUCTION PROJECT TEAM MEMBERS' RELATIONAL AND SOCIAL BEHAVIORS

3.1 Aim

The aim of Chapter 3 is to statistically model the relationship between the relational, R_{mn} (dependent variable) and social, S_n (independent variable) behaviors identified in Chapter 2, expressed by construction team members in a United States national-level survey. Binomial logistic regression is used in the analysis. Thereafter, statistically significant models are validated internally by partitioning the data into 70% training and 30% testing datasets.

3.2 Motivation

In the process of establishing construction project teams, contracts in general guide the mutual agreement of project parties to form a primary relationship structure, and to guard against unspoken assumptions (Smitka, 1994). Contracts clarify the basis for establishing relationships, thus developing the shared expectations of parties who form the construction project team. The general understanding of any exchange is that relationships are embedded in a complex matrix of social, political, and economic systems (Uzzi, 2017). The social, political, and economic systems work together in a system to reinforce one another. The advancement of relational approaches in both research and practice in construction management is anchored on relational contract theory and project procurement arrangements (e.g., binding project partnering agreements, project alliancing, and integrated project delivery). These types of agreements are aimed at achieving a collaborative atmosphere by creating a trust-based environment through open communication, cooperation, and collaboration (El-Adaway et al., 2017).

Social behaviors are described as drivers of team relationships where members establish relationships based on the well being of others, and members do so without expecting to be paid back (Triguero, 2018). This argument means that social behaviors are responsible for communal

relationships, and it is expected that positive interactions based on a team members' social behaviors will lead to collaborative project networks. Communal relationships in a team represent situations where team members are mindful and look out for the needs of others in a team without any obligation to do so or expecting any reward (Clark & Mills, 1979).

Relational behaviors stem from the well-researched relational contract theory premised on informal contracts and focused on interpersonal relationships (Harper et al., 2016). Furthermore, relational contract theory explains team member relationships as social contracts which are geared towards communal exchange (Triguero, 2018). Surprisingly, current research has ignored further investigation into the role played by communal relationships and instead focuses on the role of relational behaviors in creating a collaborative team. Uzzi (2017) concluded that both social and relational behaviors of individual team members were important in shaping team relationships.

Despite the established theoretical and empirical importance of project networks in shaping team relationships, there is a gap in research to investigate the influence of social behaviors on relational behaviors of construction team members. This study aims to bridge that research gap in construction projects teams by empirically examining the relationship between relational and social behaviors exhibited by construction project team members.

The interactions between connected team members are based on actions, acts, or practices where team members are mutually oriented towards one another, and that one member's behavior will affect the other. However, scant research exists to explore means through which construction project team members respond to one another and to their environments (Hamill & Gilbert, 2009). Therefore, understanding how social behaviors affect relational behaviors in a team environment is a step forward in bridging this gap. Relational behaviors represent informal expectations, which lack a clear understanding of the expectations of others, and which may give rise to

misunderstandings within the team. Team members' relational behaviors require the interaction and reinforcement of socially expected behaviors for the members to develop into a cohesive, high-performing team (Moran, 2005). Modeling of relational and social behaviors of construction project team members is anchored on Chinowsky et al. (2008) construction social network model.

The key differences between the theory investigated in this study and previously conducted research based on relational behaviors and construction project teams are 1) the theory shifts the focus to the role played by social behaviors in construction project team relationships; and 2) the theory targets relationships among construction project team members as a product of both relational and social behaviors, unlike past research that focused mostly on collective attributes of team members.

3.3 Methodology

3.3.1 Survey Design

A cross-sectional survey design was designed to collect data that were used to answer the research question on the relationship between relational and social behaviors exhibited by construction project team members. The questionnaire was administered through the online tool Qualtrics. The factors listed below were considered when designing the questionnaire.

- Open-ended vs closed ended: A challenge associated with open-ended questions is coding responses, especially when the sample size is large. This study used both open and closed-ended questions. Section I of the questionnaire included questions such as expected project completion date, specifying the project delivery method and the role of the respondent organization (if not included in the answer choices), number of years worked in the construction industry, number of years in their current position, and their willingness to assist with their project to be used as case study.

- Rating scales vs ranking tasks: Respondents do not enjoy rating scales as much as ranking tasks even though ranking tasks on a large sample size takes time to complete (Elig & Frieze, 1979; Kinnear & Taylor, 1971). Therefore, this study utilized a five-point Likert scale to rate individual statement items.
- Rating scale format: When scale points are all labeled with words, data quality is better than when just a section of the scale is labeled (e.g., Krosnick & Berent, 1993). Furthermore, oddly numbered scales give better options for answer choices. These factors were considered in developing the questionnaire.
- Order of response alternatives: Questions were grouped into two sections for clarity. The questions were randomly ordered across respondents to avoid bias by respondents resulting from question presentation order.
- Question wording: The questionnaire used short, simple words with which people are familiar. In case of technical or keywords used, definitions were provided before a question was asked.
- Question order: Questions were grouped by variables to make replies easier for the respondents.

The questionnaire was divided into two sections, with Section I containing questions regarding personal and project information, and Section II containing questions regarding relational and social behaviors of the project team members (see Table 3.1). Section I had both open and closed-ended questions while Section II questions consisted of statement items based on relational and social behaviors of team members. A copy of the questionnaire is provided in Appendix II.

Table 3.1. Questionnaire Questions

Section	Question emphasis
I. Project information and demographics	<ul style="list-style-type: none"> • Type of project and Project delivery method used • Respondents' role • Total number of years the respondent worked in the construction industry as well as at their current role.
II. Interpersonal relationships between project team members	<ul style="list-style-type: none"> • The section consists of statement items to measure social behaviors and relational behaviors of team members they work within the same project. The section consisted of statement items, and participants were asked to rate other members of the project team on a five-point Likert scale, where one represents strongly disagree and five represents strongly agree.

3.3.2 Questionnaire Validation

Questionnaires can encounter “errors,” which are deviations in responses from a real reflection of the population. Therefore, during the questionnaire design, the factors of construct validity, processing errors, coverage errors, sampling errors, and non-responsive errors were considered as described as follows to account for these errors without compromising the quality of the questionnaire (Groves, 2004).

Construct validity is the relationship between the measurement used and the construct being measured. Measurement errors in constructs can result when survey responses deviate from the true response. It is critical to measure constructs by designing questions that result in responses that accurately reflect the constructs measured (Groves, 2004). To recognize and eliminate measurement errors, the author engaged construction management professors and qualified industry experts to review the questionnaire, although feedback was limited and improvement of the construct validity is discussed later in this dissertation as an opportunity for significant future work. The content validity of the questionnaire was verified by pre-testing the survey on targeted respondents in the industry as detailed in the pretesting/piloting section (see Section 3.3.3).

Processing errors occur due to inaccuracies, illogical answers, or missing data in the data collection phase (Groves, 2004).. The data were collected in an ordinal format, rating from 1= strongly disagree, 2= disagree, 3= neither agree nor disagree, 4= agree, and 5= strongly disagree.

However, the rating scale was categorical and thus there was need to map the responses. Appendix III provides the relational to social behavior (R_m , S_n) mapping of the survey, based on the rubric attached to each question to generate the final format of the data that was ultimately used in the analysis. The rubric had contrasting scenarios; choice implying that team member exhibited both relational and social behavior, (1,1), choice implying team members exhibited relational behavior and no social behavior, (1,0), did not exhibit relational behavior but exhibited a social behavior, (0,1), and where team member did not exhibit relational nor social behavior (0,0). However, there were situations where neither the question nor the rubric did not capture any of these scenarios and was marked as N/A and were not included in the analysis. In situations where social behaviors were not explicitly stated in the rubric based on the social behavior measures, they were interpreted as implied (marked * in Appendix III).

Coverage errors occur when the sampling frame does not match the population investigated (Groves, 2004). This study focused on the United States construction industry; it may be assumed that the various regions and states share similarities, and thus the sample adequately represented the population. The sample size was calculated based on a margin of error of two percent assuming a 95% confidence interval and a response rate of 20-30%. The online survey tool Qualtrics recorded respondent locations, which were checked and showed that they were distributed throughout the United States.

According to Groves (2004), sampling errors occur due to sampling bias (when subjects within a sampling frame are not selected), or due to sampling variance (if a number of independent subjects are selected from the same sample). The simple random sampling technique used offered an equal chance for all subjects selected.

Non-response errors arise from the failure of survey respondents to respond to the entire survey (Groves, 2004). To decrease non-response errors, the author applied the web-based Qualtrics surveying program, where the respondent cannot proceed to the next set of questions until all current questions are answered. This “forced response” option was used to decrease non-response answers. With this study being purely academic, the author tried to make the respondents view it as such by using a university email address (.edu) in sending the request to increase the rate of response. Also, the email invitation to participate in the survey was personalized (request was received as a personal email, with their name), using the Mail Merge function in MS Word/Outlook. A distribution history was exported from Qualtrics and reminder email was sent each week to prospective respondents who had not filled out the survey after assessing recipients who had completed, started, and not started the survey. The survey was closed after the third week.

3.3.3 Pretesting/Piloting

Questionnaires commonly include items that are difficult to understand or are ambiguous. At the same time, questionnaires might include items the respondents understand, but find it difficult to interpret and answer in line the researcher’s intention. For this reason, questionnaire pretesting was an important step in detecting such issues and providing a remedy before data collection. The questionnaire was pretested and piloted, using a pool of experts (construct validity).

This study selected experts from two perspectives: Those who typically run construction projects (industry experts), and those in academia that work in similar research areas and topics. To obtain industry experts, the study chose construction workers listed in the Construction Management Association of America (CMAA) Certified Construction Managers (CCM) registry, the State Licensing Board for Contractors, Design-Build Institute of America (DBIA), the Associated General Contractors (AGC), and American Institute of Architects (AIA) databases.

The list was vetted and four participants with previous experience in managing a construction project team at a senior management level were selected. For the academic experts, a search of Ph.D. professors involved in relational contracting and relationship management in construction research was conducted, identifying four participants.

Table 3.2. Expert Pilot Study Findings and Survey Question Revisions

Question	Expert comments	Action
Section I	There was consistent feedback to include additional questions specifically on project details. Since the focus of the research was not relationships within a single organization, the experts expressed concern for the inclusion of the question on the number of years the respondents had worked with their current organizations.	Eight questions were developed (see questions 1, 2, 3, 4, 5, 6, 7, and 11 in the revised survey in Appendix II) with a focus on the name, type, and status of project, the type of project delivery method and the role of the respondent organization in the project. The question on the number of years worked with the current organization was omitted.
Section II	There was concern among the experts as to what these questions were measuring. A general feeling from the experts was that these questions were used to assess team performance in general and not necessarily individual's behaviors or team relationships.	This set of questions in this section were omitted in the revised questionnaire because the focus of the research is on individual's relational and social behaviors and not team performance.
Section III	The experts expressed concern over the repetitiveness of the questions and specifically some common terms. Most of them suggested the use of varied terms to describe the social behaviors instead of repeating the terms. Another suggestion was to use some scenarios within a team. These questions raised issues as it relates to question phrasing and concerns as to whether the respondents were part of the team or responding to questions based on what they observed in any team. The experts felt that the questions well captured the intended assessment and measures of relational and social behaviors in construction project teams.	The questions in this section were formatted to avoid repetitiveness of some key words. Definitions of past experience, benevolence and integrity were used interchangeably. Also, statements based on how these behaviors are exhibited by construction project team members were used to measure specific constructs while retaining the intended purpose of the questions. The questions were also rephrased to address the flow of the survey.
General concerns	Participants preferred brief statements and fewer questions in the questionnaire as most respondents will not have a lot of time on their hands to fill out the survey. Pretesters also noted "NA" was not included in the scale. The experts suggested revising the general format of and include an introduction section to briefly state what the research is about.	Questions were formatted to make statements brief by using definitions and case scenarios as well as omitting section II questions of the initial survey. Included "NA" in the ranking scale in section III of the initial survey.

After developing the questionnaire (version I, see Appendix I), this research set out to test these questions with the experts. The questionnaire was sent out to these two focus groups via Qualtrics (web-based survey tool). The pretesting questionnaires were analyzed for consistency and structured follow-up phone interviews were conducted (see Appendix IV for questionnaire) to

get feedback on the clarity of wording, layout and style, and the general appropriateness of the survey questions to measure and assess the targeted constructs (content validity). Phone interviews lasted between 30 and 60 minutes. The researcher took notes during the interviews on any issues raised concerning the questionnaire and noted key suggestions (see Appendix VI). Suggestions for improvements are summarized in Table 3.2.

3.3.4 Questionnaire Distribution

The population for this study includes representatives of construction project decision makers (e.g., project engineers, project managers, design engineers, superintendents, contract administrators, estimators, schedulers, foremen, and operations and maintenance personnel). The respondents to the survey were to complete the questionnaire from the perspective of an ongoing or recently completed construction project. The inclusion criteria also required that the respondents were based and working in the United States construction industry.

To develop a random sampling frame, professional organization databases listing the names and contacts of construction players were used. The questionnaire was then sent to 3,207 construction practitioners, whose contact information was obtained from the Construction Management Association of America Certified Construction Manager database, the State Licensing Boards for Contractors with online registration databases (Louisiana, Texas, Ohio, Illinois, California, Pennsylvania, and Michigan), Design-Build Institute of America, and the American Institute of Architects. Respondents also received two reminder emails throughout the three weeks that the survey was open. Of the total sent, 475 had emails that no longer worked, and ten were reported as having retired. Once the questionnaire was closed, 553 questionnaire responses (20.3% response rate) had been received which were then used for the analysis (see Section 3.5).

3.3.5 Questionnaire Data Processing

Data processing started with cleaning the data by deleting columns added by Qualtrics that are not applicable to the analysis (e.g., date and time when the survey was taken). The questions to section II (relational and social behaviors) were considered as being crucial variables in the study and therefore, the author considered responses that answered at least 19 out of the 21 (90%) questions as adequate for the analysis. After cleaning the data and checking it for completeness, 392 questionnaire responses (14.4% response rate) were used for the analysis. The relational behavior variables are represented as R_m for m relational behaviors, whereas social behaviors are designated as S_n (i.e. S_1 for past experience, S_2 for benevolence, and S_3 for integrity). For each relational behavior, R_m , there are three variables (i.e. one under each social behavior; R_{m1} , R_{m2} , and R_{m3}) as detailed in the codebook in Appendix V.

For each relational behavior, R_m , the three social behavior constructs, S_1 , S_2 , and S_3 were measured in contrasting scenarios that those behaviors are exhibited within a team. For past experience, S_1 , members were asked how they related with others whom they worked with previously. For benevolence, S_2 , varied situations in which the behavior is exhibited by construction project team members as used in the study are willingness for team members to meet, being compassionate to one another, willingness to act in good faith, and members pooling their resources together. Integrity S_3 , on the other hand was measured by the level of blame, following through commitments, willingness to help others, and how they deal with a difficult situation. In some of the questions in the survey, it was not possible to map them, and they were not included in the analysis. These questions are marked as “NA” in the questionnaire mapping (Appendix VIII). These were situations where the rubric did not clearly indicate or include a behavior in the choices/options. Table 3.3 shows the counts of the mapped responses.

Table 3.3. Absolute Frequencies for Relational and Social Behavior Data

Relational behavior, R_m		(R_{mn}, S_n)				Total
		(0,1)	(1,1)	(1,0)	(0,0)	
Harmonization of	R_{11}, S_1	4	99	229	43	375
Conflict	R_{12}, S_2	0	3	343	46	392
	R_{13}, S_3	161	1	77	77	316
Propriety of means	R_{21}, S_1	2	114	215	44	375
	R_{22}, S_2	6	97	203	52	358
	R_{23}, S_3	3	73	238	49	363
Restraint of power	R_{31}, S_1	11	50	63	63	187
	R_{32}, S_2	6	0	349	0	355
	R_{33}, S_3	2	85	243	42	372
Reliance and	R_{41}, S_1	2	96	228	54	380
Expectation	R_{42}, S_2	5	36	196	98	335
	R_{43}, S_3	3	60	223	74	360
Contractual solidarity	R_{51}, S_1	4	41	232	82	359
	R_{52}, S_2	5	75	199	68	347
	R_{53}, S_3	6	57	237	60	360
Flexibility	R_{61}, S_1	1	60	247	59	367
	R_{62}, S_2	4	37	259	66	366
	R_{63}, S_3	20	7	116	185	328
Reciprocity	R_{71}, S_1	1	83	223	67	374
	R_{72}, S_2	1	227	21	0	249
	R_{73}, S_3	0	143	142	13	298

Figure 3.1 graphically shows the absolute frequencies of the relational and social behavior data. The majority of survey respondents reported having exhibited relational behaviors, R_{mn} and not social behaviors, S_n (1,0). Situations where respondents reported to have exhibited social behaviors, S_n and not relational behaviors, R_{mn} (0,1) were least expressed.

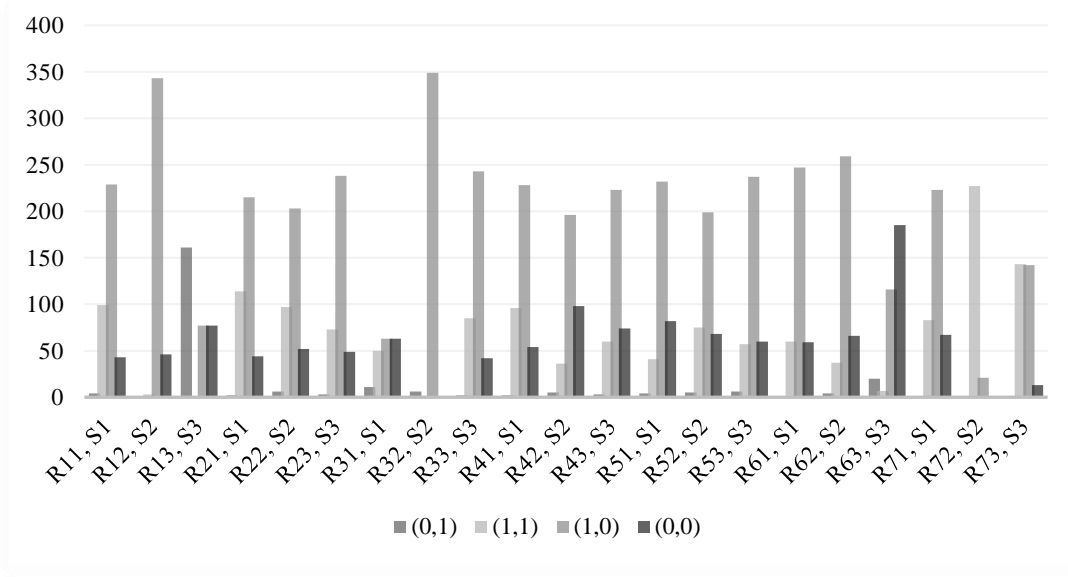


Figure 3.1. Absolute Frequencies for Relational and Social Behavior Variables

3.4 Binomial Logistic Regression

3.4.1 Model Fitting

Logistic regression is used to ascertain the relationship between relational and social behaviors exhibited by construction project team members. In Equation 3.1, R_{mn} is the m^{th} relational behavior modeled as a function of S_n , which is the n^{th} social behavior. The index variable m ranges from 1 to 7 and n ranges from 1 to 3, corresponding with the behaviors previously described. The social behavior S_n is binary, with a null value indicating it is not expressed and a value of unity indicating it is expressed. The probability $P(R_{mn} = 1)$ is the probability of that the relational behavior is expressed (i.e., the value of this variable is unity), as opposed to a null value, indicating it is not expressed. Regression coefficients β_0 and β_1 are determined by fitting this model structure to the collected data. Given the three social behaviors and seven relational behaviors, 21 models were fit.

$$P(R_{mn}=1)= \frac{1}{1+e^{-(\beta_0 + \beta_1 S_n)}} \quad (3.1)$$

After fitting the collected data to the model in Equation 3.1, logistic regression coefficients and overall models are tested for statistical significance. Significance tests are based on standard errors associated with the logistic coefficients and p values are used to test the null hypothesis that the logistic coefficient is zero (0), indicating that there is no statistically significant correlation between the social and relational behaviors.

3.4.2 Model Interpretation

Logistic regression coefficients are in log-odds units and cannot be interpreted in the same way as regular ordinary least squares (OLS), posing a challenge in their interpretation. Therefore, regression coefficients are often converted to odds (Equation 3.2) (Statistical Consulting Group, 2016). When $S_n = 1$, indicating that the social behavior is expressed, the odds are calculated as shown in Equation 3.3. When $S_n = 0$, indicating that the social behavior is not expressed, the odds are calculated as shown in Equation 3.4. The odds ratio (OR; Equation 3.5) is then calculated by comparing the odds of the two states. The odds ratio indicates how much more likely it is that the relational behavior is expressed when the social behavior is expressed, compared with when it is not expressed. Note that Equation 3.5 can also be expressed as the exponentiated value of the logistic coefficient, β_I .

$$\text{Odds}(R_{mn}=1) = e^{(\beta_0 + \beta_I S_n)} \quad (3.2)$$

$$\text{Odds}(R_{mn}=1)_{S_n=1} = e^{(\beta_0 + \beta_I)} \quad (3.3)$$

$$\text{Odds}(R_{mn}=1)_{S_n=0} = e^{\beta_0} \quad (3.4)$$

$$\text{OR} = \frac{e^{(\beta_0 + \beta_I)}}{e^{\beta_0}} \quad (3.5)$$

Lower (LCI) and upper (UCI) 95% confidence intervals for the odds ratios, collectively called OR 95% CI, are calculated in accordance with Equation 3.6, where $S.E.(\beta_1)$ is the standard error of the estimated model coefficient β_1 .

$$\text{OR 95\% CI} = e^{(\beta_1 \pm 1.96 * S.E.(\beta_1))} \quad (3.6)$$

Predicted probability values calculated in accordance with Equation 3.1 when $S_n=0$ and when $S_n=1$, can be compared using relative probability (RP; Equation 3.7). Similar to odds ratio, when relative probability is greater than 1, it means that a team member who exhibit a social behavior being associated with a relational behavior of another is higher than the probability of those who do not exhibit social behaviors.

$$\text{RP} = \frac{P(R_{mn}=1|S_n=1)}{P(R_{mn}=1|S_n=0)} \quad (3.7)$$

3.4.3 Model Goodness of Fit

The Pearson and deviance chi-square tests are often used to evaluate the goodness of fit of OLS regression models. Pearson and deviance chi-square tests are based on the minimization of squared differences between predicted and observed values, a condition that is not applicable for logistic regression. In their place, pseudo R-square (R^2) goodness of fit measures are used. Pseudo R^2 statistics commonly used are McFadden, Cox & Snell, and Nagelkerke R Squares (Allison, 2014). Cox & Snell R^2 has a score of less than 1, and therefore, Nagelkerke's pseudo R^2 adjusts this deficit to make it cover a full range from 0 to 1 (Chan, 2005). Nagelkerke's pseudo R^2 (R_{NK}^2) is calculated using Equation 3.8, where R_{CS}^2 is Cox & Snell's Pseudo R^2 and R_{MAX}^2 is explained in Equation 3.9, where n is the sample size, and LL represents log-Likelihood for the null model. The closer Nagelkerke's pseudo R^2 is to 1, the better the logistic regression model fits (Liao, 2000).

$$R_{NK}^2 = \frac{R_{CS}^2}{R_{MAX}^2} \quad (3.8)$$

$$\text{where } R_{\text{MAX}}^2 = 1 - \exp[2(n^{-1})LL(0)] \quad (3.9)$$

3.4.4 Model Validation

The intent of this research is to establish the associations between dependent and independent variables for this study, and to use the modeled relationships for future prediction. Statistical prediction requires that the models be validated, as validation gives prediction models credibility that the resulting output would occur given similar input variables. In other words, robust model validation at a specified confidence level offers credibility that the prediction model results can be relied upon. Prediction performance for logistic regression is evaluated through internal (e.g., data splitting) or external (i.e., new data) validation. For this chapter, the models are internally validated by partitioning the original data into 70% training and 30% testing datasets. Thus, the models are fit on 70% of the data, while 30% of the data were retained (i.e., not used for fitting) to validate the model on new data.

Statistically significant models are fitted and tested for prediction performance using a confusion matrix. In constructing the confusion matrix, the predicted probabilities of team members' relational behaviors given the social behaviors is calculated using Equation 3.1. Then a cutoff/classifier, p_{mn}^* is determined as a number that lies between the two probabilities (i.e. probabilities calculated when $S_n = 0$ and when $S_n = 1$). If the estimated probability is greater than this cutoff/classifier, 1 is assigned, otherwise 0 is assigned. A two by two table (e.g., Table 3.4) is formed by counting the four outcomes of the binary classifier:

- True positive, which represents positive subjects that are classified as positive (TP)
- False positive, which represents incorrect positive prediction (FP)
- True negative, which represents negative subjects that are classified as negative (TN)
- False negative, which represents incorrect negative prediction (FN)

Table 3.4. Binary Classifier Outcomes

		Predicted	
		0	1
Observed	0	TN	FP
	1	FN	TP

The models are characterized by accuracy (Equation 3.10), sensitivity (Equation 3.11), and specificity (Equation 3.12) performance metrics. The accuracy of a prediction model is its ability to correctly differentiate the relational behaviors influenced by social behaviors and those that are not. Sensitivity of the prediction models is their ability to determine relational behaviors correctly, whereas specificity is the ability of the prediction models to determine the social behaviors correctly. Perfect accuracy, sensitivity, and specificity are demonstrated when these values equal unity, while a value of zero is the lowest that can be calculated.

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \quad (3.10)$$

$$\text{Sensitivity} = \frac{TP}{TP+FN} \quad (3.11)$$

$$\text{Specificity} = \frac{TN}{TN+FP} \quad (3.12)$$

Sensitivity and specificity are useful if the values are high. High sensitivity values indicate that it is unlikely that the prediction models will predict that there is a relationship between relational and social behaviors when indeed there is no relationship. High specificity values mean that the prediction models are unlikely to predict a false relationship between relational and social behaviors when there is no relationship.

The applicability of sensitivity and specificity has strong limitations. For example, sensitivity is only useful for deciding that a negative outcome of an analysis is so unusual that it strongly indicates the absence of the situation under investigation. This means that sensitivity analysis is only useful when these values are high. On the other hand, an analysis with high

specificity is useful only for deciding that a positive outcome of an analysis is so unusual that it strongly indicates the presence of the condition under investigation. For meaningful interpretation of these metrics, both sensitivity and specificity values need to be high. Unfortunately, when sensitivity is low, specificity is high and vice versa. As such, Positive Predictive Value (PPV; Equation 3.13) and Negative Predictive Value (NPV; Equation 3.14) metrics are also calculated to aid in interpreting validation results of prediction models, with values ranging from 0 (worst) to 1 (best). High PPV is desirable, meaning that false positive results are minimized during the analysis. Moderate PPV may also be acceptable if follow-up studies are permitted. Similarly, high NPV is desirable, meaning that false negatives are minimized during the analysis. Moderate NPVs may also be acceptable if the prediction models are based on a follow up study for a known condition.

$$PPV = \frac{TP}{TP+FP}, \quad (3.13)$$

$$NPV = \frac{TN}{TN+FN} \quad (3.14)$$

3.5 Data Analysis and Results

3.5.1 Sample Characteristics

The questionnaire respondents provided their current role and years worked in the construction industry as well as the number of years in their current role (see Table 3.5). The profiles indicate that the respondents represent top management (e.g., vice president, construction coordinators, and program managers), middle management (e.g., project managers and project principals) or professional level employees (e.g., project managers, project engineers, and estimators, schedulers).

Table 3.5. Respondents' Role and Work Experience

Role	Number of years in the construction industry						Number of years in the current role				
	0-10	11-20	21-30	31-40	41+	Total	0-10	11-20	21-30	31-40	Total
Project manager	14	57	60	61	15	207	124	60	19	3	206
Project engineer	2	6	7	3	2	20	14	6	2	0	22
Design engineer	0	0	1	0	0	1	1	0	0	0	1
Estimator	1	1	3	2	4	11	4	3	0	0	7
Scheduler	2	1	0	4	0	7	6	1	0	0	7
Contracts	0	4	0	2	2	8	4	3	0	0	7
Superintendent	1	0	2	1	1	5	4	1	0	0	5
Operations	1	2	4	1	1	9	7	2	1	0	10
Others	9	41	27	35	9	121	89	27	6	1	123
Missing						3					4
Total	30	112	104	109	34	392	253	103	28	4	392

Table 3.5 includes missing values for number of years in the construction industry (n=3) and for number of years in the current role (n=4). "Others" in Table 3.5 include: owner representatives, oversight team, quality assurance, municipality representatives, utility agencies, material vendors, program managers, task order managers, construction administrators, owner's agents, quality assurance managers, accountable managers, vice president, design-build managers, pre-construction managers, construction coordinators, startup and commissioning manager, and project principal.

Table 3.6 shows that the mean number of years in the construction industry of the respondents is 26 years, while the mean number of years worked in the current role is nine years. This suggests that the respondents have substantial years of construction experience to be able to soundly respond to the survey questions.

Table 3.6. Number of Years Worked Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
No. of years in the construction industry	392	1.00	50.00	26.60	10.62
No. of years in the current role	392	0.40	40.00	9.65	7.50

In the construction project where the respondents based their responses, the organizations in which they work played the roles shown in Figure 3.2. with a majority of the respondent organizations (29%) played the role of construction manager agency, 20% of the organizations

were responsible for the actual construction in the field, ten percent acted as program managers, six percent each for the design team and consulting. Other respondents who constituted 24% of the respondents reported the roles of owner representatives, oversight team, quality assurance, municipality representatives, utility agencies, material vendors, task order managers, construction administrators, owner’s agents, quality assurance managers, accountable managers, vice president, design-build managers, pre-construction managers, construction coordinators, startup and commissioning manager, and project principal as the roles of the organizations where they worked.

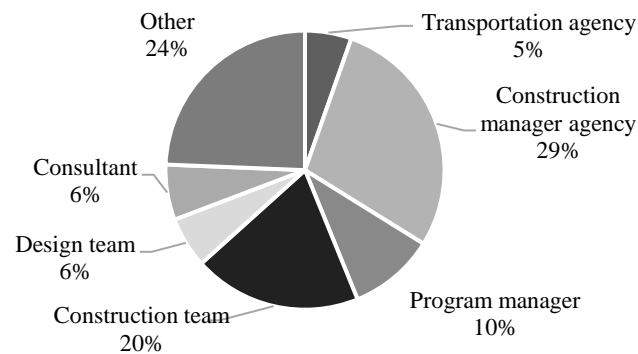


Figure 3.2. Role of Respondents' Organization in the Project

3.5.2 Project Characteristics

53% of the respondents reported to have based their responses on completed projects, 46% on projects currently in progress, and one percent of the respondents did not reveal the project status due to the confidentiality of the project. These responses were included in the analysis even though project status was unknown because this data was checked against the respondent demographics such as role and number of years worked, which proved to be valid. Figure 3.3 shows completion status for projects under construction indicating that close to half of the projects were more than 50% complete, which therefore, means that there was sufficient time for relationship building in the projects to occur (Davis et al., 2017). The overall data was checked for outliers or some common trends of inconsistency when those that were less than 50 percent

completed were included together with those that were more than 50% complete. SPSS software was used to check for outliers by running descriptive statistics for the overall data (i.e., mean, median, skewness and kurtosis values). The analysis showed low standardized kurtosis and skewness values with approximately normal distribution, meaning that there were no outliers. The responses were thus included for further analysis.

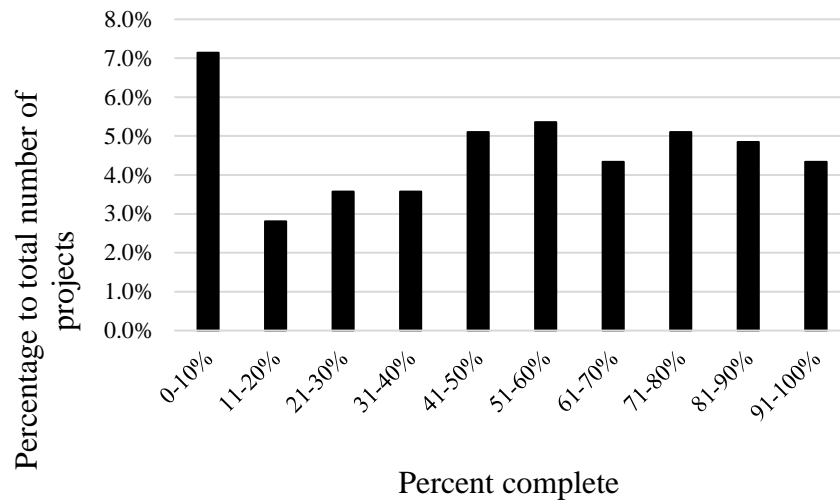


Figure 3.3. Completion Status for Projects Under Construction

3.5.3 Logistic Regression Results

3.5.3.1 Model Fitting

Table 3.9 provides the model fitting information from the data collected through the survey. Both restraint of power and reciprocity behaviors given integrity could not be modeled since the analysis returned a perfect fit for the data. Logistic coefficients for 17 of the remaining 19 models are positive, with coefficients for (harmonization of conflict, R_1 given benevolence, S_2 and flexibility, R_6 given benevolence, S_2 are negative. Furthermore, of the 21 models, 11 that are labeled as No. 1-11 in Table 3.7 had a significant slope, β_1 parameter, indicating a statistically significant relationship between the relational and social behaviors. One additional model was near the threshold of significance, while the remaining nine models were not statistically significant.

Table 3.7. Fitted Models Parameter Estimates, Standard Errors, and p values

Model	No.	β_0	S.E.	p value	β_1	S.E.	p value
$P(R_{11}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_1)}}$	1	1.74	.20	< .001*	1.71	.75	.022*
$P(R_{12}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_2)}}$		2.01	.19	< .001*	13.55	1029	.989
$P(R_{13}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_3)}}$		-.02	.19	.923	-19.55	1016	.985
$P(R_{21}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_1)}}$	2	1.64	.20	< .001*	2.68	1.03	.009*
$P(R_{22}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_2)}}$	3	1.41	.19	< .001*	1.19	.50	.018*
$P(R_{23}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_3)}}$	4	1.57	.19	< .001*	2.32	1.03	.024*
$P(R_{31}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_1)}}$	5	.16	.21	.459	1.08	.43	.013*
$P(R_{32}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_2)}}$		Not possible to model with data collected					
$P(R_{33}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_3)}}$	6	1.76	.20	< .001*	2.33	1.03	.023*
$P(R_{41}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_1)}}$		1.46	.15	< .001*	19.74	4060	.996
$P(R_{42}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_2)}}$	7	.68	.15	< .001*	1.27	.55	.022*
$P(R_{43}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_3)}}$	8	1.13	.16	< .001*	1.60	.62	.009*
$P(R_{51}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_1)}}$	9	1.04	.15	< .001*	1.64	.75	.029*
$P(R_{52}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_2)}}$	10	.99	.17	< .001*	1.74	.62	.005*
$P(R_{53}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_3)}}$		1.44	.17	< .001*	.64	.56	.252
$P(R_{61}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_1)}}$		1.43	.15	< .001*	19.77	5146	.997
$P(R_{62}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_2)}}$		1.40	.17	< .001*	.83	.63	.188
$P(R_{63}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_3)}}$		-.48	.14	< .001*	-.44	.61	.469
$P(R_{71}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_1)}}$	11	1.20	.17	< .001*	2.93	1.02	.004*
$P(R_{72}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_2)}}$		Not possible to model with data collected					
$P(R_{73}=1) = \frac{1}{1+e^{-(\beta_0 + \beta_1 S_3)}}$		2.52	.37	< .001*	18.05	1773	.992

Note: Social behaviors are Previous experience S_1 , Benevolence, S_2 , Integrity, S_3 .

Non-significant models indicate that there is not enough evidence to show a relationship between relational and social behaviors. As such, moving forward with the analysis, these non-significant models are not considered for further evaluation. For the two that were not modeled, estimation was terminated because of the perfect fit of the data. Therefore, these results are not reported further as well.

3.5.3.2 Model Evaluation

Table 3.8 shows the odds of $R_{mn}=1$ when $S_n=0$ and $S_n=1$ as well as odds ratios and predicted probabilities and relative probabilities for the significant models. Based on the analysis, the odds ratios for the logistic regression are greater than 1. These odds ratios indicate that when project team members exhibit a social behavior, the chance of expressing the corresponding relational behavior team members increases by the value of that odds ratio. For example, for harmonization of conflict, R_I given past experience, S_I , the chance of working issues informally increases by 5.53 times (on average) for team members who worked together previously, with an LCI of 1.28 times and a UCI of 23.74 times. Similar to odds ratio, the relative probability of a team member exhibiting a relational behavior given an exhibited social behavior is greater than one for all models.

Table 3.8. Fitted Model Odds Ratios with Confidence Intervals and Predicted Probabilities

Model	Odds ($S_n = 0$)	Odds ($S_n = 1$)	Odds ratio	OR 95% CI		$P(R_{mn}=1 S_n=1)$	$P(R_{mn}=1 S_n=0)$	Relative Probability
				LCI	UCI			
1	5.70	31.50	5.53	1.28	23.74	0.969	0.851	1.139
2	5.16	75.19	14.59	1.94	108.48	0.986	0.838	1.177
3	4.10	13.46	3.29	1.23	8.75	0.931	0.803	1.159
4	4.81	48.91	10.18	1.36	76.41	0.980	0.828	1.184
5	1.17	3.46	2.94	1.26	6.89	0.775	0.539	1.438
6	5.81	59.74	10.28	1.37	77.20	0.983	0.854	1.151
7	1.97	7.03	3.56	1.19	10.54	0.875	0.663	1.320
8	3.10	15.55	4.95	1.48	16.71	1.00	0.883	1.133
9	2.83	14.59	5.16	1.19	22.20	0.935	0.739	1.265
10	2.69	15.33	5.70	1.68	19.12	0.939	0.730	1.286
11	3.32	62.18	18.73	2.53	138.99	0.984	0.768	1.281

Nagelkerke R^2 goodness-of-fit values (Table 3.9) explain the likelihood of predicting relational given the social behaviors. For example, likelihood of predicting harmonization of conflict behavior, R_I given past experience, S_I (Model 1) is 4.8%. Overall, the Nagelkerke R^2 values are low, indicating small likelihoods of predicting relational behaviors given the independent social behaviors modeled in Table 3.7.

Table 3.9. Nagelkerke R-Squared Goodness-of-fit

Model	Nagelkerke R ²
1	.048
2	.093
3	.076
4	.037
5	.071
6	.035
7	.012
8	.040
9	.025
10	.067
11	.085

3.5.3.3 Model Validation

Table 3.10 shows the sensitivity, specificity, accuracy, PPVs, and NPVs of the prediction models through internal validation. The results show low values for sensitivity (11-56%), accuracy (34-44% except for model 5 with a moderately higher accuracy value of 71%), while specificity values are high (88-100%). The results also show high PPVs ranging from 86-100%, whereas NPVs are low, ranging from 18-59%.

Table 3.10. Prediction Models Internal Validation Metrics

Model	Observed	Predicted		p_{mn}^*	Sensitivity	Specificity	Accuracy	PPV	NPV
		0	1						
1	0	14	2	0.9	36%	88%	43%	95%	18%
	1	63	36						
2	0	14	2	0.9	36%	88%	43%	95%	18%
	1	63	36						
3	0	17	1	0.9	33%	94%	44%	97%	22%
	1	60	30						
4	0	14	2	0.9	26%	88%	35%	92%	17%
	1	70	24						
5	0	22	2	0.6	56%	92%	71%	90%	59%
	1	15	19						
6	0	13	1	0.9	25%	93%	34%	96%	15%
	1	74	25						
7	0	30	1	0.7	11%	97%	38%	89%	33%
	1	62	8						
8	0	25	0	0.9	20%	100%	38%	100%	27%
	1	69	17						
9	0	25	2	0.8	14%	93%	34%	86%	26%
	1	71	12						
10	0	22	2	0.8	30%	92%	44%	93%	28%
	1	58	25						
11	0	21	0	0.8	23%	100%	37%	100%	23%
	1	71	21						

Based on these statistical results, these values can be interpreted as follows:

- Sensitivity values are low (11-36%) except model 5 with 56%.
- Specificity values are high (88-100%).
- Positive predictive values are high (i.e., > 86%).
- Negative predictive values are low (i.e., 15-33%) except for model 5 with 59%.

Based on the research results that show low sensitivity values, these values are not useful in interpreting the research findings. High specificity values indicate that the prediction models have high chance of correctly predicting relational behaviors given the social behaviors of team members. High PPVs and low NPVs reveal that predicted positive expression of relational behaviors is typically correct, while the models overpredict negative/non-expression of relational behaviors given the social behaviors of construction project team members. Thus, the prediction models advanced in this chapter perform quite well based on these metrics.

3.6 Findings and Discussion

To meet the objective of this chapter, logistic regression analysis was conducted to test the hypothesis outlined in Chapter 1: There is a relationship between team members who exhibit relational behaviors and those who exhibit social behaviors. Statistically significant and non-significant models are shown as those supporting and not supporting the hypothesis, respectively (Table 3.11).

Table 3.11. Significance Test Results for the Logistic Regression β_1 Coefficients

	S_1	S_2	S_3
R_1	√	-	-
R_2	√	√	√
R_3	√	-	√
R_4	-	√	√
R_5	√	√	-
R_6	-	-	-
R_7	√	-	-

Note: √ Statistically significant; - Not statistically significant

This study finds that past experience, S_1 is a significant predictor of five of the seven relational behaviors, benevolence, S_2 , and integrity, S_3 are significant predictors of three of the seven relational behaviors each (Table 3.12). All the statistically significant models had positive and significant logistic regression coefficients, β_1 , (p value < 0.05). Positive significant logistic regression coefficients, β_1 indicate that the relational behavior is more likely to be exhibited when the social behavior is present, rather than absent. Similarly, it is expected that it is less likely for a team member to exhibit a relational behavior when the team members do not exhibit a social behavior.

The results of the analysis show that:

1. Compared with those who have not previously worked together (past experience, S_1), those with past experience were:
 - 4.2 times more likely to resolve conflicts informally, flexibly, and internally (harmonization of conflict, R_1), $p = .002$.
 - 11.7 times more likely to adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract (propriety of means, R_2), $p < .001$.
 - 4.5 times more likely to expect that members in the team will avoid applying their authority against any other team member's interest (restraint of power, R_3), $p < .001$.
 - 4.9 times more likely to be in a coordinated and peaceful state that is able to preserve a relationship (contractual solidarity, R_5), $p < .001$.
 - 24.9 times more likely to treat each other as equals (reciprocity, R_7), $p < .001$.
 - A statistically significant relationship was not found between past experience, S_1 and reliance and expectation, R_4 .

- A statistically significant relationship was not found between past experience, S_1 and flexibility, R_6 .

What these findings mean, therefore, is that interactions between first time and repeat members in a construction project may not be the same. This assertion is consistent with prior research that showed that past experiences have an influence on how team members relate through the reputations established previously (Dekker et al., 2019). Therefore, previously embedded relationships will set the tone for team member expectations, which in turn provides for trust to develop and gives room for open communication and joint conflict resolution (Buvik & Rolfsen, 2015; Kululanga et al., 2002). For example, they typically, know how to work out issues informally in the field, rather than involving upper management (harmonization of conflict, R_1).

2. Compared with those who have not shown concern for the well-being of others, generosity or kindness to others (benevolence, S_2), those who have shown benevolence were:

- 4.1 times more likely to adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract (propriety of means, R_2), $p < .001$.
- 6.5 times more likely to rely on others to fulfill their part of the bargain (reliance and expectation, R_4), $p = .003$.
- 6.5 times more likely to be in a coordinated and peaceful state that is able to preserve a relationship (contractual solidarity, R_5), $p < .001$.
- A statistically significant relationship was not found between benevolence, S_2 and harmonization of conflict, R_1 .
- A statistically significant relationship was not found between benevolence, S_2 and flexibility, R_6 .

The findings show that the relationship between benevolence and three out of seven relational behaviors exhibited by construction project team members support the argument by Ling and Tran (2012) that for a more relational team, there is a need for construction project team members to be benevolent, and desist from exploiting others to avoid conflicts. The empirical evidence in this chapter suggests that benevolent team members show a relationship with team members who exhibit relational behaviors aimed at supporting one another in the team. For example, benevolent team members are more likely to relate with those who are fair in their dealing through the principles of gain share and pain share. The role of benevolence behavior as it relates to relational behaviors highlights the underlying concept of social network theory that project networks are comprised of both relational and social behaviors.

3. Compared with those who have not acted on accepted principles of right and wrong and being attentive to how one achieves results (integrity, S_3), those who have shown integrity were:
 - 5 times more likely to adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract (propriety of means, R_2), $p = .001$.
 - 15 times more likely to expect that members of the team will avoid applying their authority against any other team member's interest (restraint of power, R_3), $p < .001$.
 - 6.6 times more likely to rely on others to fulfill their part of the bargain (reliance and expectation, R_4), $p < .001$.
 - A statistically significant relationship was not found between integrity, S_3 and harmonization of conflict, R_1 .
 - A statistically significant relationship was not found between integrity, S_3 and contractual solidarity, R_5 .

- A statistically significant relationship was not found between integrity, S_3 and flexibility, R_6 .
- A statistically significant relationship was not found between integrity, S_3 and reciprocity, R_7 .

The relationship between integrity, S_3 and relational behaviors, R_{mn} is important in explaining team relationships in construction project networks. For example, when a team member is honest to other team members, they will adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract which helps shape team relationships and thus a more cohesive team. When members are untrustworthy and not honest with others in the team, relationship building is negatively impacted and raises tension and conflicts.

Non-significant models do not support the research hypothesis that a relationship exists between team members who exhibit relational behaviors to those who exhibit social behaviors. These findings do not support previous research by Chinowsky et al. (2010) and Granovetter (1985) who advanced the theory that relationships constitute both relational and social behaviors under the social network theory. However, this research was exploratory and sought to establish the starting point for further investigation by researchers in this area. This study therefore, recommends that a confirmatory study be conducted covering a wider sample size as a follow up to this study.

Relational behaviors that show no relationship with benevolence, S_2 have a direct effect on the terms and conditions that are set out in the contract. This explains why benevolence, S_2 might be viewed as having no relationship with those behaviors. For instance, research findings do not support that benevolence, S_2 positively influence how members resolve issues and disputes, informally without involving upper management. Similarly, when team members become more

benevolent, others tend to take advantage of and exploit them (Kim & Nguyen, 2018). Results show that as members become more benevolent, team members are not willing to allow changes to occur in their operating environments (flexibility, R_6), treat them as equals (reciprocity, R_7), or expect that others will not exert their legitimate authority upon them (restraint of power, R_3).

Furthermore, it was not possible to model the relationship between benevolence, S_2 and restraint of power, R_3 , and reciprocity, R_7 relational behaviors using the collected data. This was because of the perfect fit of the data when modeling. This might be attributed to the data collection tool or the questions that might have not been better understood by the respondents. It will be worthwhile to conduct a follow-up study using a larger sample size in a bid to model the relationship between the relational and social behaviors.

3.7 Chapter Summary

This chapter presents the results of the relationship between the relational and social behaviors exhibited by construction project team members. The social behaviors, S_n include: benevolence, S_1 , integrity, S_2 , and past experience, S_3 whereas relational behaviors, R_m include: contractual solidarity, R_1 , flexibility, R_2 , harmonization of conflict, R_3 , propriety of means, R_4 , reciprocity, R_5 , reliance, expectation, R_6 , and restraint of power, R_7 . These identified behaviors were used as variables in the study by means of data collected through a cross-sectional survey sent to construction practitioners across the United States. The data collected were used to model the relationship between relational and social behaviors of construction project team members. Logistic regression was used in the data analysis. In summary, the findings of this research include:

- Past experience, S_1 predicts five of the seven relational behaviors, benevolence, S_2 and integrity, S_3 each predict three of the seven relational behaviors.

- Internal validation results show low values for sensitivity (11-56%), accuracy (34-44%, except for model 5 with a moderately higher accuracy value of 71%), and NPVs (18-59%). Specificity values (88-100%) and PPVs are high.

Limitations and Future Work

One of the primary limitations of this research was discovered when the analysis for this chapter was undertaken. In spite of efforts to ensure the construct validity of the questionnaire, it was discovered that the collected data did not map as well as anticipated to the social and relational behaviors. As shown in Appendix VII, some behaviors had to be assumed and some answers had to be mapped as N/A because one of the behaviors was not apparent from the selection. Although the analytical procedures are sound and recommended for additional studies, significant improvements to the questionnaire should be undertaken in future work. This additional development would add more credibility and reliability to the overall results.

CHAPTER 4. RELATIONSHIP EMBEDDEDNESS IN CONSTRUCTION PROJECT TEAMS

4.1 Aim

The aim of Chapter 4 is to externally validate the prediction models generated in Chapter 3, where the proposed validation technique evaluates the prediction accuracy of the models using model performance metrics of sensitivity, specificity, PPV, and NPV. Additionally, using case study data collected from transportation and wastewater projects, the following tasks are accomplished in this chapter.

- A measure of relationship embeddedness (REM) is proposed and numerically computed as the product of the expressed team members' relational and social behaviors.
- Dimensions of RQ are statistically modeled given the REM values.
- Project outcomes are statistically modeled given the REM
- Dimensions of RQ are statistically modeled given the project outcomes.

4.2 Motivation

The definition of Relationship quality varies depending on the field of study. However, previous researchers across diverse disciplines agree that RQ is a multi-dimensional construct and may only be explained by more than dimension such as trust and conflict resolution (Crosby et al., 1990). In construction project networks, attention has been drawn to RQ because of the fragmented relationships that still exist. Fragmentation is often attributed to formal contractual arrangements commonly used in construction (Egan, 1998; Latham, 1994). Fragmentation has been associated with coordination issues among project team members which ultimately impact the overall performance of the project. For example, Cook and Hancher (1991) found a correlation between fragmented relationships and less-than-ideal project outcomes (i.e., time, cost, schedule, quality, and safety).

In contractual arrangements, formal relationships exist between project parties. Formal contracts are complemented by relational approaches where project team members adopt expected relational behaviors, initiated and embedded within a social matrix (Ekberg-tamminen, 2013; Macneil, 1983). Social network theory offers a potential means of understanding interactions between team members by representing social networks as interpersonal relationships based on economic processes, which can be contractual, relational, or both. The relationships thus formed offer a platform through which team members interact (Ekberg-tamminen, 2013), based on their behaviors (i.e., relational and social) and form new relationships or withdraw from others.

The relational approach to construction contracting and conceptualization of construction project teams as project networks established that interactions between team members carries with it a level of RQ, manifested in teams through various dimensions. However, the study of RQ as it relates to construction project networks is currently limited. As a result, gaps exist in literature and practice, especially on modeling relationship embeddedness (REM) based on the behaviors of construction project team members; linking dimensions of RQ to REM and project outcomes; and modeling project outcomes based on REM.

4.3 Methodology

4.3.1 Case Study Design

A multiple case design was used through the analysis of active infrastructure construction projects. According to Yin (2003), cases must be selected carefully so that the cases either produce similar or contrasting results. In a typical sense, six to ten cases may be used to provide varied results, while only a few cases are sufficient to achieve similar results (Yin, 2003). Three highway transportation construction projects and one wastewater construction project were used as case

study projects to provide a basis for accurate replication. In all cases, the researcher played the role of a neutral observer and investigator.

Before conducting case studies, this research developed a case study protocol to ensure consistency in terms of case study selection and data collection, and used the following criteria to select the cases:

- Project located in the United States
- Publicly funded transportation or wastewater projects
- Project involves parties from various organizations
- Projects which are about 60 - 100% complete
- Project cost of at least \$10 million, whereby adequate relationship formation is anticipated because a project of this magnitude will attract a good number of project parties

To identify case studies for this research, public agencies were contacted about participating in the study and if they had a current project under construction that could be used as a case study. Four projects were selected: three highway construction projects and one wastewater construction project. The case studies were conducted between May 2017 and July 2018.

The agencies that expressed interest in providing projects to be used as case studies also provided contact information for project engineers. The engineers were then contacted through email and by phone to explain the aim and scope of the research. An introduction of the researcher by the project engineers to the other project team members ensued. In addition, the researcher requested permission to visit the project site to observe working relationships and to attend site meetings. The owner, contractor, subcontractors, and consultants involved in the selected projects were then contacted through email and followed by phone calls asking for their willingness and

availability to participate in the research. Those that agreed to participate were then interviewed using the questionnaire developed and provided in Appendix VII.

Interviews took approximately 45-60 minutes, using a set of structured, open-ended questions. The interview was conducted face-to-face for those who were at the project site when the researcher visited, or who were available in the office within driving distance from the site. The researcher then contacted those who were not at the site at the time and performed the interview via a phone call.

The case study questionnaire is provided in Appendix III and consists of items shown in Table 4.1. The questionnaire has two sections: Section I included general questions about the project, while Section II asked questions about relational, R_{mn} and social, S_n behaviors, project atmosphere, and project outcomes. Relational, R_{mn} and social, S_n behavior responses were mapped using the binary S_n , R_m mapping in Appendix VIII. Project atmosphere questions were used to measure dimensions of RQ. Participants were required to respond to the questions based on their experiences and observations of meetings or events relevant to the case study project.

Table 4.1. Question Items in the Questionnaire

Focus	Question emphasis
1. Project information and demographics	<ul style="list-style-type: none"> • The role of the respondent's organization in the project • Respondents' role • Years the respondent worked for the organization
2. Fundamentals of relationship embeddedness	<ul style="list-style-type: none"> • Questions dedicated to finding out whether social behaviors of construction project team members influence how individuals collaborate and ultimately impact project outcomes. The section consisted of statement items, and participants were asked to rate other members of the project team on a five-point Likert scale, with one representing strongly disagree and five representing strongly agree.
3. Project outcomes	<ul style="list-style-type: none"> • Budget objectives • Schedule objectives • Quality objectives • Functionality of the completed project
4. Dimensions of RQ	<ul style="list-style-type: none"> • The respondents were asked questions that were designed to connect the association of relational and social behaviors towards embedded relationships that aimed at collaborative working relationships. The main variables that were measured by these set of questions were trust, knowledge exchange and conflict resolution. The questions were based on a five-point Likert scale.

The questionnaire was administered online, using the Qualtrics online survey tool by sharing a link with the participants. The survey was designed to be completed in about 15-20 minutes. The researcher utilized the capability feature of Qualtrics online survey tool that allows an individual to complete the survey offline and then uploaded the responses online once the researcher had access to the internet. Using three iPads, the researcher was able to conduct the surveys in the field, which were given to those willing to take the survey. Further, the Qualtrics tool has mobile view support, meaning that the respondents could also take the survey on their cell phone.

The interviews and data collected from the construction documents, daily logs, change order records, and observations were analyzed qualitatively in a narrative format using content analysis. Data analysis involved examination, categorization, tabulation, and modeling of the identified variables of this study. The variable measuring relationship embeddedness for each social/relational behavior pair (REM_{mn}) was computed as a product of the exhibited relational, R_{mn} and social, S_n behaviors variables (Equation 4.1). Missing or “N/A” data were considered 0. The intention behind this computation is that team relationships are embedded in a social matrix, which can also be viewed as a product of the association between social and relational behaviors. Table 4.2 shows the result of Equation 4.1 for the possible combinations of collected data REM_{mn} which yields a total of 21 pairs.

$$REM_{mn} = R_{mn} * S_n \quad (4.1)$$

Table 4.2. REM Calculation Matrix

		Relational behaviors		
		0	1	Missing
Social behaviors	0	0	0	0
	1	0	1	0
	Missing	0	0	0

Multinomial logistic regression was used to analyze survey data. Validity of the results was conducted to show that the tests truly measured what it is supposed to (Brains et al., 2011). More specifically, research design and methods define validity. Table 4.3 discusses three types of validity crucial to this study: Construct validity, internal validity, and external validity.

Table 4.3. Types of Validity and their Description

Type of Validity	Description
Construct validity	To pass the construct validity test, the specific construct used to study a specific research question must be selected, and whose chosen measures should reflect a specific type of attribute for the selected construct. For this study, social behaviors which influence relational behaviors in construction project teams are studied and linked to project outcomes. A multiple-case design used in this study helped to enhance construct validity.
Internal validity	Internal validity is not as much of a concern in case study research. However, a strategy is needed to show the connection between empirical and predictive evidence. Therefore, both qualitative and quantitative data were used in the analysis together with an in-depth interpretation of the data and results.
External validity	The case study findings are compared to the conceptual framework developed from the literature. Validity or generalization can be claimed where two or more cases are in support of the theory (Rowley, 2002). Case study data was used an external validation as a follow-up from the analysis in Chapter 3.

The summary of the case study data is presented as relational, R_{mn} to social, S_n behavior pairs in Table 4.4. The process of validation is made possible by computing predicted probabilities of the prediction models using the external dataset.

Table 4.4. Data Representing Relational to Social Behavior Pairs

		S_1		S_2		S_3	
		0	1	0	1	0	1
R_1	0	3	0	9	0	4	23
	1	28	15	37	2	8	0
R_2	0	3	0	5	2	1	5
	1	24	19	23	12	26	11
R_3	0	7	2	7	2	12	2
	1	10	4	31	0	21	7
R_4	0	8	1	10	0	5	0
	1	25	13	26	4	27	8
R_5	0	7	1	11	1	6	1
	1	30	6	21	7	26	6
R_6	0	5	0	9	1	18	2
	1	29	9	30	2	14	2
R_7	0	10	0	0	0	3	0
	1	26	10	5	30	20	17

4.3.2 External Validation of Chapter 3 Models

Eleven relational behavior prediction models were developed in Chapter 3 from a national level survey with 392 valid responses from construction project team members. To validate these models, performance measures related to discrimination were used (Steyerberg et al., 2010). Discrimination is used to assess the ability of a model to correctly differentiate two sets of outcomes. Under the discrimination concept, the observed outcomes of the prediction models are divided into two groups using external data.

The values of the case study social behaviors, S_n were used as input into the models with the calculated coefficients from Chapter 3. The dependent variables, R_{mn} were calculated and assigned using the cut-off/classifier, p_{mn}^* as either 0 or 1 and forms the predicted group. Then the predicted vs. observed dependent variables were compared in a confusion matrix as described in chapter 3. Generally, sensitivity and specificity tests are used to evaluate the success or credibility of a predictive model. In addition, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) metrics are also used.

4.4 Multinomial Logistic Regression

4.4.1 Model Fitting

The categorical variables representing RQ dimensions and project outcomes are considered unordered because the measurement scale does not represent equal intervals across the range of measurement (Osborne, 2017). Therefore, multinomial logistic regression, an extension of logistic models, is an appropriate statistical modeling technique for unordered categorical dependent variables. Multinomial logistic regression is used to model the relationships between 1) RQ dimensions, G_g and REM, REM_{mn} ; 2) project outcomes, O_q and REM, REM_{mn} ; and 3) project outcomes, O_q and RQ dimensions, G_g . The mathematical formulation for each regression yields J -

1 intercepts (α_j) and common coefficients (β_{mn}), which meets the proportional odds assumption.

For a given relational behavior R_m , the log odds of the response variable G_g with J unordered levels 0 to 4 (see Table 4.6) and explanatory variables REM_{mn} (where $m=1,2,\dots,7$, and $n=1,2,3$) (Table 4.5), being in level j or greater is given in Equation 4.2.

$$\ln \left[\left\{ \frac{P(G_g \geq j)}{1-P(G_g \geq j)} \right\}_m \right] = \alpha_j + \sum_{n=1}^3 \beta_{mn} REM_{mn} \text{ for } j = 0 \dots J-2 \quad (4.2)$$

For example, the log odds for the response variable trust, G_I and explanatory variables REM_{mn} under the relational behavior of harmonization of conflict R_I , being in level j or greater may be defined in the sequence of cumulative logits as:

$$\ln \left[\left\{ \frac{P(G_g \geq j=0)}{1-P(G_g \geq j=0)} \right\}_{m=1} \right] = \alpha_0 + \beta_{11} REM_{11} + \beta_{12} REM_{12} + \beta_{13} REM_{13} \dots \dots \dots (1)$$

$$\ln \left[\left\{ \frac{P(G_g \geq j=1)}{1-P(G_g \geq j=1)} \right\}_{m=1} \right] = \alpha_1 + \beta_{11} REM_{11} + \beta_{12} REM_{12} + \beta_{13} REM_{13} \dots \dots \dots (2)$$

$$\ln \left[\left\{ \frac{P(G_g \geq j=2)}{1-P(G_g \geq j=2)} \right\}_{m=1} \right] = \alpha_2 + \beta_{11} REM_{11} + \beta_{12} REM_{12} + \beta_{13} REM_{13} \dots \dots \dots (3)$$

$$\ln \left[\left\{ \frac{P(G_g \geq j=3)}{1-P(G_g \geq j=3)} \right\}_{m=1} \right] = \alpha_3 + \beta_{11} REM_{11} + \beta_{12} REM_{12} + \beta_{13} REM_{13} \dots \dots \dots (4)$$

From the sequence, it is shown that the model shown in Equation 4.2 yields $J-1$ equations and ($\alpha_j + \beta_{mn} - 1$) parameters to be estimated. However, coefficients (β_{mn}) stay the same while the intercepts are different (α_j).

For the response variable O_q with unordered levels 0 to J (see Table 4.7) and explanatory variables REM_{mn} (where $m=1,2,\dots,7$, and $n=1,2,3$) (Table 4.5), the log odds of the response variable O_q in level j or greater is given in Equation 4.3.

$$\ln \left[\left\{ \frac{P(O_q \geq j)}{1-P(O_q \geq j)} \right\}_m \right] = \alpha_j + \sum_{n=1}^3 \beta_{mn} REM_{mn} \text{ for } j = 0 \dots J-2 \quad (4.3)$$

Where, REM_{mn} are 21 variables, three under each relational behavior with values of 0 or 1 calculated as the product of n social behaviors under each m relational behaviors and they represent REM; G_g represents RQ dimensions [trust (G_1), conflict resolution (G_2), and knowledge transfer (G_3)]; O_q represents recoded project outcome variables [budget (O_1), schedule (O_2), quality performance objectives (O_3), functionality of the completed project (O_4)]. Both G_g and O_q values range from 0 to 4.

For the response variable O_q with unordered levels 0 to J (see Table 4.7) and explanatory variables G_g , (where $g = 1,2,3$) the log odds of the response variable O_q in level j or greater is given in Equation 4.4.

$$\ln \left[\frac{P(O_q \geq j)}{1 - P(O_q \geq j)} \right]_m = \alpha_j + \sum_{g=1}^3 \beta_g G_g \text{ for } j = 0 \dots J-2 \quad (4.4)$$

To interpret the influence of the binary REM_{mn} independent variables on any two levels of multinomial G_g , and O_q dependent variables (under the proportional odds assumption), the odds ratio (OR) may be calculated as the exponential of the logistic coefficient, β_{mn} (Equation 4.5). This value describes the numerical odds of the dimensions of the dependent variable being in a higher level rather than a lower level given a unit increase in one of the independent variables while holding the rest constant.

$$OR_{(0,1)} = \exp(\beta_{mn}) \quad (4.5)$$

As a further step analyzing the association between RQ dimensions G_g and project outcomes O_q , a supplemental analysis was conducted because it was suspected that there was no association between variables. Goodman and Kruskal's tau, measure (Equation 4.6) and its associated plot method were used to ascertain the relationships between the variables. Goodman and Kruskal's tau gamma coefficient, α values range from -1 to +1 and the closer the value is to a

1 (or -1), the stronger the relationship. A value of 0 indicates that there is no association between the variables.

$$\alpha(G_g, O_q) = \frac{V(O_q) - E[V(O_q|G_g)]}{V(O_q)} \quad (4.6)$$

Where, G_g and O_q are variables, $V(O_q)$ is the variance of O_q , $E[V(O_q|G_g)]$ is the expected variance of O_q given G_g .

4.4.2 Model Evaluation

Multinomial logistic regression was used to model the relationships between 1) RQ dimensions, G_g and REM, REM_{mn} ; 2) project outcomes, O_q and REM, REM_{mn} ; and 3) project outcomes, O_q and RQ dimensions, G_g . The resulting models were evaluated using the following criteria;

1. The overall fit of the model and the predictive accuracy of the overall model were assessed. This assessment was done using a likelihood ratio test that compares the fitted model with predictor variables and the other without predictor variables. Likelihood ratio test yields a chi-square statistic that tests the fits of the models. Models with chi-square p values > 0.05 were rejected.
2. Multicollinearity is not considered an issue for predictor variables with standard error values between 0 and 5 and were thus considered acceptable. Models with higher standard error values (i.e. > 5) were further subjected to model assessment by removing predictor variables that had no effect on the model by using stepwise forward model selection criteria.
3. The statistical significance of model coefficient estimates was assessed. For the model to be selected, at least one of the independent variable coefficients must be significant (i.e. p value < 0.05).

The models that passed Criterion 1 were evaluated for Criterion 2 and those that passed Criterion 2, were then were evaluated for Criterion 3.

4.5 Data Analysis and Results

4.5.1 Relationship Embeddedness Data

Absolute and relative frequencies for the derived REM are shown in Table 4.5.

Table 4.5. Absolute and Relative REM Frequencies for Each Relational Behavior

			Count		Percentage	
			0	1	0	1
Harmonization of Conflict	$R_{11} * S_1$	REM_{11}	33	15	69%	31%
	$R_{12} * S_2$	REM_{12}	46	2	96%	4%
	$R_{13} * S_3$	REM_{13}	48	0	100%	0%
Propriety of means	$R_{21} * S_1$	REM_{21}	29	19	60%	40%
	$R_{22} * S_2$	REM_{22}	37	11	77%	23%
	$R_{23} * S_3$	REM_{23}	37	11	77%	23%
Restraint of power	$R_{31} * S_1$	REM_{31}	44	4	92%	8%
	$R_{32} * S_2$	REM_{32}	48	0	100%	0%
	$R_{33} * S_3$	REM_{33}	41	7	85%	15%
Reliance and Expectation	$R_{41} * S_1$	REM_{41}	35	13	73%	27%
	$R_{42} * S_2$	REM_{42}	44	4	92%	8%
	$R_{43} * S_3$	REM_{43}	40	8	83%	17%
Contractual Solidarity	$R_{51} * S_1$	REM_{51}	42	6	88%	13%
	$R_{52} * S_2$	REM_{52}	41	7	85%	15%
	$R_{53} * S_3$	REM_{53}	42	6	88%	13%
Flexibility	$R_{61} * S_1$	REM_{61}	39	9	81%	19%
	$R_{62} * S_2$	REM_{62}	46	2	96%	4%
	$R_{63} * S_3$	REM_{63}	46	2	96%	4%
Reciprocity	$R_{71} * S_1$	REM_{71}	38	10	79%	21%
	$R_{72} * S_2$	REM_{72}	18	30	38%	63%
	$R_{73} * S_3$	REM_{73}	31	17	65%	35%

Figure 4.1 presents relative frequencies for REM data graphically. The majority of survey respondents (more than 60% for each relational behavior) reported REM of 0 except the REM for reciprocity and integrity where a majority (63%) reported REM of 1.

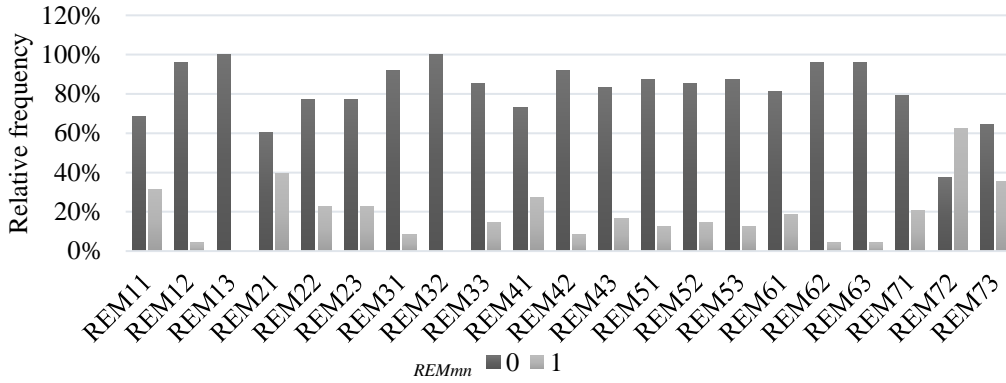


Figure 4.1. REM Relative Frequencies for Each Relational Behavior

4.5.2 Dimensions of RQ Data

Dimensions of RQ were measured by project atmosphere questions, and respondents were asked to rate statements items in terms of how the construction project team worked together. for these questions, respondents were also asked to select N/A if they were unsure. There were no N/A responses reported for these questions.

Absolute and relative frequencies for dimensions of RQ (G_1 , G_2 , G_3) variables are shown in Table 4.6. Figure 4.2 graphically shows the relative frequencies of the dimensions of RQ. The majority of survey respondents (approximately 94%) reported either good or excellent project atmosphere based on trust, approximately 77% reported either good or excellent project atmosphere based on conflict resolution, and approximately 65% reported either good or excellent project atmosphere based on knowledge transfer.

Table 4.6. Absolute and Relative Frequencies for RQ Variable Dimensions

Variable	Count					Percent				
	0	1	2	3	4	0	1	2	3	4
G_1	2	0	1	28	17	4.2	0.0	2.1	58.3	35.4
G_2	0	8	3	24	13	0	16.7	6.3	50.0	27
G_3	0	4	13	25	6	0	8.3	27.1	52.1	12.5

Note: G_1 = trust, G_2 = conflict resolution, G_3 = knowledge transfer; 0 = Very dissatisfied, 1 = Dissatisfied, 2 = Neutral, 3 = Satisfied, 4 = Very satisfied

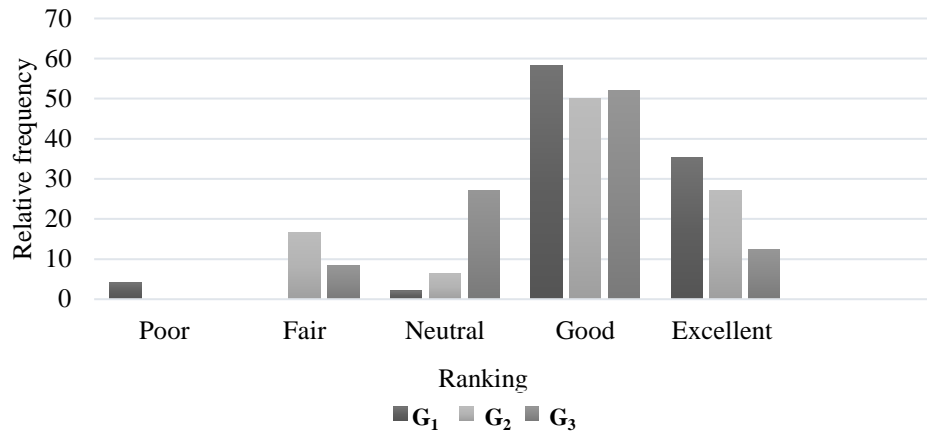


Figure 4.2. Relative Frequencies for RQ Dimension Variables

4.5.3 Project Outcomes Data

For project outcome questions, respondents were asked to rate the satisfaction level they observed in terms of project objectives being achieved at the current state of the project. Further, the survey instructed participants that if they were unsure, they were to select N/A. There were two N/A responses to the budget objective statement under project outcome questions. These N/A responses were treated as missing data. These missing data were excluded from the analysis.

Table 4.7 shows the absolute and relative frequencies of project outcome data. Relative frequencies are graphically plotted in Figure 4.3. Most of the survey respondents (>50%) were either satisfied or very satisfied with the project outcomes. Between 14-21% of the respondents were neutral regarding the satisfaction level with the project. On the dissatisfaction level with the project, only 4.2% of the respondents reported to be dissatisfied with the budget and schedule objectives of the project.

Table 4.7. Absolute and Relative Frequencies for Project Outcome Variables

Variable	Count						Percent					
	0	1	2	3	4	Missing	0	1	2	3	4	Missing
O_1	0	2	7	29	8	2	0	4.2	14.6	60.4	16.6	4.2
O_2	0	2	10	27	9	0	0	4.2	20.8	56.2	18.8	0
O_3	0	0	8	27	13	0	0	0	16.7	56.3	27.1	0
O_4	0	0	8	23	17	0	0	0	16.7	47.9	35.4	0

Note: O_1 = budget, O_2 = schedule, O_3 = quality, O_4 = functionality; 0 = Poor, 1 = Fair, 2 = Neutral, 3 = Good, 4 = Excellent

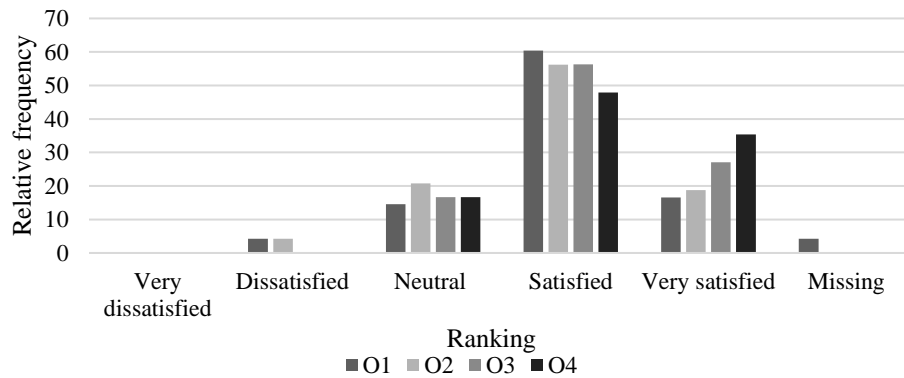


Figure 4.3. Relative Frequencies for Project Outcome Variables

4.6 Results and Discussion

4.6.1 Validation of the Relational Behavior Prediction Models.

Table 4.8 shows the prediction model validation results. The results show that sensitivity values are low (between 13-40%) while specificity values are large (ranges between 71-100%). Low sensitivity values (13-40%) are not useful in interpreting research results. High specificity values (71-100%) mean that the prediction models are unlikely to predict a false relationship between relational and social behaviors when there is no relationship. In comparing the PPVs and NPVs results (Table 4.9) between internal (Chapter 3) and external validation, test results appear to be similar. High PPVs (67-100%) and low NPVs (7-41%) indicate that predicted positive expression of relational behaviors is typically correct, while the models overpredict negative/non-expression of relational behaviors given the social behaviors of construction project team members.

Table 4.8. Sensitivity, Specificity, and Accuracy Values for the Prediction Models

Model	Observed	Predicted		P_{mn}^*	Sensitivity	Specificity	Accuracy	PPV	NPV
		0	1						
1	0	2	0						
	1	28	15	0.9	35%	100%	38%	100%	7%
2	0	3	0						
	1	24	19	0.9	44%	100%	48%	100%	11%
3	0	5	2						
	1	24	11	0.9	31%	71%	38%	85%	17%
4	0	5	1						
	1	26	11	0.9	30%	83%	37%	92%	16%
5	0	7	2						
	1	10	4	0.7	29%	78%	48%	67%	41%
6	0	12	2						
	1	21	7	0.9	25%	86%	45%	78%	36%
7	0	10	0						
	1	26	4	0.7	13%	100%	35%	100%	28%
8	0	5	0						
	1	69	8	0.8	23%	100%	16%	100%	7%
9	0	7	1						
	1	30	6	0.8	17%	88%	30%	86%	19%
10	0	11	1						
	1	21	7	0.8	25%	92%	45%	88%	34%
11	0	10	0						
	1	26	10	0.8	28%	100%	43%	100%	28%

Table 4.9. Comparison Between Chapter 3 and Chapter 4 PPV and NPV Metrics

Model	Chapter 3		Chapter 4		Percent Change	
	PPV	NPV	PPV	NPV	Δ PPV	Δ NPV
1	95%	18%	100%	7%	5%	-157%
2	95%	18%	100%	11%	5%	-64%
3	97%	22%	85%	17%	-14%	-29%
4	92%	17%	92%	16%	0%	-6%
5	90%	59%	67%	41%	-34%	-44%
6	96%	15%	78%	36%	-23%	58%
7	89%	33%	100%	28%	11%	-18%
8	100%	27%	100%	7%	0%	-286%
9	86%	26%	86%	19%	0%	-37%
10	93%	28%	88%	34%	-6%	18%
11	100%	23%	100%	28%	0%	18%

4.6.2 Multinomial Logistic Regression Results

For the 21 models for predicting dimensions of RQ using REM_m , three models satisfied the three rejection criteria. Table 4.10 shows the parameter estimates, standard errors, p values, OR and OR 95% CI for the models that satisfied the rejection criteria.

Table 4.10. Parameter Estimates, S.E., p value, OR and OR 95% CI for RQ Dimensions Models

Dimensions of RQ	Model	Coefficient	Parameter	Estimated	S.E.	p value	OR	OR 95% CI	
								LCI	UCI
G_1	1	α_0	Intercept 0	35.93	5719	.995	-	-	-
		α_1	Intercept 1	19.77	.96	< .001*	-	-	-
		α_2	Intercept 2	-17.49	7796	.998	-	-	-
		α_3	Intercept 3	19.33	.91	< .001*	-	-	-
		β_{21}	REM_{21}	-18.58	.69	< .001*	8.53E-9	2.21E-9	3.29E-8
		β_{22}	REM_{22}	16.44	.83	< .001*	1.38E+7	2.71E+6	7.03E+7
		β_{23}	REM_{23}	16.82	.81	< .001*	2.00E+7	4.11E+6	9.81E+7
	2	α_0	Intercept 0	2.78	14.14	.844	-	-	-
		α_1	Intercept 1	-8.06	19.02	.672	-	-	-
		α_2	Intercept 2	2.93	1.03	.004*	-	-	-
		α_3	Intercept 3	2.93	1.03	.004*	-	-	-
		β_{41}	REM_{41}	-1.48	1.51	.326	.227	.012	4.376
		β_{42}	REM_{42}	-8.14	99.18	.935	.000	1.11E-88	7.74E+80
		β_{43}	REM_{43}	17.05	1.38	< .001*	2.55E+7	1.70E+6	3.82E+8
G_3	3	α_0	Intercept 0	1.10	.67	.099	-	-	-
		α_1	Intercept 1	2.10	1.11	.060	-	-	-
		α_2	Intercept 2	2.67	1.08	< .001*	-	-	-
		α_3	Intercept 3	1.33	1.18	.594	-	-	-
		β_{21}	REM_{21}	-1.79	1.32	.175	.167	.013	2.22
		β_{22}	REM_{22}	20.07	1.25	< .001*	5.23E+8	4.53E+7	6.03E+9
		β_{23}	REM_{23}	20.07	1.25	< .001*	5.23E+8	4.53E+7	6.03E+9

The analysis for the association between project outcomes and REM 17 models satisfied the three rejection criteria. Table 4.11 shows the parameter estimates, S.E., p values, OR and OR 95% CI modeling output for the association between project outcomes and REM that satisfied the rejection criteria.

For models for predicting project outcomes using dimensions of RQ, none satisfied the three rejection criteria. Therefore, the analysis did not find any valid model and hence the supplemental Goodman and Kruskal's tau analysis was conducted. Gamma coefficients represent the proportion of ranked pairs which match. Figure 4.4 shows Goodman and Kruskal's tau matrix for the dimensions of RQ and project outcomes data. The analysis shows low values for the gamma coefficient, with a range of (0.03-0.38), which mean negligible or no association between the variables. Therefore, we can conclude that it will be difficult to predict one variable from another. These results can be attributed to either poor quality of data or small sample size.

Table 4.11. Parameter Estimates, S.E., p value, OR and OR 95% CI for Project Outcome Models

Project outcome	Model	Coefficient	Parameter	Estimated	S.E.	p value	OR	OR 95%CI	
								LCI	UCI
O_1	1	α_0	Intercept 0	17.46	1.79	.368	-	-	-
		α_1	Intercept 1	19.71	1.60	< .001*	-	-	-
		α_2	Intercept 2	21.92	1.50	< .001*	-	-	-
		α_3	Intercept 3	20.38	1.48	< .001*	-	-	-
		β_{21}	REM ₂₁	.705	1.76	.689	2.02	.06	63.80
		β_{22}	REM ₂₂	-1.08	1.93	.576	.34	.01	15.01
		β_{23}	REM ₂₃	-19.26	1.17	< .001*	4.33E-9	3.80E-10	4.919E-8
	2	α_0	Intercept 0	1.10	1.16	.341	-	-	-
		α_1	Intercept 1	3.26	1.02	.001*	-	-	-
		α_2	Intercept 2	1.95	1.07	.097	-	-	-
		α_3	Intercept 3	1.79	1.08	.001*	-	-	-
		B_{31}	REM ₃₁	18.41	1.41	< .001*	9.84E+8	6.26E+8	1.55E+9
		B_{32}	REM ₃₂	-2.57	1.59	.107	.08	.01	1.75
		B_{33}	REM ₃₃	-1.25	1.63	.441	.29	.01	6.91
	3	α_0	Intercept 0	1.16	1.11	.299	-	-	-
		α_1	Intercept 1	1.01	1.15	.383	-	-	-
		α_2	Intercept 2	2.00	1.06	.059	-	-	-
		α_3	Intercept 3	.62	1.20	.609	-	-	-
		β_{71}	REM ₇₁	18.09	1.11	< .001*	7.21E+7	8.16E+6	6.38E+8
		β_{72}	REM ₇₂	-1.19	1.73	.491	.30	.01	9.03
		β_{73}	REM ₇₃	16.66	1.43	< .001*	1.71E+7	1.04E+6	2.80E+8
O_2	4	α_0	Intercept 0	2.25	.74	.002*	-	-	-
		α_1	Intercept 1	.61	.85	.477	-	-	-
		α_2	Intercept 2	1.54	.78	.047*	-	-	-
		α_3	Intercept 3	1.10	.82	.178	-	-	-
		β_{21}	REM ₂₁	18.11	1.01	< .001*	7.30E+7	1.00E+7	5.31E+8
		β_{22}	REM ₂₂	17.56	9615	.999	4.22E+7	.00	-
		β_{23}	REM ₂₃	17.56	9615	.999	4.22E+7	.00	-
	5	α_0	Intercept 0	1.16	1.11	.299	-	-	-
		α_1	Intercept 1	1.50	.78	.054	-	-	-
		α_2	Intercept 2	2.20	.75	.003	-	-	-
		α_3	Intercept 3	1.39	.79	.080	-	-	-
		B_{31}	REM ₃₁	18.86	9181	.998	1.54E+8	.00	-
		B_{32}	REM ₃₂	-.373	1102	1.000	.69	.00	-
		B_{33}	REM ₃₃	19.05	1.16	< .001*	1.87E+8	1.93E+7	1.82E+9
	6	α_0	Intercept 0	2.13	1.03	.038*	-	-	-
		α_1	Intercept 1	17.59	1.69	< .001*	-	-	-
		α_2	Intercept 2	19.37	1.56	< .001*	-	-	-
		α_3	Intercept 3	.62	1.20	.609	-	-	-
		β_{71}	REM ₇₁	17.01	7438	.998	6.12E+7	.00	-
		β_{72}	REM ₇₂	-16.69	1.44	< .001*	5.63E-8	3.34E-9	9.48E-7
		β_{73}	REM ₇₃	-.43	1.52	.777	.65	.03	12.73
O_3	7	α_0	Intercept 0	1.10	.471	.020*	-	-	-
		α_1	Intercept 1	.15	.56	.782	-	-	-
		α_2	Intercept 2	1.00	.54	.064	-	-	-
		α_3	Intercept 3	.03	.63	.956	-	-	-
		β_{21}	REM ₂₁	-.234	.86	.785	.791	.15	4.28
		β_{22}	REM ₂₂	18.59	.84	< .001*	1.19E+8	2.30E+7	6.12E+8
		β_{23}	REM ₂₃	-.01	1.24	.997	1.00	.09	11.30
	8	α_0	Intercept 0	1.25	.80	.12	-	-	-
		α_1	Intercept 1	2.53	1.11	.023*	-	-	-
		α_2	Intercept 2	1.05	.44	.017*	-	-	-
		α_3	Intercept 3	.36	.49	.469	-	-	-
		B_{31}	REM ₃₁	1.05	1.48	.478	.35	.02	6.38
		B_{32}	REM ₃₂	0	-	-	-	-	-
		B_{33}	REM ₃₃	19.79	1.15	< .001*	3.91E+8	4.13E+7	3.71E+9
	9	α_0	Intercept 0	.56	.70	.43	-	-	-

Table 4.11 Continued

Project outcome	Model	Coefficient	Parameter	Estimated	S.E.	p value	OR	OR 95%CI	
								LCI	UCI
<i>O₄</i>	10	α_1	Intercept 1	.62	.68	.37	-	-	-
		α_2	Intercept 2	1.30	.50	.010*	-	-	-
		α_3	Intercept 3	.66	.55	.230	-	-	-
		β_{41}	<i>REM₄₁</i>	-1.10	.92	2.33	.33	.06	2.03
		β_{42}	<i>REM₄₂</i>	.944	1018	1.000	2.57	.00	-
		β_{43}	<i>REM₄₃</i>	19.21	1.51	< .001*	2.19E+8	15E+7	4.19E+8
		α_0	Intercept 0	2.83	1.03	.006*	-	-	-
		α_1	Intercept 1	2.49	1.04	.017*	-	-	-
		α_2	Intercept 2	.86	.42	.041*	-	-	-
		α_3	Intercept 3	.33	.46	.477	-	-	-
	11	β_{51}	<i>REM₅₁</i>	18.29	1.36	< .001*	8.79E+7	6.15E+6	1.26E+8
		β_{52}	<i>REM₅₂</i>	18.24	1.53	< .001*	8.32E+7	4.16E+6	1.67E+8
		β_{53}	<i>REM₅₃</i>	17.35	1123	.999	3.41E+7	.00	-
		α_0	Intercept 0	2.93	1.03	.004*	-	-	-
		α_1	Intercept 1	2.58	1.04	.013*	-	-	-
		α_2	Intercept 2	1.05	.44	.017*	-	-	-
		α_3	Intercept 3	.36	.49	.469	-	-	-
		β_{61}	<i>REM₆₁</i>	.56	1.18	.635	1.75	.173	17.69
		β_{62}	<i>REM₆₂</i>	17.71	1.79	< .001*	4.89E+7	1.47E+6	1.63E+8
		β_{63}	<i>REM₆₃</i>	18.27	1.47	< .001*	8.56E+7	4.84E+6	1.52E+8
	12	α_0	Intercept 0	3.29	1.06	.002*	-	-	-
		α_1	Intercept 1	2.81	1.07	.009*	-	-	-
		α_3	Intercept 2	2.08	.75	.006*	-	-	-
		α_3	Intercept 3	1.87	.76	.014	-	-	-
		β_{11}	<i>REM₁₁</i>	-1.90	.96	.049*	.15	.02	1.00
		β_{12}	<i>REM₁₂</i>	-2.08	1.60	.194	.13	.01	2.89
		β_{13}	<i>REM₁₃</i>	0	-	-	-	-	-
		α_0	Intercept 0	3.09	1.02	.003*	-	-	-
		α_1	Intercept 1	2.64	1.04	.011*	-	-	-
		α_2	Intercept 2	1.39	.61	.024*	-	-	-
	13	α_3	Intercept 3	.66	.67	.324	-	-	-
		β_{21}	<i>REM₂₁</i>	-.77	.87	.372	.46	.09	2.52
		β_{22}	<i>REM₂₂</i>	18.90	.83	< .001*	1.62E+8	3.17E+7	8.26E+8
		β_{23}	<i>REM₂₃</i>	-1.44	1.14	.207	.24	.03	2.21
		α_0	Intercept 0	1.97	1.06	.064	-	-	-
		α_1	Intercept 1	1.58	1.09	.149	-	-	-
		α_2	Intercept 2	1.95	.62	.002*	-	-	-
		α_3	Intercept 3	1.47	.64	.022*	-	-	-
		B_{31}	<i>REM₃₁</i>	-2.64	1.37	.054	.07	.01	1.05
		B_{32}	<i>REM₃₂</i>	0	-	-	-	-	-
	14	β_{33}	<i>REM₃₃</i>	-3.05	1.31	.020*	.05	.00	.62
		α_0	Intercept 0	.76	.54	.161	-	-	-
		α_1	Intercept 1	.11	.60	.857	-	-	-
		α_2	Intercept 2	1.53	.56	.006*	-	-	-
		α_3	Intercept 3	1.17	.58	.043*	-	-	-
		β_{41}	<i>REM₄₁</i>	-1.34	1.02	.189	.26	.04	1.93
		β_{42}	<i>REM₄₂</i>	19.18	1.33	< .001*	2.13E+8	1.56E+7	2.90E+9
		β_{43}	<i>REM₄₃</i>	-18.59	1.27	< .001*	8.45E-9	7.04E-10	1.02E-7
		α_0	Intercept 0	.89	.42	.040*	-	-	-
		α_1	Intercept 1	-.98	.68	.147	-	-	-
	15	α_2	Intercept 2	1.18	.47	.011*	-	-	-
		α_3	Intercept 3	.73	.50	.139	-	-	-
		β_{51}	<i>REM₅₁</i>	-1.89	1.67	.258	.152	.01	3.97
		β_{52}	<i>REM₅₂</i>	40.62	1.46	< .001*	4.36E+17	2.50E+16	7.62E+18
		β_{53}	<i>REM₅₃</i>	-20.87	8709	.998	8.63E-10	0	-
		α_0	Intercept 0	1.11	.47	.019*	-	-	-
		α_1	Intercept 1	.26	.55	.631	-	-	-
		α_2	Intercept 2	1.39	.50	.006*	-	-	-
		α_3	Intercept 3	.88	.53	.100	-	-	-

Table 4.11 Continued

Project outcome	Model	Coefficient	Parameter	Estimated	S.E.	p value	OR	OR 95%CI	
								LCI	UCI
		β_{61}	REM_{61}	-1.79	1.04	.085	.167	.022	1.28
		β_{62}	REM_{62}	1.46	.01	.999	4.31	4.31	4.31
		β_{63}	REM_{63}	17.84	1.46	< .001*	5.59E+7	3.19E+6	9.79E+8

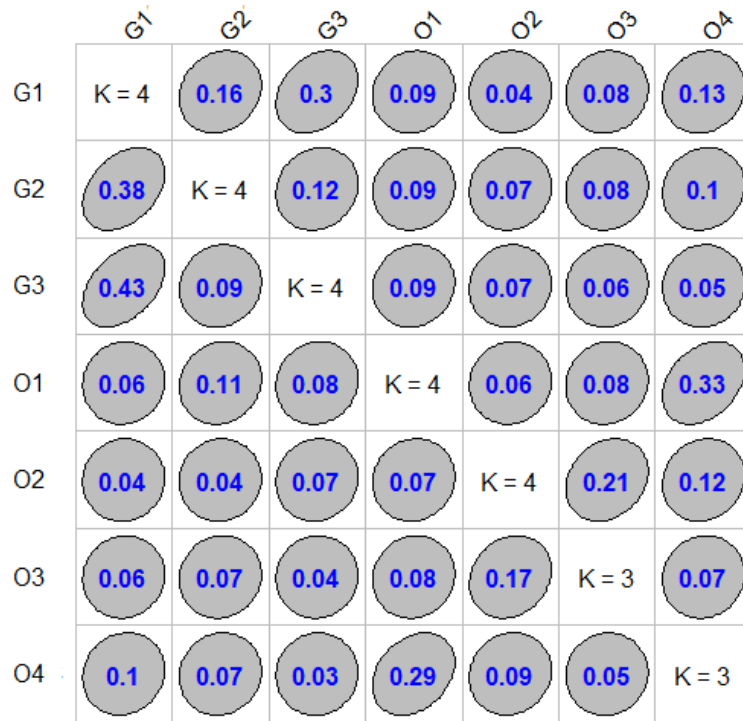


Figure 4.4. Goodman-Kruskal Tau Matrix for RQ Dimensions and Project Outcomes

4.6.2.1 Interpreting Logistic Regression Models

In predicting dimensions of RQ based on REM, results show that:

- Trust, G_1 is 8.53E-9 times more likely to be in a higher level given 1 unit increase in REM_{21} (associated with propriety of means, R_2 and past experience, S_1)
- Trust, G_1 is 1.38E+7 times more likely to be in a higher level given 1 unit increase in REM_{22} (associated with propriety of means, R_2 and benevolence, S_2)
- Trust, G_1 is 2.00E+7 times more likely to be in a higher level given 1 unit increase in REM_{23} (associated with propriety of means, R_2 , and integrity, S_3)

- Trust, G_1 is $2.55E+7$ times more likely to be in a higher level given 1 unit increase in REM_{43} (associated with reliance and expectation, R_4 and integrity, S_3)
- Knowledge transfer, G_3 is $5.23E+8$ times more likely to be in a higher level given 1 unit increase in REM_{22} (associated with propriety of means, R_2 and integrity, S_3)

In predicting project outcomes based on REM, results show the following.

Satisfaction with budget objectives is:

- $4.33E-9$ times more likely to be in a higher level given 1 unit increase in REM_{23} (associated with propriety of means, R_2 and integrity, S_3).
- $9.84E+6$ times more likely to be in a higher level given 1 unit increase in REM_{31} (associated with restraint of power, R_3 and past experience, S_1).
- $7.21E+7$ times more likely to be in a higher level given 1 unit increase in REM_{71} (associated with reciprocity, R_7 and past experience, S_1)
- $1.71E+7$ times more likely to be in a higher level given 1 unit increase in REM_{73} (associated with reciprocity, R_7 and integrity, S_3).

Schedule objectives were predicted by:

- $7.30E+7$ times more likely to be in a higher level given 1 unit increase in REM_{21} (associated with propriety of means, R_2 and past experience, S_1).
- $1.87E+8$ times more likely to be in a higher level given 1 unit increase in REM_{33} (associated with restraint of power, R_3 and integrity, S_3).
- $5.63E-8$ times more likely to be in a higher level given 1 unit increase in REM_{72} (associated with reciprocity, R_7 and benevolence, S_2).

Quality performance objectives were predicted by:

- 1.19E+8 times more likely to be in a higher level given 1 unit increase in REM_{22} (associated with propriety of means, R_2 and benevolence, S_2).
- 3.91E+8 times more likely to be in a higher level given 1 unit increase in REM_{33} (associated with restraint of power, R_3 and integrity, S_3).
- 2.19E+8 times more likely to be in a higher level given 1 unit increase in REM_{43} (associated with reliance and expectation, R_4 and integrity, S_3).
- 8.79E+7 times more likely to be in a higher level given 1 unit increase in REM_{51} (associated with contractual solidarity, R_5 and past experience, S_1).
- 8.32E+7 times more likely to be in a higher level given 1 unit increase in REM_{52} (associated with contractual solidarity, R_5 and benevolence, S_2).
- 4.89E+7 times more likely to be in a higher level given 1 unit increase in REM_{62} (associated with flexibility, R_6 and benevolence, S_2), a
- 8.56E+7 times more likely to be in a higher level given 1 unit increase in REM_{63} (associated with flexibility, R_6 and integrity, S_3).

Functionality of the completed project was predicted by:

- 0.15 times more likely to be in a higher level given 1 unit increase in REM_{11} (associated with harmonization of conflict, R_1 and past experience, S_1).
- 1.62E+8 times more likely to be in a higher level given 1 unit increase in REM_{22} (associated with propriety of means, R_2 and benevolence, S_2).
- 0.5 times more likely to be in a higher level given 1 unit increase in REM_{33} (associated with restraint of power, R_3 and integrity, S_3).
- 2.13E+8 times more likely to be in a higher level given 1 unit increase in REM_{42} (associated with reliance and expectation, R_4 and benevolence, S_2).

- 8.45E-9 times more likely to be in a higher level given 1 unit increase in REM_{43} (associated with reliance and expectation, R_4 integrity, S_3).
- 4.36E+17 times more likely to be in a higher level given 1 unit increase in REM_{52} (associated with contractual solidarity, R_5 and benevolence, S_2).
- 5.59E+7 times more likely to be in a higher level given 1 unit increase in REM_{63} (associated with flexibility, R_6 and integrity, S_3).

4.6.2.2 Accounting for Non-association between Dimensions of RQ and Project Outcomes

This analysis did not find an association between dimensions of RQ and project outcomes. Based on the followup interviews with project team members, additional observations are presented that may further explain findings between dimensions of RQ and projects outcomes.

A majority of the respondents representing the owner in Case I (Louisiana Department of Transportation, LaDOTD project) were of the opinion that cost growth resulted from the contractor underbidding the project and submitting change orders to make extra money for an increase in profit margin. The project was in close proximity to a closed landfill, posing environmental, technical, and schedule challenges. Schedule changes further resulted from unexpected heavy rainfall that led to flooding, requiring work to stop for a few weeks to drain and dry the site. In terms of construction quality, some concrete segments did not attain the required strength. Team members pointed out that for the flooding and concrete issues, all project team members worked together to find a solution.

For Case II, project team members noted that a spirit of teamwork thrived on this project, and that everyone worked well with one another towards achieving the project objectives. The cost growth reported in this project was due to change orders regarding means and methods of construction, which simultaneously impacted the schedule.

Case III represented a project that was below budget and ahead of schedule at the time of this study, which was attributed to a contractor initiated change to the means and methods of construction. In terms of team member commitment to collaboration, interviewees noted that team members were flexible and were ready to learn from each other. There was a level of trust especially among team members who had worked together before and thus they shared critical information and all team members understood their individual roles well. Planning was critical in improving the coordination among project parties. This also worked well in creating, maintaining, and sustaining relationships among project team members.

For Case IV, the cost and schedule growth was attributed to extra work introduced by the owner. Interviewees reported that the partnering effort was well coordinated.

Based on the findings from the interviews, it was clear that project outcomes were influenced by other circumstances beyond the control of the team. However, how team members behaved before or after such a situation arose played a critical role in shaping the team relationships.

4.7 Chapter Summary

This chapter externally validates Chapter 3 prediction models and then presents the results of the relationships between 1) RQ dimensions, G_g and REM, REM_{mn} ; 2) project outcomes, O_q and REM, REM_{mn} ; and 3) project outcomes, O_q and RQ dimensions, G_g . This chapter utilized multinomial logistic regression models to predict the relationship between the three constructs. In summary, the findings of this research include;

- External validation of Chapter 3 models shows high specificity values (71-100%) and low sensitivity values (13-40%). In comparing The PPVs and NPVs results between internal

(Chapter 3) and external validation in this chapter, test results appear to be similar with high PPVs (67-100%) and low NPVs (7-41%).

- Computed measure of REM (product social and relational behaviors) indicates a relationship with dimensions of RQ, G_g and project outcome, O_q . Results show that for the modeled dimensions of RQ using REM_{mn} as predictors, three satisfied the three rejection criteria whereas, for the modeled project outcomes using REM_{mn} as predictors, 17 satisfied the three rejection criteria.
- Low values for the gamma coefficient, with a range of (0.03-0.38), which mean negligible or no association between RQ dimensions, G_g and project outcomes, O_q .

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The goal of this dissertation research was to improve our understanding of the role of relational and social behaviors on project team member relationships and the impact of those relationships on construction project outcomes. The overall research methodology (Figure 5.1) depicts the research process, starting with literature review and developing the conceptual model, then proceeding with data analysis and results. Specifically, the methodology used in this research was twofold. First, the study conducted an intensive, systematic literature review. Second, case study data were used to establish REM within a construction project team guided by the conceptual framework. The attributes presented in the conceptual framework were used as variables in the study. Table 5.1 shows the research tools used to achieve the objectives. The conclusions drawn from the research findings are presented below, as they relate to the research objectives.

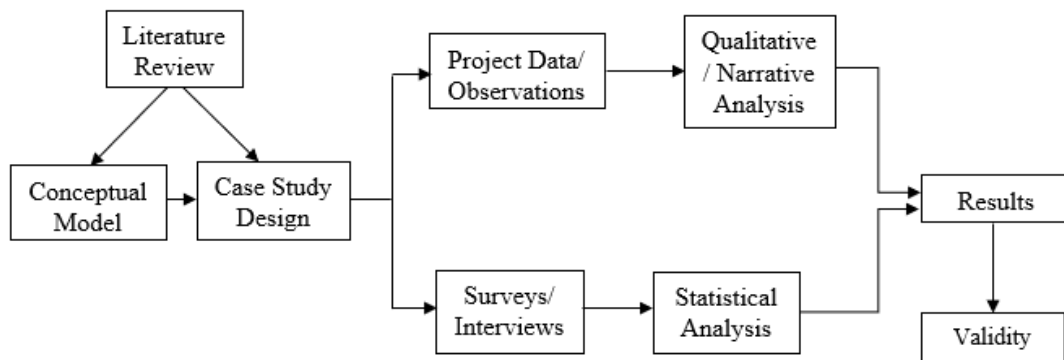


Figure 5.1. Research Methodology Process

Table 5.1. Data Collection Tools by Objective

Research objective	Literature review	Survey	Case studies
1 Conduct an in-depth literature review and content analysis to identify social behaviors common in construction project teams.	√		
2 Statistically model the relationship between construction project team members' relational and social behaviors as expressed through a national-level survey	√	√	
3 Statistically predict project outcomes and dimensions of RQ using RQ based on case study data collected from transportation and wastewater projects.	√	√	√

This chapter presents the conclusions based on this core purpose of the dissertation. First, a review of the research objectives and key findings are presented, and then the research conclusions drawn from the findings are outlined under each research objective. The implications and contributions of this research are then explained, and recommendations for future research.

5.2 Conclusions and Key Findings

5.2.1 Social Behaviors Common in Construction Project Teams

Chapter 2 is based on the argument that construction project team members exist in a network of relationships. The model created in the study by Chinowsky et al. (2008) together with the arguments presented by Rousseau Trust Model (1998), are used in understanding the social behaviors of construction project team member relationships. Throughout Chapter 2, the social life of construction projects is reviewed to understand relationship management in construction which encompasses construction project networks, RQ, and collaboration. The understanding of relationship management is based on team member interactions, and how human behavior is associated with a collaborative team.

Regardless of the industry, the social characteristics of high performing teams were described in the literature. These social characteristics include shared goals, open communication, trust, shared commitment to working together, shared accountability, shared values, and experience. What is common from previous research identifying these characteristics regardless of the industry is that these characteristics pointed towards the behaviors of team members. Review of the literature and an analysis of the construction social model by Chinowsky et al. (2008) together with the relational trust model by Rousseau (1998), reveals that the Chinowsky et al. (2008) model presents the levels of relationships that exist between construction project team members. By contrasting the two models and published literature, social behaviors exhibited by

construction project team members were identified as: previous experience, benevolence, and integrity. Also, a review of the literature identified relational behaviors commonly related to construction project teams as: as harmonization of conflict, propriety of means, restraint of power, reliance and expectation, contractual solidarity, flexibility, and reciprocity.

The key research findings of Chapter 2 are:

- Identified social behaviors affecting team member relationships as previous experience, benevolence, and integrity.
- Identified relational behaviors commonly related to construction project teams found in the literature as harmonization of conflict, propriety of means, restraint of power, reliance and expectation, contractual solidarity, flexibility, and reciprocity.

5.2.2 Relationship between Relational and Social Behaviors

This dissertation research is anchored on the concept of relationship embeddedness in construction project teams (i.e. that construction project teams exist in a network of relationships initiated through social means). Social network theory explains team member relationships through the relational and social behaviors of members constituting a team.

- This study finds that past experience (S_1) predicts five of the seven relational behaviors, benevolence (S_2) and integrity (S_3) predict three of the seven relational behaviors each (Table 3.9). All the statistically significant models had positive and significant logistic regression coefficients, β_1 , (p value < 0.05). Positive significant logistic regression coefficients indicate that the relational behavior is more likely to be exhibited when the social behavior is present, rather than absent. Similarly, it is expected that it is less likely for a team member to exhibit a relational behavior when the other team member does not exhibit a social behavior. Internal validation results show low values for sensitivity (11-56%), accuracy (34-44%, except for

model 5 with a moderately higher accuracy value of 71%), and NPV (18-59%). Specificity values (88-100%) and PPVs are high. External validation of Chapter 3 models show high specificity values (71-100%) and low sensitivity values (13-40%). PPVs (67-100%) are high and NPVs (7-41%) are low.

The key research findings of Chapter 3 are:

- Past experience is a significant predictor of harmonization of conflict, propriety of means, restraint of power, contractual solidarity, and reciprocity.
- Benevolence is a significant predictor of propriety of means, reliance and expectation, and contractual solidarity.
- Integrity is a significant predictor of propriety of means, restraint of power, reliance and expectation.
- Internal validation results show low values for sensitivity (11-56%), accuracy (34-44%, except for model 5 with a moderately higher accuracy value of 71%), and NPVs (18-59%). Specificity values (88-100%) and PPVs are high (89-100%).

5.2.3 Relationship Embeddedness

Based on the social network theory argument that team relationships are embedded in a social matrix, which can also be viewed as a product of the association between social and relational behaviors, a measure of REM for each social/relational behavior pair (REM_{mn}) was computed as a product of the exhibited relational, R_{mn} and social, S_n behaviors variables. REM_{mn} was then used to model relationships between 1) RQ dimensions, G_g and REM, REM_{mn} ; 2) project outcomes, O_q and REM, REM_{mn} . The relationship between project outcomes, O_q and RQ dimensions, G_g was also modeled.

The key research findings of Chapter 4 are:

- External validation of Chapter 3 models shows high specificity values (71-100%) and low sensitivity values (13-40%). In comparing The PPVs and NPVs results between internal (Chapter 3) and external validation in this chapter, test results appear to be similar with high PPVs (67-100%) and low NPVs (7-41%).
- Computed measure of REM indicates a relationship with dimensions of RQ, G_g and project outcome, O_q . Results show that for the modeled dimensions of RQ using REM_{mn} as predictors, three satisfied the three rejection criteria whereas, for project outcomes models using REM_{mn} as predictors, 17 satisfied the three rejection criteria.
- Low values for the gamma coefficient, with a range of (0.03-0.38), which mean negligible or no association between RQ dimensions, G_g and project outcomes, O_q .

5.3 Implications

Findings from this dissertation have practical implications and include the following:

- Social behaviors were found to be associated with some relational behaviors. Project managers and other construction practitioners leading a construction project may want to consider these potential effects when assigning people to teams.
- REM has been shown to be a component of both relational and social behaviors. It is, therefore, important for project managers and other construction practitioners to consider both relational and social behaviors when forming teams to undertake a construction project. For researchers, these findings have an impact future research with the understanding that both relational and social behaviors are important in team relationships and not just the relational behaviors.
- Eleven statistically significant models were internally and externally validated to predict relational behaviors using social behaviors. Construction industry practitioners' efforts to

create a more relational team can use these prediction models in predicting the relational aspects of the team.

5.4 Contributions

This research made contributions to construction management research, specifically on relationship management of construction project teams from a social network standpoint. The research also contributed new knowledge in understanding construction project team management, using the social network theory in the following two areas:

- First, this study introduces the concept of network theory into construction project team management and investigates the interpersonal relationships of construction project teams from a social standpoint. This provides insights into the concept of relationship embeddedness based on the relational and social behaviors exhibited by construction project team members. The concept entices new directions for future research in construction project networks and collaboration in construction project teams. The findings show the influence of social behaviors on relational behaviors of construction project teams.
- Second, this research extends knowledge by reviewing dimensions of RQ, introducing and computing a measure of REM in construction project teams based on the relational and social behaviors. The research then further predicts project outcomes and dimensions of RQ using REM of construction project team.

5.5 Future Research

Future research regarding this topic can focus on the following areas:

- A future study would be to find how relational and social behaviors can be incorporated at a team formation level to assist with project procurement procedures.

- Investigate the concept of over-embeddedness, or what is commonly referred to as redundancy in construction project teams under the social network theory to see the effects it has on project performance.
- A future research that can improve on the data collection tool is recommended as discussed at the end of Chapter 3. The sample size for questionnaire validation can be increased to make sure that substantive feedback is gathered that can improve the questions to be asked.

APPENDIX I. SURVEY QUESTIONNAIRE (VERSION 1)

SECTION I – PARTICIPANT’S INFORMATION

1) Please state your role with your organization:

- a) Project Manager
- b) Project Engineer
- c) Design Engineer
- d) Estimator
- e) Scheduler
- f) Contracts
- g) Other (please specify): _____

2) Please state how many years you have worked in the construction industry:

a) _____

3) Please state how many years you have worked with your organization:

a) _____

4) Please state how many years you have worked in your current position:

a) _____

SECTION II – TEAM INTEGRATION

1) The project team is united in trying to reach the performance goals of this project

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2) The members of this project feel proud to be a part of the team

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3) Parties to this project do not stick together outside of work

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4) Some of my best friends are on this team

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5) People in this project work well together as a team

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SECTION III – RELATIONAL AND SOCIAL BEHAVIORS

This section will ask you questions related to relational and social behaviors. You are asked to answer them as much as you can based on your experience in interacting with other project parties within your most recently completed project. Please answer each statement to the best of your knowledge. There are no right or wrong answers here, so be as accurate as you can.

- Reciprocity Behavior:** Reciprocity refers to team members who treat each other as equals, and exchanges or transactions take place with these individuals being symmetrically placed. It can be said that reciprocity is a relation between individuals who mutually depend on each other's actions or influence.

“For members to treat each other as equals, their interpersonal relationship was based on past experience, competence and/or ability to get the job done”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to treat each other as equals, their relationship was based on their demonstration of common courtesies to all, compassion, concern, kind-heartedness, good faith, sensitivity and patience towards others”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to treat each other as equals, their relationship was based on integrity which includes being trustworthy and counted on to follow through on commitments”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. **Flexibility Behavior:** Allows changes to occur in the environment to which the parties operate, or if the transaction exchanges between the parties are outdated, the flexibility of the team allows for termination and creation of appropriate new exchanges.

“For members to allow changes to occur in the project, their interpersonal relationship was based on past experience, competence and/or ability to get the job done”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to allow changes to occur in the project, their relationship was based on their demonstration of common courtesies to all, compassion, concern, kind-heartedness, good faith, sensitivity and patience towards others”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to allow changes to occur in the project, their relationship was based on integrity which includes being trustworthy and counted on to follow through on commitments”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. **Contractual Solidarity:** refers to the harmonious and peaceful state of a team that is able to preserve a relationship, especially in situations where on team member is faced with a difficult situation. Please rate the following statement below. If you are unsure, please select "NA"

“For members to be harmonious and peaceful especially when faced with difficult situations in the project, their interpersonal relationship was based on past experience, competence and/or ability to get the job done”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to be harmonious and peaceful especially when faced with difficult situations in the project, their relationship was based on their demonstration of common courtesies to all, compassion, concern, kind-heartedness, good faith, sensitivity and patience towards others”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to be harmonious and peaceful especially when faced with difficult situations in the project, their relationship was based on integrity which includes being trustworthy and counted on to follow through on commitments”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4. **Reliance & Expectations Behavior:** Team member relations are based on the reliance (promise) that others will fulfill their part of the bargain. The expectations are anchored on the exchange of promises. Please rate the following statement below. If you are unsure, please select "NA"

“For members to rely on the promise that others in the team will fulfill their part of the bargain, their interpersonal relationship was based on past experience, competence and/or ability to get the job done”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to rely on the promise that others in the team will fulfill their part of the bargain, their relationship was based on their demonstration of common courtesies to all, compassion, concern, kind-heartedness, good faith, sensitivity and patience towards others”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to rely on the promise that others in the team will fulfill their part of the bargain, their relationship was based on integrity which includes being trustworthy and counted on to follow through on commitments”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. **Restrain of Power Behavior:** an expectation between team members in that none of the project team members will apply their legitimate authority against any other's interest. Please rate the following seven statements using the scale below. Please rate the following statement below. If you are unsure, please select "NA"

“For members to expect that team members in that none of the project team members will apply their legitimate authority against any other's interest, their interpersonal relationship was based on past experience, competence and/or ability to get the job done”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to expect that team members in that none of the project team members will apply their legitimate authority against any other’s interest, their relationship was based on their demonstration of common courtesies to all, compassion, concern, kind-heartedness, good faith, sensitivity and patience towards others”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to expect that team members in that none of the project team members will apply their legitimate authority against any other’s interest, their relationship was based on integrity which includes being trustworthy and counted on to follow through on commitments”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. **Propriety of Means Behavior** requires that the team members adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract. Also team members are to be fair in their dealings through the principle of gain share and pain share through risk and benefit sharing. Please rate the following statement below. If you are unsure, please select "NA"

“For members to adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract, their interpersonal relationship was based on past experience, competence and/or ability to get the job done”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract, their relationship was based on their demonstration of common courtesies to all, compassion, concern, kind-heartedness, good faith, sensitivity and patience towards others”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract, their relationship was based on integrity which includes being trustworthy and counted on to follow through on commitments”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

7. **Harmonization of Conflict Behavior:** Harmonization and conflict resolution informal, flexible, and internal because team members establish a distinct social order as an exchange becomes more relational. Please rate the following seven statements using the scale below. If you are unsure, please select "NA"

“For members to harmonize conflict resolution informally, flexibly, and internally, their interpersonal relationship was based on past experience, competence and/or ability to get the job done”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract, their relationship was based on their demonstration of common courtesies to all, compassion, concern, kind-heartedness, good faith, sensitivity and patience towards others”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

“For members to adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract, their relationship was based on integrity which includes being trustworthy and counted on to follow through on commitments”

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

APPENDIX II. SURVEY QUESTIONNAIRE (VERSION 2)

Relationship Quality Model Survey

Welcome and thank you for agreeing to participate in this Survey aimed at modelling relationship quality between project parties based on their relational and social behaviors. Your input is highly appreciated and will be used to better understand the association between relational and social behaviors of project parties and their influence on the overall quality of the team relationships. Your responses are expected to be project specific, so please focus on your relationships with other members of the project team on a ***project you are involved with either currently under construction or a project that you most recently completed.***

The survey has two sections:

I. Provide personal information (3 to 5 minutes to complete) – Basic information regarding your position, role, years of experience

II. Rate human behaviors (Relational and social) (10 to 15 minutes to complete) – Rate the project team members that are not a part of your firm/crew. We would like to understand how well people from different firms/agencies were able to get along and cooperate during the project.

This survey should take approximately 15-20 minutes and it is recommended that you complete the survey all at once, although the Survey will be available for two weeks for you to complete. Your participation is voluntary, and your responses will be kept confidential. Your responses will not be reported in any manner that can be associated with any specific individual, organization, project, agency, or program.

If you have any questions or concerns about this survey or this research project, please contact:

James Kereri at 217-721-1836 or jkerer1@lsu.edu

Chris Harper at 225-578-0131 or charper@lsu.edu

I understand the above information and voluntarily consent to participate in the research questionnaire

☐

Yes, continue with survey

- ☐ No, opt out of survey

SECTION 1 - PERSONAL INFORMATION

Please provide the following information for ***your most recently completed project***. This project will be the focus of the questions throughout this survey. This information is valuable because it will assist in understanding the influence of relational and social behaviors on interpersonal relationships. Please answer all of the questions to the best of your knowledge. If you are unsure or are unable to provide this information for confidentiality purposes, please select "Other".

1. Name of Project: (NOTE: If unable to share project name, please write "Confidential")

2. Specify the Type of the Project

- ☐ Bridge
- ☐ Paving
- ☐ Interchange
- ☐ Other (Please Specify)
-

3. Is the project completed or currently under construction?

- ☐ Under construction
- ☐ Completed

4. What percent of the project is complete?

- ☐ 0-10%
- ☐ 11-20%
- ☐ 21-30%
- ☐ 31-40%
- ☐ 41-50%
- ☐ 51-60%
- ☐ 61-70%
- ☐ 71-80%

- ☐ 81-90%
- ☐ 91-100%

5. When was the project completed? If your project is not yet complete, what is the expected date of substantial completion? (Please state in MM/DD/YYYY format)

6. What is the delivery method used for your project?

- ☐ Design-bid-build (DBB)
 - ☐ Design-build (DB)
 - ☐ Construction manager/general contractor (CMGC or CMAR)
 - ☐ Public-Private Partnership
 - ☐ Other, _____ please _____ specify:
-

7. Please state **your organization's role in the project:**

- ☐ Transportation Agency
- ☐ Construction Manager Agency
- ☐ Program Manager
- ☐ Construction Team
- ☐ Design Team
- ☐ Consultant
- ☐ Other, please specify: _____

8. Please state your role with your organization:

- ☐ Project manager
- ☐ Project engineer
- ☐ Design engineer
- ☐ Estimator
- ☐ Scheduler
- ☐ Contracts

- ☐ Superintendent
- ☐ Foreman
- ☐ Maintenance
- ☐ Operations
- ☐ Other (please specify): _____

9. Please state how many **years** you have worked in the construction industry:

10. Please state how many years you have worked in your current position:

11. Do you have a project or the one you are involved in and are willing to assist in using it as a case study in this research?

☐ Yes, Name and email/phone number:

☐ No

SECTION II - RELATIONAL AND SOCIAL BEHAVIORS

This following question will ask you to rate a series of statement items based on your experience in interacting with other project parties on the project used in the previous sections. Please answer each statement to the best of your knowledge. There are no right or wrong answers here, so be as accurate as you can.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Never fully worked through issues informally	Never had previous experience working together	Neither worked together before nor solved issues informally	Worked issues informally even without previous experience	Worked issues informally with participants worked together before
Willingness to meet	Participants mean well and are ready to meet	Participants are well-meaning	Neither ready to meet nor well meaning	Participants not ready to meet but mean well to others	Participants not ready to meet but mean well to others
Level of blame	Participants do not blame each other for not following through their commitments	Participants do not blame each other	Neither blame nor follow through their commitments	Participants blame each other not for failing to follow through their commitments	Participants blame each other for failing to follow through their commitments

- 12. HARMONIZATION OF CONFLICT BEHAVIOR:** Harmonization and conflict resolution is informal, flexible, and internal because team members establish a distinct social order as an exchange becomes more relational.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants who have worked together before are able to fully work through issues informally and in the field rather than involving upper management						
II. Project participants tend to refuse to meet because conflicts are typically divisive						
III. Project participants are critical and blame each other for failing to follow through on commitments						

- 13. PROPRIETY OF MEANS BEHAVIOR:** Requires that the team members adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract. Also, team members are to be fair in their dealings through the principle of risk and benefit sharing.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Never respect each other	Never had previous experience working together	Neither worked together before nor respect each other	Respect each other even without previous experience	Participants respected others they worked together before
Level of compassion	No regular solutions that benefit the team	No compassion, good faith and patience	Neither regular solutions that benefit the team nor compassion, good faith and patience	Regular solutions that benefit the team without compassion, good faith and patience	Regular solutions that benefit the team with compassion, good faith and patience
Level of integrity	Participants never adhered to the principles of division of responsibility	No integrity	Neither integrity nor adhering to the principles of division of responsibilities	Participants adhere to the principles of division of responsibilities with less regard to integrity	Participants through integrity adhere to the principles of division of responsibilities

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
--	-------------------	----------	----------------------------	-------	----------------	----

I. Project participants who have worked together before, respect each other's need to do their part and avoid impeding another in executing their roles						
II. Through compassion, good faith, and patience towards others, members regularly look for solutions that benefits all team members and the project						
III. Through the integrity of project participants, they adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract						

14. RESTRAINT OF POWER BEHAVIOR: An expectation between team members in that the project team members will avoid applying their authority against any other team member's interest.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Participants do not try to take advantage of others given the chance	Never had previous experience working together before	Neither worked together before nor try to take advantage of others given a chance	Participants try to take advantage of others given a chance even without previous experience	Participants try to take advantage of others they worked together before given a chance
Willingness to act in good faith	Participants exert authority over others	Participants do not act in good faith	Neither exert authority nor act in good faith	Participants do not exert their authority on others but do not act in good faith	Participants do not exert their authority on others and do act in good faith
Level of following on commitments	Participants in authority do not help others	Participants do not follow through commitments	Neither exert authority over others nor follow through their commitments	Participants in authority help others but fail to follow through their commitments	Participants in authority help others for to follow through their commitments

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants try to take advantage of others given the chance based on past experiences with team members						
II. Project participants act in good faith without exerting their authority over other team members' interest						

III. Project participants with authority tend to help others to follow through on their project commitments						
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15. RELIANCE & EXPECTATION BEHAVIOR: Team member relations are based on the reliance (promise) that others will fulfill their part of the bargain. The expectations are anchored on the exchange of promises.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Participants do not rely on each other in completing their project tasks	Never had previous experience working together before	Neither worked together before nor rely on each other in completing their tasks	Participants rely on each other in completing their project tasks	Participants rely on others they worked together before in completing their project tasks
Level of compassion	Participants do not rely on each other in completing their project tasks	Participants are not compassionate and do not act in good faith	Neither rely on each other in completing their project tasks nor act in good faith or are compassionate	Participants rely on each other in completing their project tasks	Participants rely on others in completing their project tasks in good faith
Level of integrity	Participants did not fulfill their promises	Participants were not trustworthy	Neither fulfilled their promises nor were they trustworthy	Participants fulfilled their promises	Participants fulfilled their promises based on their trustworthiness

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants with past experience working together can rely on each other in completing their project tasks						
II. Project participants tend to be compassionate, good faith, and patience in order to rely on others to fulfill their responsibilities						
III. Project participants were trustworthy that they will deliver on their commitments						

16. CONTRACTUAL SOLIDARITY BEHAVIOR: Refers to a coordinated and peaceful state of a team that is able to preserve a relationship, especially in situations when one team member is faced with a difficult or unplanned situation.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Participants not willing to compromise	Never had previous experience working together before	Neither worked together before nor do participants willing to compromise	Participants willing to compromise	Participants willing to compromise with others they worked together before
Resource pool	Participants do not pool their resources to generate solutions for another in a difficult situation	Participants are not compassionate and patient to others	Neither pool their resources to generate solutions for another in a difficult situation nor act in good faith or are compassionate	Participants pool their resources to generate solutions for another in a difficult situation	Participants pool their resources to generate solutions for another in a difficult situation because of their compassion and patience
Level of integrity	Participants did not do their job in order to preserve the relationship	Participants were not trustworthy	Neither did their job to preserve a relationship nor were they trustworthy	Participants did their job in order to preserve the relationship	Participants did their job in order to preserve the relationship based on their trustworthiness

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants are willing to compromise because of their past experiences with the other team members						
II. Project participants actively pool their resources to generate solutions to help one another when faced with a difficult situation because of their compassion and patience towards others						
III. Project participants are trustworthy to do their job in order to preserve team relationships						

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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Previous experience	Participants not willing to accommodate unplanned activities	Never had previous experience working together before	Neither worked together before nor do participants willing to accommodate unplanned activities	Participants willing to accommodate unplanned activities	Participants willing to accommodate unplanned activities with others they worked together before
Willingness to act in good faith	Participants do not change their point of view to take into account new information or changing priorities	Participants do not act in good faith	Neither change their point of view to take into account new information or changing priorities nor act in good faith	Participants change their point of view to take into account new information or changing priorities	Participants change their point of view to take into account new information or changing priorities in good faith
Willingness to help others	Participants did not fail to deliver on their work commitments	Participants did not help others	Neither did participants fail to deliver on their commitments nor were they helpful to others	Participants failed to deliver on their commitments	Participants helped others who failed to deliver on their commitments

17. FLEXIBILITY BEHAVIOR: Flexibility behavior allows changes to occur in the environment to which the parties operate, or if the transaction exchanges between the parties are outdated, the flexibility of the team allows for termination and creation of appropriate new exchanges.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants were willing to accommodate unplanned activities by other participants with whom they had worked together with before						
II. Project participants had to change their point of view in good faith to take into account new information or changing priorities						
III. Project participants were ready to help others who failed to deliver on their work commitments						

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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Previous experience	Participants not willing to go out of their way to help others	Never had previous experience working together before	Neither worked together before nor do participants willing to out of their way to help others	Participants willing to go out of their way	Participants willing go out of their way to help others who had been kind to them before
Willingness to act in good faith	Participants seek retaliation	Participants treat others poorly	Neither retaliate nor treat others poorly	Participants do not seek retaliation of another	Participants do not seek retaliation of another if they were treated poorly before
Dealing with a difficult situation	Participants did the same thing to others who put them in a difficult situation	Participants put others in a difficult situation	Neither did participants do put others in a difficult situation nor do the same thing to others who put them in a difficult situation	Participants do not do the same thing to others	Participants do not do the same thing to others who put them in a difficult situation

18. RECIPROCITY BEHAVIOR: Reciprocity refers to team members who treat each other as equals, and exchanges or transactions take place with these individuals being symmetrically placed. It can be said that reciprocity is a relation between individuals who mutually depend on each other's actions or influence.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants go out of their way to help others who had been kind to them before						
II. Project participants may seek retaliation of another participant if they were treated poorly						
III. Project participants could do the same thing to others who put them in difficult situations						

APPENDIX III. CASE STUDY QUESTIONNAIRE

Relationship Quality Model Survey

Welcome and thank you for agreeing to participate in this Survey aimed at modelling relationship quality between project parties based on their relational and social behaviors. Your input is highly appreciated and will be used to better understand the association between relational and social behaviors of project parties and their influence on the overall quality of the team relationships. Your responses are expected to be focused on your relationships with other members of the team in this project.

The survey has two sections:

I. Provide personal information (3 to 5 minutes to complete) – Basic information regarding your position, role, years of experience

II. Rate human behaviors (Relational and social) (5 to 10 minutes to complete) – Rate the project team members that are not a part of your firm/crew. We would like to understand how well people from different firms/agencies are able to get along and cooperate during the project and then finally, your perception on the project atmosphere and satisfaction on the project progress.

This survey should take approximately 10-15 minutes and it is recommended that you complete the survey all at once, although the Survey will be available for two weeks for you to complete. Your participation is voluntary, and your responses will be kept confidential. Your responses will not be reported in any manner that can be associated with any specific individual, organization, project, agency, or program.

If you have any questions or concerns about this survey or this research project, please contact:

James Kereri at 217-721-1836 or jkerer1@lsu.edu

Chris Harper at 225-578-0131 or charper@lsu.edu

I understand the above information and voluntarily consent to participate in the research questionnaire

- ☐ Yes, continue with survey
- ☐ No, opt out of survey

1. Please state *your organization's role in the project:*

- ☐ Transportation Agency
- ☐ Construction Manager Agency
- ☐ Program Manager
- ☐ Construction Team
- ☐ Design Team
- ☐ Consultant
- ☐ Other, please specify: _____

2. Please state your role with your organization:

- ☐ Project manager
- ☐ Project engineer
- ☐ Design engineer
- ☐ Estimator
- ☐ Scheduler
- ☐ Contracts
- ☐ Superintendent
- ☐ Foreman
- ☐ Maintenance
- ☐ Operations
- ☐ Other (please specify): _____

3. Please state how many *years* you have worked in the construction industry:

4. Please state how many years you have worked in your current position:

SECTION II - RELATIONAL AND SOCIAL BEHAVIORS

These following questions will ask you to rate a series of statement items based on your experience in interacting with other team members on this project. Please answer each statement to the best of your knowledge. There are no right or wrong answers here, so be as accurate as you can.

5. **HARMONIZATION OF CONFLICT BEHAVIOR:** Harmonization and conflict resolution is informal, flexible, and internal because team members establish a distinct social order as an exchange becomes more relational.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Never fully worked through issues informally	Never had previous experience working together	Neither worked together before nor solved issues informally	Worked issues informally even without previous experience	Worked issues informally with participants worked together before
Willingness to meet	Participants mean well and are ready to meet	Participants are well-meaning	Neither ready to meet nor well meaning	Participants not ready to meet but mean well to others	Participants not ready to meet but mean well to others
Level of blame	Participants do not blame each other for not following through their commitments	Participants do not blame each other	Neither blame nor follow through their commitments	Participants blame each other not for failing to follow through their commitments	Participants blame each other for failing to follow through their commitments

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants who have worked together before are able to fully work through issues informally and in the field rather than involving upper management						
II. Project participants tend to refuse to meet because conflicts are typically divisive						
III. Project participants are critical and blame each other for failing to follow through on commitments						

6. **PROPRIETY OF MEANS BEHAVIOR;** Requires that the team members adhere to the principles of division of responsibilities together with the terms and conditions set out in the

contract. Also, team members are to be fair in their dealings through the principle of risk and benefit sharing.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Never respect each other	Never had previous experience working together	Neither worked together before nor respect each other	Respect each other even without previous experience	Participants respected others they worked together before
Level of compassion	No regular solutions that benefit the team	No compassion, good faith and patience	Neither regular solutions that benefit the team nor compassion, good faith and patience	Regular solutions that benefit the team without compassion, good faith and patience	Regular solutions that benefit the team with compassion, good faith and patience
Level of integrity	Participants never adhered to the principles of division of responsibility	No integrity	Neither integrity nor adhering to the principles of division of responsibilities	Participants adhere to the principles of division of responsibilities with less regard to integrity	Participants through integrity adhere to the principles of division of responsibilities

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants who have worked together before, respect each other's need to do their part and avoid impeding another in executing their roles						
II. Through compassion, good faith, and patience towards others, members regularly look for solutions that benefits all team members and the project						
III. Through the integrity of project participants, they adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract						

7. **RESTRAINT OF POWER BEHAVIOR:** An expectation between team members in that the project team members will avoid applying their authority against any other team member's interest.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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Previous experience	Participants do not try to take advantage of others given the chance	Never had previous experience working together before	Neither worked together before nor try to take advantage of others given a chance	Participants try to take advantage of others given a chance even without previous experience	Participants try to take advantage of others they worked together before given a chance
Willingness to act in good faith	Participants exert authority over others	Participants do not act in good faith	Neither exert authority nor act in good faith	Participants do not exert their authority on others but do not act in good faith	Participants do not exert their authority on others and do act in good faith
Level of following on commitments	Participants in authority do not help others	Participants do not follow through commitments	Neither exert authority over others nor follow through their commitments	Participants in authority help others but fail to follow through their commitments	Participants in authority help others for to follow through their commitments

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants try to take advantage of others given the chance based on past experiences with team members						
II. Project participants act in good faith without exerting their authority over other team members' interest						
III. Project participants with authority tend to help others to follow through on their project commitments						

8. **RELIANCE & EXPECTATION BEHAVIOR:** Team member relations are based on the reliance (promise) that others will fulfill their part of the bargain. The expectations are anchored on the exchange of promises.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Participants do not rely on each other in completing their project tasks	Never had previous experience working together before	Neither worked together before nor rely on each other in completing their tasks	Participants rely on each other in completing their project tasks	Participants rely on others they worked together before in completing their project tasks

Level of compassion	Participants do not rely on each other in completing their project tasks	Participants are not compassionate and do not act in good faith	Neither rely on each other in completing their project tasks nor act in good faith or are compassionate	Participants rely on each other in completing their project tasks	Participants rely on others in completing their project tasks in good faith
Level of integrity	Participants did not fulfill their promises	Participants were not trustworthy	Neither fulfilled their promises nor were they trustworthy	Participants fulfilled their promises	Participants fulfilled their promises based on their trustworthiness

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants with past experience working together can rely on each other in completing their project tasks						
II. Project participants tend to compassion, good faith, and patience in order to rely on others to fulfil their responsibilities						
III. Project participants were trustworthy that they will deliver on their commitments						

9. **CONTRACTUAL SOLIDARITY BEHAVIOR:** Refers to coordinated and peaceful state of a team that is able to preserve a relationship, especially in situations when one team member is faced with a difficult or unplanned situation.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Participants not willing to compromise	Never had previous experience working together before	Neither worked together before nor do participants willing to compromise	Participants willing to compromise	Participants willing to compromise with others they worked together before
Resource pool	Participants do not pool their resources to generate solutions for another in a difficult situation	Participants are not compassionate and patient to others	Neither pool their resources to generate solutions for another in a difficult situation nor act in good faith or are compassionate	Participants pool their resources to generate solutions for another in a difficult situation	Participants pool their resources to generate solutions for another in a difficult situation because of their compassion and patience

Level of integrity	Participants did not do their job in order to preserve the relationship	Participants were not trustworthy	Neither did their job to preserve a relationship nor were they trustworthy	Participants did their job in order to preserve the relationship	Participants did their job in order to preserve the relationship based on their trustworthiness
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	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants are willing to compromise because of their past experiences with the other team members						
II. Project participants actively pool their resources to generate solutions to help one another when faced with a difficult situation because of their compassion and patience towards others						
III. Project participants are trustworthy to do their job in order to preserve team relationships						

10. FLEXIBILITY BEHAVIOR: Flexibility behavior allows changes to occur in the environment to which the parties operate, or if the transaction exchanges between the parties are outdated, the flexibility of the team allows for termination and creation of appropriate new exchanges.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Participants not willing to accommodate unplanned activities	Never had previous experience working together before	Neither worked together before nor do participants willing to accommodate unplanned activities	Participants willing to accommodate unplanned activities	Participants willing to accommodate unplanned activities with others they worked together before
Willingness to act in good faith	Participants do not change their point of view to take into account new information or changing priorities	Participants do not act in good faith	Neither change their point of view to take into account new information or changing priorities nor act in good faith	Participants change their point of view to take into account new information or changing priorities	Participants change their point of view to take into account new information or changing priorities in good faith
Willingness to help others	Participants did not fail to deliver on their work commitments	Participants did not help others	Neither did participants fail to deliver on their commitments nor were they helpful to others	Participants failed to deliver on their commitments	Participants helped others who failed to deliver on their commitments

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants were willing to accommodate unplanned activities by other participants with whom they had worked together with before						
II. Project participants had to change their point of view in good faith to take into account new information or changing priorities						
III. Project participants were ready to help others who failed to deliver on their work commitments						

11. RECIPROCITY BEHAVIOR: Reciprocity refers to team members who treat each other as equals, and exchanges or transactions take place with these individuals being symmetrically placed. It can be said that reciprocity is a relation between individuals who mutually depend on each other's actions or influence.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Previous experience	Participants not willing to go out of their way to help others	Never had previous experience working together before	Neither worked together before nor do participants willing to out of their way to help others	Participants willing to go out of their way	Participants willing go out of their way to help others who had been kind to them before
Willingness to act in good faith	Participants seek retaliation	Participants treat others poorly	Neither retaliate nor treat others poorly	Participants do not seek retaliation of another	Participants do not seek retaliation of another if they were treated poorly before
Dealing with a difficult situation	Participants did the same thing to others who put them in a difficult situation	Participants put others in a difficult situation	Neither did participants do put others in a difficult situation nor do the same thing to others who put them in a difficult situation	Participants do not do the same thing to others	Participants do not do the same thing to others who put them in a difficult situation

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	NA
I. Project participants go out of their way to help others who had been kind to them before						
II. Project participants may seek retaliation of another participant if they were treated poorly						
III. Project participants could do the same thing to others who put them in difficult situations						

12. Project Outcomes - Please rate the satisfaction level you observed in terms of the following project objectives being achieved at the current state of the project. If you are unsure, please select "NA"

	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied	NA
I. Budget Objectives						
II. Schedule Objectives						
III. Quality requirements & performance objectives						
IV. Functionality of the completed project						

13. Project atmosphere: Please rate the following statements in terms of how the construction team have in working together. If you are unsure, please select "NA"

	Poor	Fair	Neutral	Good	Excellent	NA
I. A trust existed that each participant was keeping the project's best interests in mind						
II. When participants had a difference of opinion, they worked out the issue respectfully and jointly						
III. Participants effectively shared critical construction information with one another						

APPENDIX IV. EXPERT INTERVIEW QUESTIONNAIRE

- How long did it take to complete the survey? Were there any particular questions that you spent more time on?
- Are the survey questions sufficient, too few, or too many?
- Do the questions sound correct and natural when you read through? How about the flow?
- Did you have any difficulties understanding any of the questions?
- Is the ranking scale sufficient?
- Do the survey questions retain the respondents' attention throughout?
- Do the questions answer the survey brief?
- What do you think about the general format of the questionnaire?
- Did you have any difficulties accessing the survey online?
- Are there other issue that you would like to share?

APPENDIX V: CODEBOOK

Measured on a 5-point Likert scale. The numbers were taken directly from the survey. (1-Strongly disagree, 2-strongly agree, 3 neither agree nor disagree, 4-agree, 5-strongly agree).

Relational behavior	Social behaviors	Y variable	X variable
Flexibility	Past experience	R_{11}	S_1
	Benevolence	R_{12}	S_2
	Integrity	R_{13}	S_3
Contractual solidarity	Past experience	R_{21}	S_1
	Benevolence	R_{22}	S_2
	Integrity	R_{23}	S_3
Reliance and expectation	Past experience	R_{31}	S_1
	Benevolence	R_{32}	S_2
	Integrity	R_{33}	S_3
Restraint of power	Past experience	R_{41}	S_1
	Benevolence	R_{42}	S_2
	Integrity	R_{43}	S_3
Propriety of means	Past experience	R_{51}	S_1
	Benevolence	R_{52}	S_2
	Integrity	R_{53}	S_3
Harmonization of conflict	Past experience	R_{61}	S_1
	Benevolence	R_{62}	S_2
	Integrity	R_{63}	S_3
Reciprocity	Past experience	R_{71}	S_1
	Benevolence	R_{72}	S_2
	Integrity	R_{73}	S_3

APPENDIX VI. QUESTIONNAIRE IMPROVEMENT SUGGESTIONS FROM EXPERT INTERVIEWS

Suggestion	Quote from expert
Would prefer short statements	<p>The statements to me a very long and in some instance, I got lost on what the statement was all about. For example, the second statement under reliance and expectation, I was completely lost.</p> <p style="text-align: center;">EXP001</p>
Section II questions do not add any value based on your research brief	<p>I do not see how these questions relate to individual behaviors. The questions appear to me as a standard questionnaire to assess team performance.</p> <p style="text-align: center;">EXP004</p>
Section II questions	<p>I am thinking about how I can tell that some of my colleagues in the project are proud to be part of the team. I mean there needs to be some ranking scale on how I will gauge pride otherwise these questions are more subjective and might end up with undesired results.</p> <p style="text-align: center;">EXP005</p>
Section III questions	<p>I am looking at these questions and am like, are these similar questions? Are these questions asking the same thing? I was tempted to run down the same answer for each question because along the way I got a bit bored.</p> <p style="text-align: center;">EXP005</p>
Should have a 'not applicable' option	<p>Team members allow for changes to occur in the project and maybe I did not know why they did so.... Or just think through it like this... in my ongoing project or the one I completed recently I never experienced such a scenario.... So, I was tied to answer this question even though I didn't have an appropriate answer and could not proceed by leaving it blank...</p> <p style="text-align: center;">EXP006</p>
Participant information	<p>I feel that collecting this information is very important in your research but when you get into more details, I was very hesitant on what exactly you look looking for.... look, for example I might not be willing to disclose how many years I have been with my current employer but will be willing to state the number of years in my current role or overall experience. I would also be willing to reveal some details about the project with which I am basing my responses...</p> <p style="text-align: center;">EXP006</p>
Project details	<p>Looking at your questions I was like... you not interested with details of the project like the project delivery method... whether the project is</p>

	<p>ongoing or complete? I think this is something you might want to look at.</p> <p>EXP007</p>
Overall format	<ul style="list-style-type: none"> - In the first question on “reliance and expectation behavior and mostly all questions..... it would be nice to phrase the statement as the past when you were working on the project...“project participants, in my project,” - In contractual solidarity section, correct the first sentence..”refers to the..... <p>EXP008</p>

APPENDIX VII. CASE STUDY INTERVIEW QUESTIONNAIRE

1. Does trust exist in this project?

2. How do you perceive the intentions of the other team members working in this project?

3. Are there more team members who are more collaborative than others?

4. Has trust affected performance?
 - a. Has any type of team member behavior affected performance? (E.g. spying, talking behind your back, honesty, kindness, compassion, friendship, etc.)

 - b. Why do you think they behave the way they do?

APPENDIX VIII: RELATIONAL TO SOCIAL BEHAVIOR (R,S) QUESTIONNAIRE MAPPING

R₁. HARMONIZATION OF CONFLICT BEHAVIOR: Harmonization and conflict resolution is informal, flexible, and internal because team members establish a distinct social order as an exchange becomes more relational.

S₁:	Previous experience	Never fully worked through issues informally	Never had previous experience working together	Neither worked together before nor solved issues informally	Worked issues informally even without previous experience	Worked issues informally with participants worked together before
	(R,S)	(0,1*)	N/A	(0,0)	(1,0)	(1,1)
S₂:	Willingness to meet	Participants mean well and are ready to meet	Participants are well-meaning	Neither ready to meet nor well meaning	Participants not ready to meet but mean well to others	Participants not ready to meet but mean well to others
	(R,S)	(1,1)	(1,0*)	(0,0)	(1,0)	(1,0)
S₃:	Level of blame	Participants do not blame each other for not following through their commitments	Participants do not blame each other	Neither blame nor follow through their commitments	Participants blame each other not for failing to follow through their commitments	Participants blame each other for failing to follow through their commitments
	(R,S)	(1,0)	N/A	(1,0)	(0,1)	(0,0)

R₂. PROPRIETY OF MEANS BEHAVIOR: Requires that the team members adhere to the principles of division of responsibilities together with the terms and conditions set out in the contract. Also, team members are to be fair in their dealings through the principle of risk and benefit sharing.

S₁:	Previous experience	Never respect each other	Never had previous experience working together	Neither worked together before nor respect each other	Respect each other even without previous experience	Participants respected others they worked together before
	(R,S)	(0,1*)	N/A	(0,0)	(1,0)	(1,1)
S₂:	Level of compassion	No regular solutions that benefit the team	No compassion, good faith and patience	Neither regular solutions that benefit the team nor compassion, good faith and patience	Regular solutions that benefit the team without compassion, good faith and patience	Regular solutions that benefit the team with compassion, good faith and patience
	(R,S)	(0,1*)	N/A	(0,0)	(1,0)	(1,1)

S₃:	Level of integrity	Participants never adhered to the principles of division of responsibility	No integrity	Neither integrity nor adhering to the principles of division of responsibilities	Participants adhere to the principles of division of responsibilities with less regard to integrity	Participants through integrity adhere to the principles of division of responsibilities
	(R,S)	(0,1*)	N/A	(0,0)	(1,0)	(1,1)

R₃. RESTRAINT OF POWER BEHAVIOR: An expectation between team members in that the project team members will avoid applying their authority against any other team member's interest.

S₁:	Previous experience	Participants do not try to take advantage of others given the chance	Never had previous experience working together before	Neither worked together before nor try to take advantage of others given a chance	Participants try to take advantage of others given a chance even without previous experience	Participants try to take advantage of others they worked together before given a chance
	(R,S)	(1,1*)	N/A	(1,0)	(0,0)	(0,1)
S₂:	Willingness to act in good faith	Participants exert authority over others	Participants do not act in good faith	Neither exert authority nor act in good faith	Participants do not exert their authority on others but do not act in good faith	Participants do not exert their authority on others and do act in good faith
	(R,S)	(0,1*)	N/A	(1,0)	(1,0)	(1,0)
S₃:	Level of following on commitments	Participants in authority do not help others	Participants do not follow through commitments	Neither exert authority over others nor follow through their commitments	Participants in authority help others but fail to follow through their commitments	Participants in authority help others for to follow through their commitments
	(R,S)	(0,1)	N/A	(0,0)	(1,0)	(1,1)

R₄. RELIANCE & EXPECTATION BEHAVIOR: Team member relations are based on the reliance (promise) that others will fulfill their part of the bargain. The expectations are anchored on the exchange of promises

S₁:	Previous experience	Participants do not rely on each other in completing their project tasks	Never had previous experience working together before	Neither worked together before nor rely on each other in completing their tasks	Participants rely on each other in completing their project tasks	Participants rely on others they worked together before in completing their project tasks
	(R,S)	(0,1)	N/A	(0,0)	(1,0*)	(1,1)

S₂:	Level of compassion	Participants do not rely on each other in completing their project tasks	Participants are not compassionate and do not act in good faith	Neither rely on each other in completing their project tasks nor act in good faith or are compassionate	Participants rely on each other in completing their project tasks	Participants rely on others in completing their project tasks in good faith
	(R,S)	(0,1*)	N/A	(0,0)	(1,0*)	(1,1)
S₃:	Level of integrity	Participants did not fulfill their promises	Participants were not trustworthy	Neither fulfilled their promises nor were they trustworthy	Participants fulfilled their promises	Participants fulfilled their promises based on their trustworthiness
	(R,S)	(0,1*)	N/A	(0,0)	(1,0*)	(1,1)

R₅. CONTRACTUAL SOLIDARITY BEHAVIOR: Refers to a coordinated and peaceful state of a team that is able to preserve a relationship, especially in situations when one team member is faced with a difficult or unplanned situation.

S₁:	Previous experience	Participants not willing to compromise	Never had previous experience working together before	Neither worked together before nor do participants willing to compromise	Participants willing to compromise	Participants willing to compromise with others they worked together before
	(R,S)	(0,1*)	N/A	(0,0)	(1,0*)	(1,1)
S₂:	Resource pool	Participants do not pool their resources to generate solutions for another in a difficult situation	Participants are not compassionate and patient to others	Neither pool their resources to generate solutions for another in a difficult situation nor act in good faith or are compassionate	Participants pool their resources to generate solutions for another in a difficult situation	Participants pool their resources to generate solutions for another in a difficult situation because of their compassion and patience
	(R,S)	(0,1*)	N/A	(0,0)	(1,0*)	(1,1)
S₃:	Level of integrity	Participants did not do their job in order to preserve the relationship	Participants were not trustworthy	Neither did their job to preserve a relationship nor were they trustworthy	Participants did their job in order to preserve the relationship	Participants did their job in order to preserve the relationship based on their trustworthiness
	(R,S)	(0,1*)	N/A	(0,0)	(1,0*)	(1,1)

R₆. FLEXIBILITY BEHAVIOR: Flexibility behavior allows changes to occur in the environment to which the parties operate, or if the transaction exchanges between the parties are

outdated, the flexibility of the team allows for termination and creation of appropriate new exchanges.

S1:	Previous experience	Participants not willing to accommodate unplanned activities	Never had previous experience working together before	Neither worked together before nor do participants willing to accommodate unplanned activities	Participants willing to accommodate unplanned activities	Participants willing to accommodate unplanned activities with others they worked together before
	(R,S)	(0,1*)	N/A	(0,0)	(1,0*)	(1,1)
S2:	Willingness to act in good faith	Participants do not change their point of view to take into account new information or changing priorities	Participants do not act in good faith	Neither change their point of view to take into account new information or changing priorities nor act in good faith	Participants change their point of view to take into account new information or changing priorities	Participants change their point of view to take into account new information or changing priorities in good faith
	(R,S)	(0,1*)	N/A	(0,0)	(1,0*)	(1,1)
S3:	Willingness to help others	Participants did not fail to deliver on their work commitments	Participants did not help others	Neither did participants fail to deliver on their commitments nor were they helpful to others	Participants failed to deliver on their commitments	Participants helped others who failed to deliver on their commitments
	(R,S)	(1,1*)	N/A	(1,0)	(0,0*)	(0,1)

R7. RECIPROCITY BEHAVIOR: Reciprocity refers to team members who treat each other as equals, and exchanges or transactions take place with these individuals being symmetrically placed. It can be said that reciprocity is a relation between individuals who mutually depend on each other's actions or influence.

S1:	Previous experience	Participants not willing to go out of their way to help others	Never had previous experience working together before	Neither worked together before nor do participants willing to out of their way to help others	Participants willing to go out of their way	Participants willing go out of their way to help others who had been kind to them before
	(R,S)	(0,1*)	N/A	(0,0)	(1,0*)	(1,1)

S₂:	Willingness to act in good faith	Participants seek retaliation	Participants treat others poorly	Neither retaliate nor treat others poorly	Participants do not seek retaliation of another	Participants do not seek retaliation of another if they were treated poorly before
	(R,S)	N/A	N/A	(1,1)	(1,1*)	(1,0)
S₃:	Dealing with a difficult situation	Participants did the same thing to others who put them in a difficult situation	Participants put others in a difficult situation	Neither did participants do put others in a difficult situation nor do the same thing to others who put them in a difficult situation	Participants do not do the same thing to others	Participants do not do the same thing to others who put them in a difficult situation
	(R,S)	(0,0)	N/A	(1,0)	(1,1*)	(1,0)

Note:




*Assumed social behavior response

APPENDIX IX. PERMISSION TO INCLUDE PUBLISHED MATERIAL

RE: Permission to include published paper in my dissertation



PERMISSIONS <permissions@asce.org>
To: James Kereri

 Reply  Reply All  Forward 

Tue 2/19/2019 10:39 AM

Dear James,

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Sincerely,

Leslie Connelly

APPENDIX X. IRB EXEMPTION LETTER

James O Kereri

From: Institutional R Board
Sent: Friday, March 16, 2018 3:09 PM
To: James Kereri
Cc: Christofer M Harper
Subject: IRB Application

Hi,

The IRB chair reviewed your application, Constructing and Maintaining Collaborative Project Networks: A Relationship Quality Model, and determined IRB approval for this specific application (IRB# E10943) is not needed. There is no manipulation of, nor intervention with, human subjects. Should you subsequently devise a project which does involve the use of human subjects, then IRB review and approval will be needed. Please include in your recruiting statements or intro to your survey, the IRB looked at the project and determined it did not need a formal review.

You can still conduct your study. It falls under a certain category that does not need IRB approval.
Elizabeth



Elizabeth Cadarette

IRB Coordinator

Office of Research and Economic Development

Louisiana State University

131 David Boyd Hall, Baton Rouge, LA 70803

office 225-578-8692 | fax 225-578-5983

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VITA

James Kereri has a background in Construction Management, having earned his bachelor's degree in Construction Management from Jomo Kenyatta University of Agriculture and Technology (JKUAT) in 2011. Upon graduation, James worked in the construction industry handling a variety of construction projects ranging from residential, commercial, healthcare, and heavy construction. He then proceeded to Bowling Green State University in 2013, earning a master's degree in Technology Management majoring in Construction Management in May 2015. At Bowling Green State University, he served as a teaching assistant in the Contracts and Construction Scheduling courses. James enrolled in the Engineering Science PhD program at Louisiana State University in 2016 and served as a research and teaching assistant in the Bert S. Turner Department of Construction Management.