TRUST AS A PREDICTOR OF INNOVATION NETWORK TIES IN PROJECT TEAMS

Abstract

We examine the influence of trust on the formation of social network ties for the idea generation and idea realisation stages of innovation. Drawing on data from 153 employees working in project teams at two firms, we find two dimensions of trustworthiness, Ability and Benevolence, predict tie formation for both *idea generation* and *idea realisation*, whereas Integrity predicts tie formation for *idea generation* only. Moderation analyses further reveal that perceptions of another's ability only predicts tie formation positively when that person is also perceived to be benevolent or have integrity. Across both firms and stages of innovation, a lack of benevolence makes ability largely irrelevant as a criterion for choosing a partner for innovation activities, whereas high benevolence increases the extent to which ability influences partner choice. Additionally, a lack of integrity makes ability either irrelevant or a negative criterion for partner section. Overall the results suggest that people need to perceive others as benevolent (i.e. collegial behaviour and concern for others) and not lacking in integrity in order to seek out their skills and knowledge for innovation in project teams.

Keywords: Innovation, social networks, trust and trustworthiness

1. Introduction

Innovation can be conceptualized as a process made up of various linked stages from the generation of ideas to the implementation of new products and services (for review see Garud et al., 2013; Janssen et al., 1997). Each stage of the innovation process has unique challenges which require the alignment and integration of cognitive, structural and social resources residing in different domains (Amabile, 1988; Hargadon, 2002). Coordination of these resources allows organizations to deal with the many challenges of innovation including the generation and refinement of ideas (Hargadon, 2002; Hargadon and Douglas, 2001), their coordination and production across the organization (Axtell et al., 2000; 2006), the minimization of risks (Berardo and Scholz, 2010) and initiation of market uptake. The theory of social capital explains the motives for coordination and advice seeking in innovation (Agneessens and Wittek, 2012; Nahapiet and Ghoshal, 1997; Nahapiet and Ghoshal, 1998). Two elements of social capital are the structural patterns of the communication networks (i.e. social networks), and the relational aspect of the ties within those networks, which includes trust (Nahapiet and Ghoshal, 1998, pp. 250-251).

The structural patterns of communications in an organization can be quantified using social network analysis (Marsden, 1990; Tichy et al., 1979). This approach traces employees' informal social ties and has recently been applied in innovation research to highlight the social side of idea development. Research in this vein has shown how social network structure influences innovation and its supportive elements in project teams and organizations (Axtell et al., 2000; Kastelle and Steen, 2010; Kijkuit and van den Ende, 2010; Madjar et al., 2002; Simon and Tellier, 2011; Steen et al., 2008).

The relational element of trust is also understood to be a fundamental driver of the formation of network ties (Burt, 2005; Granovetter, 1973, 1983). Tie formation is dependent not only on

people identifying desired resources that reside in others, but perceiving that the interaction will bring benefits. This perception of others' trustworthiness consists of three dimensions: Ability, Benevolence, and Integrity (Mayer et al., 1995). Ability refers to the cognitive beliefs about the other party's skills, competencies, and expertise that enable him or her to have influence in a particular domain. Benevolence captures the perception that the other person has genuine care and concern for the trustor and wants to do the right thing by them, including aspects of emotional attachment and positive orientation (pp. 717-719). Integrity relates to the perception that the other party adheres to a set of principles and values that the trustor finds acceptable, such as delivering on promises.

Psychometrically-valid measures of trust and its antecedents have rarely been utilised in network research (McEvily and Tortoriello, 2011), with researchers instead using global proxy indicators (e.g. van de Bunt et al., 2005; for a recent exception see Yakovleva et al., 2010). Yet, recent research implies there may be complex interactions between the various dimensions of trust in social networks. The collective work of Casciaro and Lobo (2005, 2008) showed how interpersonal affect (e.g. liking another) moderates the impact of competence on the formation of task-related ties. Extending this finding to trust in social networks, we propose that employees in project teams tasked with innovation need to perceive that a potential work partner is trustworthy, before seeking out the task resources that reside in that partner. This leads to an important yet largely unaddressed question (Ferrin et al., 2006): how does trust and its related dimensions influence the formation of social network ties in innovation processes? To our knowledge, there have been no attempts to examine this question, or the role of unique dimensions of trust in predicting social networks formed for different stages of the innovation process.

In the next section, we elaborate on the role of social networks and trust at the various stages of the innovation process, and describe our hypotheses.

2. Networks, Trust and the Innovation Process

2.1. Stages of the Innovation Process

Innovation is a process made up of divergent and convergent phases which includes research and development and its associated activities (see review by Garud et al., 2013; OECD and Eurostat, 2005). Several models of the innovation process exist, and a review of these models suggest two dominant stages (Garud et al. 2013): idea generation (IG) and idea implementation or realisation (IR). Research on Innovative Work Behaviours (IWB; De Jong and Den Hartog, 2010; Ramamoorthy et al., 2005) captures the distinct behaviours and activities at each stage. IG is defined by behaviours that help create new ideas for difficult issues, the search for new work methods and the generation of original solutions. In contrast, IR is defined by behaviours that transform innovative ideas into useful applications, evaluate the utility of novel ideas and introduce innovative work systems systematically into a work environment (p. 150). Figure 1 illustrates the specific stages of the innovation process and the links between them (Janssen et al., 1997).

Insert Figure 1 about here

2.2 Social Capital as Contributor to Innovation

Social capital theory is based on the principle that ties to others provides access to resources (Portes, 1998). That is, employees invest in social relationships by establishing and sustaining ties with others who are perceived to bring benefits. This study focuses on two distinct but inter-related aspects of social capital: the Structural and Relational elements. The interplay between these elements brings about benefits to the individuals, as well as their organizations (Burt, 2005; Nahapiet and Ghoshal, 1997).

2.3 Social Networks as a Structural Contributor to Innovation

Social networks explain how certain network structures of project teams bring advantages to the project. Research suggests high-density structures support data accuracy (Ibarra, 1995), shared norm development (Nahapiet and Ghoshal, 1998; Obstfeld, 2005) and trust (Coleman, 1988; Reagans and McEvily, 2003). In contrast, sparse networks bring different benefits, namely facilitating diverse information from various domains to combine to create novel ideas (Burt, 1992; Burt et al., 2013; Coleman, 1990), enabling contingencies (Mizruchi and Stearns, 2001), and supporting collective action and synchronization (Burt, 2004; Obstfeld, 2005). Through network relationships, opportunities are created for information sharing and coordinated action to mutually reinforce and accumulate over time (Burt, 1997). Networks can facilitate not only cooperation to pursue opportunities (Podolny and Baron, 1997) but also the transmission of a person's trustworthiness and the corroboration of that reputation within the network (Ferrin et al., 2012).

Social network analysis treats each actor as a node in the network, and ties between the actors are denoted by lines between the nodes. The term *ego* and *alter* are used to denote the actors, with the ego being the focal person, and the alter being the actor approached. The nodes and lines create a graph with resulting structures that can be analysed visually as well as mathematically. Analysing these networks allows for the measurement and correlation of variables (Ahuja, 2000; Drach-Zahavy and Somech, 2001; Tortoriello and Krackhardt, 2010).

2.4 Trust as A Relational Contributor To Innovation Networks

Trust is defined by Mayer et al. (1995) as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control the other party" (Mayer et al., 1995, p. 712). Similar definitions abound (e.g. Rousseau et al., 1998) which

highlight two essential characteristics of trust: The positive expectations of the trustor or ego, and a willingness to be vulnerable to the actions of the trustee or alter (Lewicki, Tomlinson and Gillespie, 2006). The latter implies the presence of risk.

Trust is particularly salient for the innovation process, due to the risks and uncertainties inherent in creating and implementing novel ideas. Uncertainties and risks may take the form of opportunistic behaviours, failure of technology, unforeseen organizational hurdles and financial concerns. Trust allows actors involved in innovation to share information and collectively solve problems to manage these risks. Trust that can be facilitated through networks (Nahapiet and Ghoshal, 1997) is a key lever for the management of such risks. Applying a dominant model of trust development (Mayer et al., 1995) to the context of innovation projects suggests that the decision of who to trust will be driven by the ego's perception that the alter is trustworthy, that is that the alter has the Ability to assist in the endeavour (i.e. are perceived to be competent with task-specific skills and technical capabilities) the Benevolence to operate collegially with genuine concern for the ego's interests, and the Integrity to stand by their word, fulfil commitments and adhere to mutually-agreed guidelines and principles. Benevolence is understood to be largely affect-based, while Ability and Integrity are more cognition-based (McAllister, 1995).

We join recent and emerging research (Levin and Cross, 2004; Marks et al., 2001; Schulte et al., 2010) to argue that trust is the over-arching attitudinal construct that drives tie formation for innovation in social networks. Since innovation is viewed as a process with distinct phases that fulfil different objectives (Janssen et al., 1997), this paper argues that trust will play both universal and context-specific roles within the idea generation (IG) and idea realisation (IR) stages. We bring together conceptual models in the fields of trust and innovation, combined with advances in social network analysis, to examine how the dimensions of trust influence network formation during these two innovation stages. In so

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doing, we test our proposition that employees need to perceive that a potential work partner is trustworthy, before seeking out the task resources that reside in that partner for innovation.

In this study, we clearly delineate between social networks and trust, both in theory and measurement. The field of social network analysis (Reagans and McEvily, 2003; Uzzi, 1997) to date has not used psychometrically-validated measures to explore how the various dimensions of trust influence social networks (e.g. van de Bunt et al., 2005). This research attempts to overcome the limitations of previous research by incorporating validated trust measures in characterising innovation network structures.

3. Hypotheses

Our first three hypotheses address the question of how trust and its dimensions influence social network formation for the two stages of the innovation process. The fourth and fifth hypotheses examine the interplay between the trust dimensions, addressing the question of whether actors need to perceive benevolence and integrity in potential partners before seeking out their expertise for innovation.

3.1 Perceived Trustworthiness

For project teams developing innovations, we theorise that the decision to seek out another person to support the generation or implementation of ideas is likely to be influenced by how trustworthy the other is perceived to be (Mishra, 1996). Specifically, we suggest that Ability, Benevolence and Integrity will play similar roles in IG and IR networks. Both IG and IR stages pose risks and vulnerabilities that make trust salient and pivotal to tie formation. For example, during IG, there are risks related to disclosing, discussing and refining ideas, which are more opportunistic as opposed to operational in nature. These include the possibility of the ideas being stolen or ridiculed. Trustworthy actors are seen as able to help reduce these

risks. Competent actors bring useful skills and perspectives to the table (Ability). Actors who are perceived to care for the focal actor (Benevolence) will be expected to act honourably and with concern. They are also expected to observe formal and unwritten guidelines agreed upon between them and other parties (Integrity).

In the IR stage, attention turns to the implementation of the innovation by the project teams (Axtell et al., 2000; Baer, 2012). Many organizations have clear chains of command through hierarchies and job roles that stipulate who will be involved in project implementation. However, actors still have considerable discretion to choose from those around them and actors are expected to choose those with the Ability to drive innovation implementation plans and reduce operational risks, as well as the political skills to acquire required financial support, convince other managers to support the innovation, and resolve barriers to innovation realisation. Actors will choose those who are perceived to be benevolent in order to secure these resources. At this juncture, the risk of disclosed ideas being lost or stolen is no longer significant, but delivering on commitments is. Actors with Integrity will be sought after to ensure milestones and objectives of the project are achieved. This leads to the following hypotheses:

H1: Perceptions of the alters' Ability will be positively associated with tie formation in IG and IR networks.

H2: Perceptions of the alters' Benevolence will be positively associated with tie formation in IG and IR networks.

H3: Perceptions of the alters' Integrity will be positively associated with tie formation in IG and IR networks.

3.2 The moderating effect of Benevolence and Integrity

In this research, we illuminate the interplay between dimensions of trustworthiness in the formation of IG and IR ties. We first ask whether the impact of Ability on tie formation is dependent on whether the alter is perceived to be benevolent or not. While formal team membership is usually under the control of management, employees can also self-select whom within the team they will go to for IG or IR, as well as potentially seek input from non-team members within the organization. We suggest that the Benevolence experienced when interacting with another can trigger *behavioural self-regulation mechanisms* (Carver & Scheier, 2000; Davidson et al., 1990; Gray, 1994). These mechanisms include behavioural *approach* which prompts action and interaction towards goal achievement, and behavioural *inhibition* which responds to signals of punishment or lack of rewards to inhibit interaction. We relate these to positive and negative perceptions of Benevolence respectively, based on the proposition that a person's choice of tie formation is linked to the perception that the potential work partner has the focal person's interests at heart.

Applying behavioural self-regulation theory to Benevolence in the context of innovation suggests that positive perceptions of an alter's Benevolence leads to the view that task-related resources are within reach. This activates the behavioural approach system and the seeking out of resources to achieve goals. Once actors are assured through the alter's Benevolence that resources are available, they will then evaluate the alter's Ability, as a further criterion for tie formation. Conversely, when a potential work partner or alter is perceived to have low Benevolence, the focal person is likely to perceive that resources for innovation are beyond reach. Consequently, tie formation with this alter will be perceived as untenable, activating the behavioural inhibition system which retards movement toward, and hence tie formation with the alter. Subsequently, the relevance of the alter's Ability for tie formation declines. Aligned with findings that affect towards another party can have overwhelming hold over interactions and render the task-related skills of the other party irrelevant (Casciaro and Lobo,

2005; 2008), we suggest that perceptions of the alter's Benevolence will influence whether Ability is important for tie formation.

Simply put, when someone is perceived to not have the ego's interests at heart, whether that person is perceived to be skilled or not is irrelevant. It is thus unlikely that this person will be sought after for either IG-related or IR-related tasks. This holds true even if the person is allocated as a team member by management. In contrast, alter's who are perceived to have their colleagues' interests at heart will be sought after for their IG or IR resources, making their ability an important criterion for tie formation. Taken together, this leads us to the following hypothesis:

H4: The positive association between the alter's perceived Ability and tie formation is moderated by Benevolence, such that the relationship between Ability and tie formation is stronger when Benevolence is high than when Benevolence is low.

Using the same line of argument, we further propose that the Integrity of the alter may also influence the importance of Ability for tie formation. Currently how Integrity predicts tie formation is not well understood. We propose that behavioural inhibition mechanism will play a role ((Carver & Scheier, 2000; Gray, 1994). Actors who are perceived to lack Integrity and hence unpredictable in sticking to commitments and completing objectives, are unlikely to be sought out for innovation, even if they are perceived to be technically competent. Conversely, if the alter is perceived to have high Integrity, a person who reliably delivers on promises and commitments, the focal actor will be interested to work with them and the alter's Ability will be a relevant criterion influencing tie formation. Based on these arguments, it is suggested that Integrity moderates the relationship between Ability and tie formation for innovation. Hence:

H5: The positive association between the alter's perceived Ability and tie formation is moderated by Integrity, such that the relationship between Ability and tie formation is stronger when Integrity is high than when Integrity is low.

4 Data and Methodology

4.1 Interviews and Survey Design

Network data and personal attribute information was collected from firms A and B. Firm A was a department in a large multinational overseeing execution of projects in the oil, gas and mining sector. It operates out of 2 locations in Australia. The department had 58 employees, 56 of which were men, and 2 women. Firm B on the other hand is a division of a large R&D organisation carrying out world class research and innovation projects. In contrast with firm A, firm B has offices at 13 locations throughout Australia and a total of 550 employees (113 women, and 437 men).

Prior to the administration of surveys, we interviewed a number of employees representing a cross-section of the two firms' population to ascertain the level and type of innovation within the project teams, and understand how the innovation process worked in each firm. As an operational organisation, firm A relies on delivering existing products and services in the best possible way, working in conjunction with other firms. Firm B is a large research-based organization that produces new-to-the-world technologies. Interviews indicated that on an incremental-radical innovation scale, firm A is more incremental, whereas firm B is more radical. Such information informed the design of the surveys. The initial surveys were pilot tested with management and staff to ensure the surveys were appropriately worded.

An online link inviting participation in the network survey was sent to all employees of the relevant department and division. The survey was voluntary and no inducements were offered

in return for participation. Once collected, survey information was de-identified to protect respondent identity.

Table 1 shows descriptive statistics for both firms. In total, 21 usable responses were received from firm A representing 5 project teams, and 132 responses from firm B, representing 11 research programs (similar to project teams). This corresponds to a response rate of 36% and 24% for firm A and B respectively. The resultant IG and IR networks consisted of 43 and 33 employees respectively in Firm A, and 337 and 237 employees respectively in Firm B. The networks in Firm B are thus approximately 8 times larger than that of Firm A, with correspondingly more ties as well as greater geographical spread across office locations (13 vs. 2). In spite of these differences, the network degree or average number of ties sent out by employees in both firms is similar (2.28 vs. 2.44), suggesting similar levels of IG and IR network activity across the firms. The levels of trust propensity and trustworthiness across the firms were very similar with no significant differences in the perceived trustworthiness of alters for IG and IR.

<center>Insert Table 1 about here</center>

4.2 Measures

Innovation Networks: To assess the IG and IR networks, questions were derived from the Innovative Work Behaviour (IWB) scale (De Jong and Den Hartog, 2010; Ramamoorthy et al., 2005) that characterised IG and IR respectively (Janssen, 2000). Respondents were asked to identify the project they were working on, and then, using name generator questions, identify from a pull-down list of all employees, those they communicate with to generate and implement novel ideas.

The following question was used to construct the IG network: "In the past six months, were there any colleagues in your division from whom you regularly sought information and advice to help you with: 1) Creating new ideas to tackle difficult problems, 2) Searching out new work methods, techniques, or instruments, and/or, 3) Generating original solutions to solve problems? Please identify anywhere up to eight (8) contacts who meet at least one of the criteria above."

Similarly the following question was used to construct the IR network: "In the past six months, were there any colleagues in your division from whom you regularly sought information and advice to help you with: 1) Acquiring approval for innovative ideas, 2) Making important company members enthusiastic for innovative ideas, 3) Transforming innovative ideas into useful applications, and/or, 4) Introducing innovative ideas into the work environment in a systematic way? Please identify anywhere up to eight (8) contacts who meet at least one of the criteria above."

Perceived Trustworthiness: The trustworthiness of alters identified through the name-generator questions was assessed using six items derived from Mayer et al., (1999). Participants indicated the extent to which they agreed with the following statements: *Ability* (1) This person is very capable of performing his/her job and (2) This person has much expert knowledge in the field I need advice in; *Benevolence* (3) This person cares about my welfare, (4) This person will go out of his/her way to help me; and *Integrity* (5) I never have to wonder if this person will stick to their word, (6) Sound principles seem to guide this person's behaviour. A seven point scale was used (1= Strongly Disagree; 4= Neither Agree or Disagree; 7= Strongly Agree).

Control Variables: Tie formation can be influenced by individual demographic variables, as well as trust propensity (Mayer and Davis, 1999). The HR departments of the two firms

provided information on project team membership, office location and seniority. Tenure data was provided for Firm B only. *Common project team membership* was calculated by constructing a matrix where 1 denoted the same project team between focal actor and alter, and 0 a different project team. Similarly, *office (co)location* was constructed as a matrix, where 1 indicates the focal actor is in the same office as the alter, and 0 indicates different location. *Seniority* was calculated by constructing a matrix of the seniority ranking of a focal actor. Hence, this captures whether seniority of the alter predicts tie formation. In a similar fashion, *Tenure* was measured as the focal actor's length of service.

To control for possible alternative explanations for the presence of innovation-related ties (see Granovetter, 1983), we added measures for *availability* (This person is available when I need him/her; 1= Strongly Disagree, 4= Neutral, 7= Strongly Agree), *closeness of relationship* (How close is your working relationship with this person? 1= Not at all close; 4= Moderately close; 7=Very close) and *trust propensity* (1. I believe that most people are basically well-intentioned; 2. I think most of the people I deal with are honest and trustworthy; 3. My first reaction is to trust people; 1= Strongly Disagree, 4= Neutral, 7= Strongly Agree; Costa and McCrae, 1992*)*.

4.3 Analytical Procedure

In this research, the unit of analysis is the whole network made up of the dyadic relationship between pairs of actors. A single mode network framework is used to analyse global IG and IR networks of each employee. The key independent variables are the actor's perception of the alters' trustworthiness. The dependent variable is the ties between the actors in the respective IG and IR networks.

In network data the assumptions of traditional regression do not hold because the observations and the variables are not independent. Rather, networks evolve and actors are interdependent.

One of the typically erroneous assumptions in network research is that 'network structures are exogenous, with actors randomly assigned to network positions....clearly the assumption that network positions are exogenous.... is, at best questionable and, at worst, violated in the majority of cases' (Stuart and Sorenson, 2007, p. 217). The assumption that regression models can be constructed with 'independent' variables is risky when data are taken from the same network. One approach to make the analysis more tenable is to ensure that the mechanisms of interdependency that influence the evolution of the network are also modelled.

To deal with these interdependencies, Borgatti and Cross (2003) developed a special procedure called the Multiple Regression Quadratic Assignment Procedure (MRQAP) as part of the UCINET software (Borgatti et al., 2002). This method was used to run the correlations and multiple variable regressions to test the hypotheses. Fundamentally, the procedure is similar to traditional procedures especially in the estimation of parameters. It differs in the random permutation of the rows of data, essentially creating the sample space of similar matrices and studying the significance of the observed matrix in comparison to this generated data set. A double semi-partialing approach recommended by Dekker et al. (2007) was used to calculate the significance levels based on 2000 random permutations that generated values as great as that in the observed statistic. This number of random permutations is determined after evaluating the stability criterion of the residuals. Any increase beyond this value increases the computation time with no significant improvement in the results.

As MRQAP regresses variables onto logistic scores, while the significance statistics are valid, the regression coefficients have not been transformed into scores such as odds ratios, so comparisons between coefficients can't be made easily (Borgatti et al., 2013). For this reason, logistic regression (LRQAP) was utilised for hypotheses 4 and 5 which provides a more accurate interpretation of the effect sizes via the regression coefficients of the logit function. It is similar in nature to MRQAP, but is more accurate in comparing parameter magnitudes. The

drawback of using this approach is that it is computationally more intensive, and the probability of model divergence is relatively higher. This is the reason why MRQAP was used for the first three hypotheses, where the focus was on significance values rather than parameter sizes.

To test for the moderation effect, we identified low and high Benevolence ties, and then determined the different regression coefficients for the relationship between Ability and tie formation. We adopt this approach instead of using a multiplicative term because as pointed out by Casciaro and Lobo (2008), various moderation patterns could cause a statistically significant multiplicative term. To determine the coefficients, we based the segmentation on the basis that a given percentage of ties are low and the remainder are high (Grosser et al., 2010; Labianca and Brass, 2006). We used the same approach for the moderation effect of Integrity.

We define low Benevolence ties as ties with alters whose Benevolence score corresponded to the '1- Strongly disagree' to '4 - Neutral' portions of the 7 –point scale. In contrast, high Benevolence ties corresponded to scores of '5- Agree' to '7 -Strongly agree'. While the neutral point of 4 on a 7-point Likert scale does not define a clear threshold, evidence suggests that the proportion of negative perceptions in most empirical data is only 1 to 8 percent of the distribution of ties in organizations (Labianca and Brass, 2006; Labianca et al., 1998). We checked this in our data by calculating the cumulative distribution of the raw survey scores for each of the seven points on the Likert scale for Benevolence. The cumulative distributions of low and high Benevolence ties were in line with existing empirical findings (Gersick et al., 2000; Labianca and Brass, 2006; Labianca et al., 1998). Based on this, we specified a 4 on the scale to correspond with the low Benevolence tie matrix. We used the same process for testing the moderation effect of Integrity. Hence, the low Benevolence/ Integrity ties included neutral responses, similar to the approach used by

Casciaro and Lobo (2008) for affect. Applying this to the original network splits it into two matrices, representing high and low Benevolence/Integrity ties.

5 Results

5.1 MRQAP Regressions to test Hypotheses 1-3

Table 2 shows the MRQAP regression results of the predictors of tie formation in IG and IR networks across the two firms. Model 1a introduced the four control variables of Project Team co-membership, office co-Location, Seniority and Tenure (tenure data available only for Firm A). Model 1b then enters the relational factors of Availability and Closeness of the alter (used in prior network research), as well as the ego's Trust Propensity. In Model 2, the trustworthiness variables were added.

Insert Table 2 about here

In line with Hypotheses 1 and 2, Ability and Benevolence were significant predictors of tie formation across both IG and IR networks in both firms. Integrity was a significant predictor of tie formation in the IG network of Firm B, providing limited support for hypothesis 3.

There were considerable differences across firms and innovation networks in the amount of variance in tie formation that was accounted for by the control, relational and trust variables. As shown in Table 2, the trust variables consistently added considerably more variance to the prediction of tie formation, beyond the control and relational variables, in the larger R&D organisation that focused on radical, rather than incremental innovation. Focusing first on Firm A, the control and relational variables collectively accounted for 9% and 8% of the variance in tie formation for IG and IR, respectively, with the trustworthiness variables adding a further 7% and 1% respectively. In striking contrast, in Firm B, the control and relational variables accounted for 18% of the variance in the IG network, with the trust

variables accounting for an additional 64% of the variance. In Firm B's IR network, the trust variables account for 12% of the variance, beyond the 25% predicted by the control and relational variables. This pattern shows that trust was most predictive of tie formation in the IG network of the larger, R&D focused firm B.

5.2 *Moderation Analyses to test Hypotheses 4-5*

To test hypotheses 4 and 5 relating to the moderating effect of Benevolence and Integrity on the relationship between Ability and tie formation, LRQAP analyses were conducted (please see analysis section 4.3). Table presents the results for the LRQAP correlation of low and high Benevolence networks of all firms, regressed onto Ability. The results show that across both firms and both stages of the innovation process, Benevolence moderates the relationship between perceived Ability and tie formation. When Benevolence is low, the LRQAP coefficient for Ability is close to zero, indicating that increases in the perceived Ability of an alter will have virtually no impact on tie formation. In contrast, when Benevolence is high, increases in perceived Ability translate significantly into the likelihood of the alter being sought after for IG and IR. Figures 2 and 3 are graphical depictions of the moderation effect of Benevolence on the relationship between Ability and Tie Formation in IG and IR for firm B. Collectively these results fully support Hypothesis 4.

Insert Table 3 about here

Insert Figures 2 & 3 about here

Table 4 presents the same analyses to test the moderation effect of Integrity on the relationship between Ability and tie formation. In both the IG and IR networks of firm A, the regression coefficients are consistently negative and significant at low levels of Integrity. This indicates that when the alter is perceived as having low Integrity, tie formation is *less likely*

the more competent the alter is perceived to be. For firm B, at low levels of Integrity, ability has no significant influence on tie formation. Taken together, these findings suggest that a lack of Integrity makes ability either irrelevant or a negative criterion for tie formation.

Examining the results for high Integrity reveals that Integrity moderates the relationship between Ability and tie formation as expected but only in IR networks. When integrity was high, ability has a stronger positive influence on tie formation in IR networks, than when integrity was low. Hence, these results partially support Hypothesis 5 (IR networks only). Table 5 provides an overall summary of the support for each hypothesis.

Insert Table 4 about here

Insert Table 5 about here

6 Discussion and Conclusions

While trust has been implicitly linked with the effective functioning of social networks, its role in tie formation, and consequently in network structure formation and maintenance, has remained unclear and unexplored. This paper contributes to the literature by extending scholarly understanding of the role that trustworthiness plays in the formation of ties for different stages of the innovation process.

Our findings show that project members were consistently more likely to seek information and advice for generating and realising ideas from people they perceived to be *competent* and *benevolent*. The significance of ability and benevolence as criteria for selecting a partner for innovation related work generalised across both firms and stages of innovation. In contrast, the perceived *integrity* of a potential partner was an important criterion only for idea generation and only in the large research intensive firm. These dimensions of trustworthiness were significant predictors even after controlling for the influence of partner availability and

relationship closeness - relational variables commonly used in social network research as proxies of trust - as well as demographic variables (e.g. co-project membership, co-location and seniority).

We further find that benevolence moderates the relationship between perceived ability and tie formation for both idea generation and idea realisation, such that ability only significantly influences tie formation when the alter is perceived to be high in benevolence. When the person is perceived to be low in benevolence, ability is largely irrelevant as a criterion for partner selection. This suggests that when choosing who to seek information and advice for innovation, people first consider whether the other party is benevolent, and then if so, how competent they are. A clear implication is that individuals with high levels of competence will not be sought out if people question whether they genuinely care and have concern for others. Benevolence is thus pivotal to opening up relationships that bring in skills and expertise in support of innovation.

An interesting pattern of moderation effects was found for integrity. When a potential partner was perceived to have high integrity, their ability became a relevant criterion for tie formation, but only for idea realisation. When the integrity of a potential partner was perceived to be low, their competence became either a negative criterion for tie formation (Firm A) or was irrelevant (Firm B). This suggests that in at least some firms, skilled actors who lack integrity – that is, the highly competent Machiavellian - are actively avoided for innovation work. These actors might be perceived as opportunists, idea thieves or employees who will not fulfil their promises, thus posing too much risk to the individual and the innovation project. In other firms, the lack of integrity of a potential partner simply renders their competence irrelevant for tie formation. The overall implication of these findings is that a) highly skills employees will not be sought out for innovation related work, if they are

perceived to lack integrity, and b) integrity is pivotal for tapping into people's task-related resources to innovate, but its influence is constrained to the IR phase.

These moderation effects extend previous research showing that general affect towards another (e.g. liking or disliking) influences whether people seek out the task-related resources of potential partners (Casciaro and Lobo, 2008). The results indicate that not only interpersonal affect, but also two dimensions for evaluating the trustworthiness others – Benevolence and Integrity – influence the relevance of competence as a basis for partner selection. As trust and interpersonal affect are understood to be conceptually distinct concepts (Cascio & Lobo, 2008), we recommend future research examine the interplay between perceptions of trustworthiness and interpersonal affect, to tease out whether these factors have additive or redundant influences on tie formation. We also call for research to further investigate and clarify the role of perceived integrity in unlocking task-related competencies in organisations.

A strength of this study is the support found for several of the hypothesised relationships across both innovation networks (IG and IR) and across two firms. This consistency provides confidence in the robustness of these relationships. In contrast, in most of the network literature, conclusions have been drawn from just a single organization in a specific industry (Borgatti and Cross, 2003; Ohly et al., 2010). At the same time, our findings reveal that some relationships are influenced by the context, holding only in one firm or for one stage of the innovation process. Notably, we find trustworthiness adds considerable more variance to the prediction of tie formation in the large R&D firm that focused on radical innovation (64% for IG; 12% for IR), particularly in its idea generation network, compared to the smaller firm that focused on incremental innovation (between 5-7%). We suspect this is due to the fact that the larger firm offered a much more expansive pool of potential ties, and placed greater importance on innovation for career progression and security, compared to the smaller firm.

The radical nature of innovation in the larger firm meant that novel ideas and solutions were highly valued and critical for employee career success and status, reinforcing the need for trust during idea generation.

These contextual differences also explain why integrity emerged as a significant predictor of tie formation for idea generation in the large firm, but not for IR or the other firm. Because idea generation was so important for career success in the large R&D firm, these employees were more vulnerable to the opportunistic behaviour of their colleagues, making integrity a critically important criterion when choosing who to work with. More generically, these context-specific findings suggest that the role and importance of trust for tie formation is influenced by firm characteristics, particularly the organisation's position on the incremental-radical innovation spectrum (Gilson and Madjar, 2011; Madjar et al., 2011) and size (potential partner pool) and stage of innovation. We advocate future research employ multi-firm designs that measure discrete networks for different stages of the innovation process to provide greater understanding of the potential moderators and boundary conditions to the role of trust in social network formation.

Future research should also focus on the generalizability of these results to other types of networks and firms. In contrast, to previous research (e.g., Borgatti and Cross, 2003; Ohly et al., 2010), the findings here are robust across two firms that deal with different levels of innovation in different industries. However, studying the impact of trust in different industries, firms, and cultures will improve the generalizability further. Additionally, further examination can be carried out into the effect of Ability, Benevolence, and Integrity on tie formation for non-innovation related work tasks, where different risks are present, to determine the pervasiveness of this relationship.

A limitation of the current study is the cross-sectional design. An important avenue for future research is to examine the causality of the hypothesised relationships using a longitudinal design that enables modelling of social networks over multiple time points. Understanding how perceived trustworthiness influences the relationship between the actual trust behaviour, network structures and employee performance is also a fruitful area for future research.

The findings have clear implications for management practice. They suggest that one way to enhance social networks for innovation work in project teams is through activities and training that reinforce employee benevolence and integrity in the workplace, in addition to skill and knowledge development. This can be supported by an organizational culture and set of management practices that reinforces trustworthy conduct as a core value and behavioural expectation (see Hurley, Gillespie, Ferrin and Dietz, 2012). Examining the level and types of trust in the firm's social networks also provides a starting point for diagnosing problems in networks and tailoring interventions. Attempting to align resources in firms through project team formation requires an understanding of the drivers of connections. There might be pockets of disconnected people within the teams, but without knowing why they are isolated, it is difficult to plan effective interventions. This research suggests that perceived trustworthiness is one important driver that can be assessed and enhanced to make a specific network thrive. For example, if the problem in a project team is that there is climate of self-interested behavior as opposed to benevolence, interventions can be put in place to align interests, develop common goals and support, role model and develop collegial behaviour (Dietz and Gillespie, 2011).

In conclusion, this study confirms that perceived trustworthiness is indeed an overarching construct that determines network formation. All three dimensions of trustworthiness - Ability, Benevolence and Integrity – were found to play a significant role in tie formation for phases of the innovation process. Notably, the perceived benevolence of a potential partner,

an affective construct, consistently emerges as an important predictor of idea generation and implementation, beyond Ability and other structural constraints of network formation.

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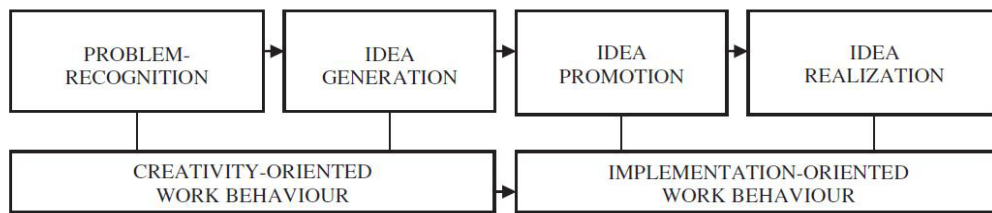
Figure 1: The four stages of the innovation process (adapted from Janssen et al., 1997)

Table 1: Descriptive statistics for the two firms.

Category	Variable	Firm A		Firm B	
		Total/mean	S.D.	Total/Mean	S.D.
Respondents	-	21	-	148	-
Network size	IG	43	-	337	-
	IR	33	-	237	-
	Male	42	-	269	-
	Female	1	-	56	-
No. of dyads	N, IG	89	-	695	-
	N, IR	46	-	390	-
Demographic	Project Teams	5	-	11	-
	Office location	2	-	13	-
	Tenure	5.53	1.53	3.70	1.81
	Seniority	n/a	n/a	4.26	1.15
	Trust Propensity	5.34	0.90	5.93	0.82
Trustworthiness	Ability	5.99	1.25	6.04	1.43
	Benevolence	5.43	1.40	5.55	1.42
	Integrity	5.94	1.25	5.96	1.42
Network Attributes	Avg. Degree, IG	2.28	-	2.44	-
	Density, IG	0.05	-	0.01	-
	Avg. Distance	2.57	1.42	5.64	2.50
	Density, IG	0.05	-	0.01	-

Table 2: MRQAP regression of the predictors of tie formation in IG and IR networks across two firms.

IG network	FIRM A			FIRM B		
	Model 1a	Model 1b	Model 2	Model 1a	Model 1b	Model 2
Controls						
Project Team	.06*	-.12	-.20*	.11**	.62**	.04
Location	.09**	-.27**	-.25*	.10**	.20**	.02
Seniority	.04	-.08	-.01	.02**	-.10**	-.10**
Tenure	n/a	n/a	n/a	.01**	.05	-.01
Relational factors						
Availability	-	.16	.23*	-	.00	-.12**
Closeness	-	.18	.16	-	.00	.02
Trust Propensity	-	.10	.04	-	.04	.00
Trustworthiness						
Ability	-	-	.23*	-	-	.10**
Benevolence	-	-	.06*	-	-	.17*
Integrity	-	-	.32	-	-	.61**
Adj R-Squared	.01	.09	.16	.03	.18	.82
IR network						
Controls						
Project Team	.06*	.07	.03	.08**	.32**	.19*
Location	.09**	.16	.18	.07**	.12	.11
Seniority	.04	-.03	-.07	.03**	.22**	.23**
Tenure	n/a	n/a	n/a	.01**	.04	.02
Relational factors						
Availability	-	-.21*	-.16	-	-.10	-.11*
Closeness	-	.23*	.13	-	.16**	.15**
Trust Propensity	-	-.16	-.12	-	-.07	-.05
Trustworthiness						
Ability	-	-	.02*	-	-	.19**
Benevolence	-	-	.25*	-	-	.47**
Integrity	-	-	-.01	-	-	-.18
Adj R-Squared	.01	.08	.09	.02	.25	.37

*p<.05, **p<.01; based on 2000 permutations.

Table 3: The moderating effect of Benevolence on the relationship between Ability and Tie
Formation.

	Firm A		Firm B	
	IG	IR	IG	IR
Low Benevolence	.00	.02	.02*	.00
High Benevolence	.24*	.38**	.22*	.28**

Table 4: The moderating effect of Integrity on the relationship between Ability and Tie

Formation.

	Firm A		Firm B	
	IG	IR	IG	IR
Low Integrity	-.79**	-.37**	0	0
High Integrity	-.15	.37*	-.01	.06**

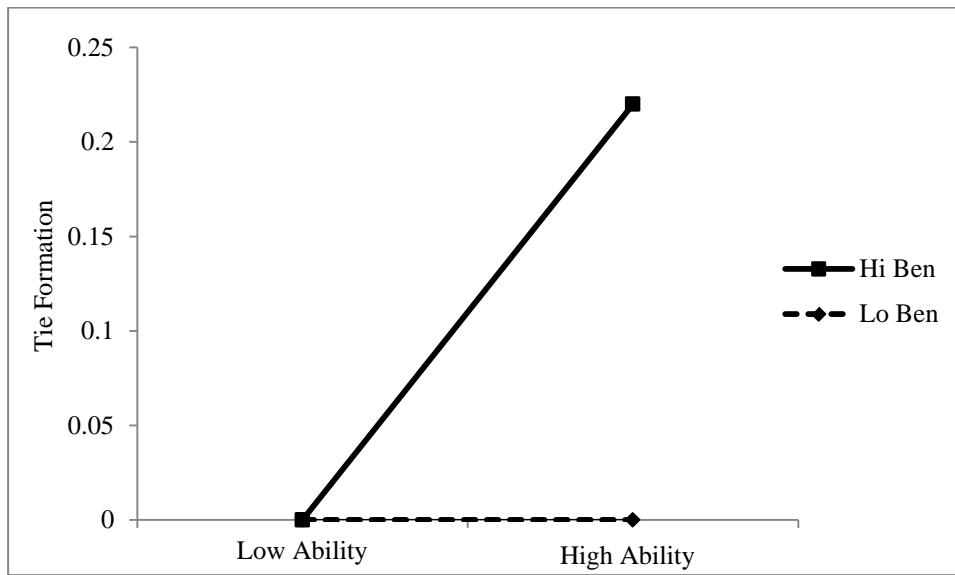*p<.10, **p<.01; based on 2000 permutations

Figure 2: Graphical depiction of the moderation effect of Benevolence on the relationship between Ability and Tie Formation in IG networks (Firm B).
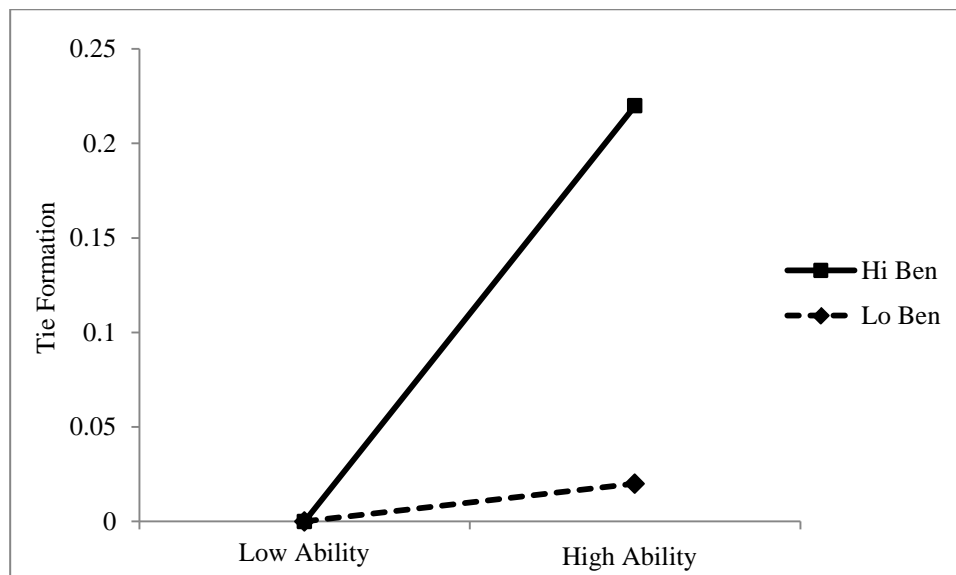

Figure 3: Graphical depiction of the moderation effect of Benevolence on the relationship between Ability and Tie Formation in IR networks (Firm B).

Table 5: Summary of support for the hypothesized relationships.

Hypothesis	Support
H1: Perceptions of alters' Ability will be positively associated with tie formation in IG and IR networks.	Full
H2: Perceptions of alters' Benevolence will be positively associated with tie formation in IG networks.	Full
H3: Perceptions of alters' Integrity will be positively associated with tie formation in IG and IR networks.	Limited
H4: The positive association between alter's perceived Ability and tie formation is moderated by Benevolence such that the relationship between Ability and tie formation is stronger when Benevolence is high, rather than when Benevolence is low.	Full
H5: The positive association between alter's perceived Ability and tie formation is moderated by Integrity such that the relationship between Ability and tie formation is stronger when Integrity is high, rather than when Integrity is low.	Partial