# COOPERATIVE STRATEGY AND SOURCES OF KNOWLEDGE INTEGRATION CAPABILITY AND INNOVATION: A RELATIONAL VIEW

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Faced with the challenges to addressing the novelties of the changing business environments (e.g., new customer requirement, changes in customers taste and preferences, the introduction of new products or services by competitors), organizations seek to build collaboration among their employees who possess complementary knowledge. Integrating complementary knowledge enhances employees' ability to address environmental challenges and foster innovation. Despite the importance of knowledge integration for innovation, integration of such knowledge becomes difficult when employees lack a shared understanding of knowledge, and when the knowledge is newly generated. Because new knowledge is tacit in nature and highly personal to a particular individual, it is difficult to articulate, making knowledge integration (KI) an arduous task. Lack of shared understanding, the presence of new knowledge, and lack of common interests in employees creates three types of knowledge boundaries – syntactic (information processing) boundaries, semantic (interpretive) boundaries, and pragmatic (political) boundaries. The presence of knowledge boundaries makes it difficult for employees to share and access their knowledge with each other. To overcome the challenges related to the knowledge boundaries, employees use boundary-spanning objects, which are common lexicons, common meaning, and common interests, to share and access their knowledge across the boundaries.

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# CHAPTER 1

# INTRODUCTION

Faced with the challenges to addressing the novelties of the changing business environments (e.g., new customer requirement, changes in customers tastes and preferences, introduction of new products or services by competitors), organizations seek to build collaboration among their employees who possess complementary knowledge (Carlile & Rebentisch, 2003; Dyer & Singh, 1998). Integrating complementary knowledge enhances employees' ability to address environmental challenges and foster innovation, for example, the discovery of drugs (Dougherty & Dunne, 2011) and development of transistor liquid crystal display (Hu, 2012). Knowledge integration is also beneficial across various environmental contexts, for example, high-tech alliances in China (Fang, 2011), manufacturing companies in Australia (Singh & Power, 2014), and telecommunication manufacturers in the U.S. (Yang, Phelps, & Steensma, 2010).

Despite the importance of complementary knowledge for innovation, integration of such knowledge becomes difficult when employees lack a shared understanding of knowledge (Cohen & Levinthal, 1990), and when the knowledge is newly generated (Nonaka, 1991). Because new knowledge is tacit in nature and highly personal to a particular individual, it is difficult to articulate, making knowledge integration an arduous task. Knowledge integration is also difficult to attain without the presence of shared experience of employees (Gardner Gino & Staats, 2012; Nonaka, 1994). The shared experience helps to store common information on a group's knowledge repository, which enables group members to develop shared interpretation of new knowledge (Cramton, 2001), which may enhance the knowledge integration (KI) capability of employees. KI capability refers to the reliable communication that allows joint contributions from all the organizational members to solve complex problems (Gardner, Gino, and Staats, 2012).

The KI capability consists of the three interrelated aspects of communication, which are reliable communication, joint contributions, and solving a complex problem. The interrelated aspects of KI capability are measured by examining a communication between members. As in Gardner et al.'s (2012) study, in this study also the communication among organizational members is central to measuring the KI capability because it creates common experiences and common knowledge bases of employees, allowing them to work together (Eisenhardt & Martin, 2000). Reliable communication is less fraught with distraction, confusion, and is less overwhelming (Cronin & Weingart, 2007). Therefore, a reliable communication should be timely, concise, and done in the right amount (Gardner et al., 2012).

The presence of reliable communication alone may not ensure the joint contributions from all the organizational members. If a problem is complex, one has to solve different elements of a given problem, therefore, employees require multiple knowledge bases to solve complex problems (e.g., increasing marketing size requires not only an increase in the production volume but also changes in marketing activities that cater to the larger target audience). Therefore, joint contributions from different employees from an organization may be required for solving different components of a particular problem. Existing studies indicated that employees will jointly contribute as long their interactions is supportive, non-confrontational, and truthful (Edmondson, 1999). Moreover, despite everyone's willingness to contribute, employees may still lack sufficient coordination of their actions, a process which is important to solve a unified objective (Cronin & Weingart, 2007). While one employee may perceive a particular element of a problem to be important, another employee may try to solve another element of that problem. For employees to solve complex problems they need to discuss, evaluate, and apply their ideas. Therefore, they should all exchange information that is clear, objective, and relevant (Gardner et al., 2012).

The presence of new knowledge poses an additional challenge to knowledge integration. When the changes in business environment require employees to create new knowledge, the existing mutual knowledge among employees is eroded. As a result, they have to go through the iterative process of mutual dialogue and interactions to refine their newly created knowledge and have it stored in a group's knowledge repository (Nonaka, 1994). Therefore, the lack of mutual knowledge among employees during the initial phase of knowledge creation creates the three types of knowledge boundaries – syntactic boundary (information processing), semantic (interpretive) boundary, and pragmatic (political) boundary. A syntactic knowledge boundary is an information-processing boundary. Boundary spanning object that is important at a syntactic boundary is common lexicon, which facilitates processing or transferring information. A semantic knowledge boundary is an interpretive boundary. The primary activity that employees undertake at this boundary is to translate their knowledge by developing shared understanding of tacit and new knowledge. A pragmatic knowledge boundary is a political boundary. The primary activity at a pragmatic knowledge boundary is transforming employees' existing knowledge. Organizational members do so by learning new knowledge that is relevant to solving a particular problem at hand (Carlile, 2004).

In each of these knowledge boundaries, employees use boundary-spanning objects, which are common lexicon, common meaning, and common interests, to share and access their knowledge. The boundary-spanning objects are material artifacts or epistemic artifacts (Nicolini, Mengis, & Swan, 2012). For example, common lexicon consists of scripts, designs, languages, and standardized rules, whereas common meaning refers to the shared understanding of rules, roles and responsibilities, and process related to completing a task. These objects provide a shared platform to knowledge actors to collaborate their idiosyncratic knowledge across functional areas. In a syntactic knowledge boundary, individuals make the

use of common language, tools, designs, specifications and rules to communicate. In a semantic knowledge boundary, individuals develop the shared interpretation of tacit and new knowledge. In a pragmatic knowledge boundary, individuals develop common interests to achieve a unified objective.

The presence of the knowledge boundaries creates obstacles to the proper integration of employees' knowledge. These obstacles arise from the newness of knowledge, and differences of knowledge among employees. Consider a know-how, which is a type of knowledge that improves as individuals gain experience of conducting a task. The know-how is tacit in nature, and, therefore, difficult to articulate (Leonard & Sensiper, 1998). Because innovations require both the exploration and synthesis of various ideas (Leonard & Sensiper, 1998), individuals facing difficulty in articulating their know-how may also face difficulty synthesizing their knowledge, hindering innovation.

Differences in individuals' functional specialization (Ashfort & Mael, 1989; Bunderson & Sutcliffe, 2002) also pose the challenge to collaborate the efforts of knowledge workers (Homan et al., 2008). When employees come from a diverse functional background, development of shared understanding is difficult. This creates dysfunctional interpersonal conflict, which hinders innovation as strategic consensus becomes difficult to attain (Yap, Chai, & Lemaire, 2005). Moreover, the belief among employees that specialists from other functional areas do not understand their activities demotivates them in sharing their information with those specialists (Bunderson & Sutcliffe, 2002). Experts generate creative ideas because the connection and integration of two or more distinct ideas are basic requirements to create new insights (Rodan & Galunic, 2004). The challenge is to integrate such knowledge base (Verona, 1999), as the effective integration of employees' knowledge contributes to organizational innovations (Tenkasi & Boland, 1996; West, 2002).

## The Academic Gap

The importance of knowledge integration in organizational innovation has been gaining traction over the past two decades. Grant (1996a) theorized that knowledge integration is essential for the production of goods and services. About a decade later, Ju, Li, and Lee (2006) examined the effect of characteristics of knowledge on knowledge integration. Their results indicated that knowledge with a high degree of explicitness is more general and simple. Such characteristics make the integration of various components of knowledge easy. Similarly, Gardner et al. (2012) found the relational resources, a prior shared work experience of individuals, enhance their KI capability. Such experiences make individuals' ongoing communication valid and efficient. Researchers have also used knowledge integration as a mediator in their research model and examined its effect on organizational innovation (Ju et al., 2006) and e-service innovation (Tsou, 2012). Other researchers present a conceptual framework that includes knowledge and innovations (e.g., Malhotra & Majchrzak, 2014).

Although prior studies have emphasized the importance of knowledge integration of various knowledge sources, for example market knowledge and internal knowledge (Zhou & Li, 2012), knowledge embedded in multinational corporations (Berry, 2014), network ties (Tiwana, 2007), and partners who operates in a value chain (Cheung, Myers, & Mentzer, 2011) for innovations, examinations of what enhances the KI capability of employees for organizational innovation remain limited (Edmondson & Nembhard, 2009). In addition, apart from Carlile, (2004) and Franco (2013), which are both case studies, other studies that examine the role of boundary spanning objects for knowledge integration are missing. The knowledge management literature also fails to measures (the success of common lexicon, common meaning, and common interests for achieving KI capability) boundary spanning

objects. Therefore, we also develop new items to measure boundary spanning objects and novelty to test our hypotheses.

Based on the discussion, the research questions on this study are as follows:

1) Does the presence of boundary spanning objects (common lexicon, common meaning, and common interests) support the development of KI capability?

2) Does the level of novelty influence the importance of relationship between boundary spanning objects and KI capability?

3) Does the development of the KI capability support organizational innovation?

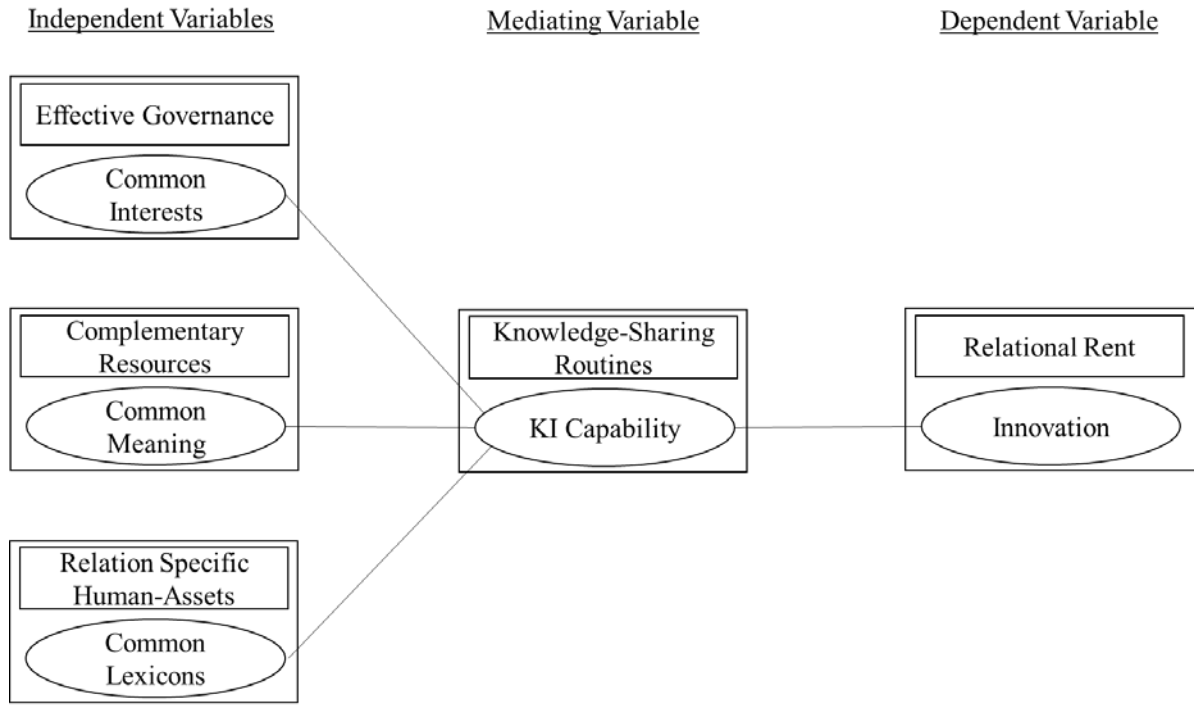
## Theoretical Framework of the Study

The researcher in this study uses the theoretical framework proposed by Dyer and Singh (1998) that emphasizes cooperative strategies for generating relational rents, a term which refers to a supernormal profit generated through the joint contribution of relational partners who are in an exchange relationship. The joint contribution of relational partners generates profit that is more than that generated by the contribution of individuals working in isolation (Dyer & Singh, 1998). Although originally developed in the context of inter-firm relationships, the relational view in this study provides a theoretical foundation for examining an exchange relationship between organizational members who share and access their knowledge with each other. Specifically, this study presents the relational view perspective to examine the relationship between boundary spanning objects, KI capability, and innovation. According to the Dyer and Singh (1998), there are various sources of relational rent. The ones that are relevant to our research are human assets specificity, complementary resources and capabilities, effective governance, and knowledge-sharing routines, which corresponds to common lexicon, common meaning, common interests, and the KI capability respectively.

Human assets specificity is transaction specific know-how that relational actors accumulate through a long-term relationship. Because of repeated transactions over time, the

relational actors develop language, know-how, and experience specific to a particular transaction. Human assets specificity is similar to the common lexicon as both emphasize the storage and retrieval of information that gets refined through repeated interactions of relational actors. Complementary resources and capabilities are synergy-sensitive knowledge resources that are distinct in characteristics, and the one that produces a greater return than the sum of return generated by each individual. The development of a common meaning provides a framework whereby employees can integrate their complementary knowledge (distinct and multiple knowledge domains) by developing shared understanding. Effective governance refers to the alignment of incentives of relational partners and lowering of transaction costs. Subsequently, the alignment of incentive and lowering of transaction costs motivates relational actors to sustain their ongoing relationship. Similarly, the development of common interests in employees arises from the negotiation of interests, which acts as a self-enforcing safeguard against opportunism to sustain the relationship of relational actors. Lastly, knowledge-sharing routines refer to the sharing of information and know-how of employees. Knowledge-sharing routines are related to the KI capability because both the constructs use the elements of communications such as collaboration between employees, regular pattern of interactions, and development of superior knowledge for problem-solving. Figure 1.1 presents the theoretical model used in the study. The figure also presents the association of relational view of a firm and boundary spanning objects, and KI capability and relational rent.

**Figure 1.1: Association Between Relational-View of a Firm and Boundary Spanning Objects, KI Capability and Relational Rent.**




The rest of the study is organized as follows. Chapter Two presents the literature review of primary constructs used in this study, which are 1) boundary spanning objects – common lexicon, common meaning, and common interests, 2) KI capability – reliable communication, joint contribution, and solving complex problems, 3) innovations, and 4) novelty. Control variables that are used in this study are presented. Because the author in the current study relies on the relational view (Dyer & Singh, 1998), the association between the relational approach to generating relational rent and knowledge boundary objects to generate an organizational innovation is also developed. The last section of Chapter Two develops testable hypotheses. Chapter Three describes the research methodology. Results of data analysis are presented in Chapter Four. Finally, Chapter Five presents the discussion and conclusions of this study.

# CHAPTER 2

# LITERATURE REVIEW, THEORY AND HYPOTHESES

## Knowledge Integration Capability

Knowledge Integration (KI) capability is a reliable pattern of employees' communication that generates joint contributions to understanding and solving complex problems (Gardner et al., 2012). *Reliable communication* produces consistent results because such communication is timely, concise and in the right amount – one that is neither too excessive nor too less. *Joint contribution*s facilitate employees' participations (Edmondson, 1999) through supportive, truthful and non-confrontational communication. Finally, when employees are communicating contents that are relevant, objective and clear, they are able to *solve complex problems*. Communication of such contents encourages employees to discuss, evaluate and apply their ideas (Gardner et al., 2012).

Researchers have examined the importance of knowledge integration as a determinant of a firm's performance (Gardner et al., 2012), a mechanism to attain organizational innovation (Berry, 2014; Ju et al., 2006; Zhou & Li, 2012), and an outcome of an organizational process (Boh et al., 2007; Majchrzak et al. 2011; Okhuysen & Eisenhardt, 2002). In the current study, the role of the KI capability and its relational antecedents in generating organizational innovation is examined. Relational antecedents refer to the boundary spanning objects, which are common lexicon, common meaning, and common interests.

Studying the importance of knowledge integration capability is important, as previous studies revealed several organizational benefits associated with it. Knowledge integration, along with, knowledge generation, fosters innovations (Gebert et al. 2010). Knowledge generated from external organizational sources (market) benefits organizational innovation as long as such knowledge gets integrated with employees' existing knowledge (Laursen & Slater, 2006). Knowledge integration of employees also supports the development of a new

product (Carlile, 2002). Moreover, it fosters the exchange of high-quality information, interdepartmental learning, learning between relational partners, and reduction of costs of developing new products (Cheung et al., 2011; Edmondson & Nembhard, 2009).

Despite its benefits, knowledge integration is difficult to achieve because of obstacles that arise out of the integration process. Task complexity, knowledge characteristics, group differences, and lack of new knowledge generation make knowledge integration difficult (Edmondson & Nembhard 2009). The complexity of tasks increases uncertainty of organizational members. Tasks that are accompanied by ambiguity, uncertainty, and time pressure create stress-laden work environment (Edmondson & Nembhard, 1990) and are detrimental to group work (Weick, 1993). Moreover, while performing complex tasks, employees need to communicate and exchange knowledge that is tacit, sticky and ambiguous (Kogut & Zander, 1992; Nelson & Winter, 1982, 1996; Papargyris, Poulymenakou, & Samiotis, 2002). Tacit knowledge embedded in practice (or a practical knowledge) is difficult for a performer to explain and express, an obstacle hindering knowledge integration (McIver et al., 2013). Difficulties in knowledge integration are compounded when employees lack shared understanding and common vocabularies of process related to completing a task (Tiwana & Ramesh, 2001). Moreover, the conflict of interests in processes and outcomes related to solving a particular task stems from the misalignments of incentives that knowledge actors receive upon completing a task. Such conflict of interests also hinders their ability to integrate knowledge (Gandori, 2001).

Broadly, three relational resources are presented that help to overcome the challenges related to knowledge integration. The first relational resource is common lexicon. Common lexicon is mostly material artifacts, which are in the form of sketches or prints, specifications, terminologies and organizational rules. These lexicons are common across an organization, as everyone can use it to communicate and complete a task. Second, common meaning refers to

shared understanding among all employees in a firm (Carlile 2004; Cronin & Weingart 2007; Majchrzak et al. 2011). Common meaning exists when all members have developed a shared understanding of organizational rules, their roles, and responsibilities. Moreover, employees may also develop the shared understanding of time and process required for completing a task. Third, the presence of common interests in employees may be important to building a consensus for solving a complex problem. The common interests in employees exist when all members jointly agree to invest additional time and resources to learn new knowledge and discard knowledge that is not relevant to solving a particular task.

To summarize the literature review of knowledge integration, table 2.1 presents the articles related to knowledge integration and contexts in which knowledge integration is studied. In summary, the review of the articles reveals that knowledge integration helps the knowledge actors to get access to each other knowledge, overcoming the limits of one's bounded knowledge.

**Table 2.1.: Knowledge Integration: Literature Review**

| Citations | Independent Variables | Moderators | Dependent Variables | Methods | Results |
|---|---|---|---|---|---|
| Berry (2014) | • Manufacturing integration<br>• Technology diversity<br>• Forward self-citation | • Multicountry knowledge generation Multicountry collaborative innovation | | • Archival data (firm- and patent-level estimations) | • MNCs with wider technological knowledge base are likely to result in multicountry collaborative innovations |
| Gardner et al. (2012) | • Relational resources<br>• Experiential resources<br>• Structural resources | • Environmental uncertainty | • KI capability (mediator)<br>• Team performance (dependent variable) | • Cross-sectional study<br>• Team level data collection | • Relational resources are positively associated with team KI capability<br>• Experiential resources are negatively associated with team the KI capability (opposite to the hypothesis)<br>• Distributed relational resources with team are positively associated with team KI capability<br>• Distributed experiential resources with team are negatively associated with team KI capability<br>• Under uncertain environment, relational resources play a greater role in developing team's KI capability |
| Zhou and Li (2012) | Knowledge Characteristics<br>• Knowledge sharing<br>• Knowledge acquisitions | • Knowledge breadth and knowledge breadth | • Radical innovation | • Study 1: Survey data collected from 177 high-tech Chinese firms; Study 2: Longitudinal study. Response received from managers from 68 firms | • Firm having a knowledge breadth can attain radical innovation through internal knowledge sharing. On the other hand, a firm having knowledge depth can attain radical innovation through knowledge acquisition from external sources. |

*(table continues)*

| Citations | Independent Variables | Moderators | Dependent Variables | Methods | Results *(continued)* |
|---|---|---|---|---|---|
| Cheung et al. (2011) | Knowledge integration (one of the dimensions of relational learning) | • Relationship performance | • Context<br>• Cross-border customer-supplier relationship<br>• Moderation – cultural distance | • Archival data from 126 cross-border dyads. | • Knowledge integration in the cross-national buyer-suppliers relationship is positively associated with relationship performance.<br>• Evidence was not found for the cultural distance moderating such relationship. |
| Majchrzak et al. (2011) | Transcending approach of KI | | • KI | • Observation study | • Demonstrates how a team overcome the challenges of knowledge integration by the use of fluid boundary objects, which are *voicing fragments; co-creating a scaffold, dialoguing around the scaffold, moving the scaffold aside, and sustaining engagement.* |
| Gebert et al. (2010) | • Knowledge integration<br>• Knowledge generation | • Closed-action strategy<br>• Open-action strategy | Leaders | • Proposed framework | • Team members who are autonomous and the one who believes that the knowledge is uncertain and questionable are better able to foster knowledge generation. On the other hand, team members who are more controlled, seek consensus, and the one who believe that the knowledge is certain and definitive fosters knowledge integration. |
| Boh et al. (2007) | Effective staffing decision | • Geographically dispersed organization | KI | • Interviews and archival data of project staffing decision for 493 projects over a five-year period. | • Managerial ability to formulate effective staffing decision leads to better KI between organizations that are geographically dispersed.<br>• Managers created dispersed projects when other sites required meeting the customer's demand.<br>• Managers prefer local, rather than dispersed, projects sites, as they believe that dispersed projects are costly. *(table continues)* |

| Citations | Independent Variables | Moderators | Dependent Variables | Methods | Results *(continued)* |
|---|---|---|---|---|---|
| Carlile (2004) | Traversing approach of KI<br>• Common lexicon<br>• Common meaning<br>• Common interest | • Novelty (from low to high) | KI | • Case study<br>• Development of knowledge boundaries framework. Empirical context is used to illustrate the framework. | • Individuals operate in three knowledge boundaries – *syntactic, semantic, and pragmatic* boundaries. Each boundary represents the increasing degree of novelty required for innovation. In syntactic boundary, novelty required for innovation is low; therefore, common lexicon enables employees to knowledge sharing. In semantic boundary, as a novelty required for innovation increases, individuals are also required to develop shared understanding for sharing and assessing knowledge at the boundary. Similarly, in pragmatic boundary, employees develop common interests to share and access each other knowledge. |
| Carlile (2002) | Structure of Knowledge In Practice<br>• Localized<br>• Embedded<br>• Invested | • Knowledge structure of four communities of practices<br>• Context – new product development | • New product development | • Ethnographic study | • Localized, embedded, and invested characteristics of knowledge makes KI a difficult pursuit.<br>• Boundary objects such as repositories, standardized forms and methods, objects, models, and map facilitate to resolve knowledge integration challenges that arise at a particular boundary.<br>• Boundary objects allow organizational members to transfer, translate, and transform their knowledge. |

*(table continues)*

| Citations | Independent Variables | Moderators | Dependent Variables | Methods | Results *(continued)* |
|---|---|---|---|---|---|
| Okhuysen and Eisenhardt (2002) | Formal Interventions<br>• Questioning others<br>• Managing time<br>• Sharing information | | • KI behavior | • Experimental setting | • Formal interventions (questioning others, and managing time) shifts team members focus from conducting a primary task to focusing on improving knowledge integration process.<br>• Sharing information among the team members encourage team members to reveal their uniquely held knowledge. In the process, they also disregard the value of unique knowledge of other team members. Sharing information did not result in knowledge integration. |

Knowledge is a firm's crucial resource, which is stored in individuals' memory. Individuals require a range of multiple and distinct knowledge bases to complete a complex task. Bounded rationality limits the expansion of an individual's knowledge horizon (Cyert & March, 1963). Organizational members can overcome the challenges to bounded rationality through collaboration and joint contribution (Teece, 1998). Collaboration between knowledge actors who possess specialized knowledge arises from a dependency between them (Carlile & Rebentisch, 2004).

Researchers have studied the dependency of knowledge actors at the both the inter-firm and intra-firm level. The formation of alliances, joint ventures, and mergers and acquisitions indicates that two or more firms are dependent on complementary resources (Dyer & Singh, 1998). In the automobile parts manufacturing industry, innovation of components that controls automobile emission required not only the complementary knowledge of partners but also common lexicon to facilitate effective information exchange to attaining innovations (Lee & Veloso, 2006). For an organizational actor to complete a certain task, the strength of his or her dependency on others depends on the novelty of circumstances surrounding the dependency, differences in knowledge domain of actors, and the requirement for developing shared knowledge among them (Al-Natour & Cauvusoglu, 2009).

Dependencies between knowledge actors arise when there is a need for knowledge integration of specialized knowledge (Grant, 1996a). Specialize knowledge of individuals refers to their technical expertise in an area that they have developed through experience and repeated practice (Zhou & Li, 2012). The presence of specialized knowledge alone does not ensure the completion of a complex task. Integration of specialized knowledge is important to the production of goods and services (Grant, 1996a; Zhou & Li, 2012). Consider an automobile

manufacturer, which requires, among other people, employees who can design, manufacture, and market a product. Designers develop a basic design of an automobile, using computer-aided design equipment. The design enables members to visualize the appearance of a proposed vehicle. In a manufacturing unit, employees make a proposed vehicle by sequentially installing different components. Marketers keep an eye on changing customers taste and preferences and communicate such changes to designers, assisting them in visualizing an upcoming design. The completion of a task in this example requires not only the presence of experts but also communication between designers, marketers and manufacturers. Knowledge integration of all actors facilitates the production of a vehicle (Campbell, 1988).

## Antecedents of Knowledge Integrations Capability

Gardner et al. (2012) examined whether or not relational resources, which refers to the shared work experience of employees, and experiential resources, which refers to accumulated practices or skills of employees, improve KI capability. Their results demonstrated that the relational and experiential resources have a disparate impact on KI capability. Members who have the experience and familiarity of working with others have a higher level of relational resources. Relational resource increases the shared beliefs among knowledge actors, improving their KI capability. On the other hand, members accumulated work experience – an experiential resource, has a negative effect on KI capability. Higher levels of experiential resources can make employees rigid and unwilling to respond efficiently to environmental uncertainties (Gardner et al., 2012).

A simple and formal process related intervention also facilitates the integration of specialized knowledge (Okhuysen & Eisenhardt, 2002). An intervention is a process in which members question each other to extract uniquely held information by others. This process also requires them to institute effective time management for a task completion. When more

members emphasize the improvement on the process related to a task completion, it facilitates knowledge integration (Okhuysen & Eisenhardt, 2000).

## Boundaries of Knowledge

The three interrelated properties of knowledge, which are the differences in knowledge, dependencies among knowledge actors, and novelty of circumstances, create the boundaries of knowledge. These knowledge boundaries are syntactic, semantic, and pragmatic. Boundary spanning objects, which are common lexicon, common meaning, and common interests, facilitate sharing and accessing of knowledge at the boundaries. Common lexicon facilitates the transfer of information on a syntactic boundary; common meaning develops shared understanding among relational actors on a semantic boundary, and common interests facilitate the transformation of knowledge of relational actors on a pragmatic boundary. While common lexicon refers to artifacts or norms, common meaning is the understanding of how these artifacts are used. For example, the presence of standardized rules, sketches, printed forms, designs are the material artifacts, whereas the development of shared understanding of rules, roles and responsibilities and processes is a common recipe for completing a task. By developing shared understanding of these objects, knowledge actors are able to transfer, translate and transform their knowledge.

Knowledge differences relate to the two aspects of knowledge held by individuals. These aspects are amounts of knowledge and types of knowledge. *Amounts* of knowledge differences refer to the dissimilarities in depth of individuals' accumulated knowledge. Such differences are present, for example, in the novice versus expert employees (Hinds, 1999). *Types* of knowledge differences refer to dissimilarities in individuals' technical expertise, which they have developed through experience and practice. Such differences are found among employees working in different functional units (Weber, 1946).

Knowledge dependency brings the workers from different parts of an organization together so that they can achieve a common organizational goal. Without the dependency, the specialized knowledge of workers will not yield a joint performance gain (Carlile, 2002). One of the aspects of the KI capability is members' ability to jointly contribute to solving a complex task (Gardner et al., 2012). Although studied at interfirm mergers and acquisition level, Casciaro and Piskorski (2005) found that the mutual dependencies between firms brought them together to form interfirm mergers and acquisitions, as neither firms were able to obtain resources from alternate sources (Emerson, 1962).

Novelty is the third relational property of knowledge boundary, which arises from novel situations such as the changing consumer taste and preferences. Novel situations require new knowledge to provide the best-fit response as old knowledge may be inadequate to address new situations (Ashby, 1958). Although knowledge sharing and the combination can generate new knowledge (Carlile, 2004), knowledge actors find difficulty in accessing and sharing the new knowledge at a boundary. Unlike information, which can be coded and articulated, and are in the form of routines and specifications, new knowledge is tacit and evolving in nature, which makes it difficult to articulate and share (Nonaka & Von Krogh, 2009; Polanyi, 1966). Moreover, others lacking familiarity with the new knowledge make it difficult for them to understand it (Cohen & Levinthal, 1990).

The difference, dependencies, and novelty of knowledge create three types of knowledge boundaries, which are *syntactic*, *semantic*, and *pragmatic* knowledge boundaries (Carlile, 2004). The knowledge boundaries represent hurdles to effective knowledge integration. To overcome each knowledge boundary, one needs to use pertinent boundary spanning objects that facilitate

the transfer, translation, and transformation of knowledge among members. These boundary spanning objects are *common lexicon*, *common meaning*, and *common interests*.

**Syntactic Boundary**

The primary activity that occurs at a syntactic boundary is a processing or transferring of information. In this knowledge boundary, actors use lexicons to process information, communicate with each other, and transfer knowledge. Lexicons are in the form of shared tools such as sketches or printed forms, common designs, standard specifications, common language, and standardized organizational rule. The value of lexicons in syntactic boundary decreases with the increase in novelty, as existing lexicons become insufficient to represent newer realities.

**Semantic Boundary**

The primary activity that occurs at a semantic knowledge boundary is the translation of complex concepts into a simpler one. As such, actors develop common meaning to translate the knowledge. The presence of common meaning ensures that all the employees have developed shared understanding of organizational rules, expected results of completing a task, and time and processes required to complete a task. The objective of the development of common meaning is to reduce interpretation gap when employees face new situations.

Actors who operate in a semantic knowledge boundary face challenges to the development of shared interpretation (common meaning) of new situations. People base the interpretation of knowledge on their experiences, which are subjective and tacit in nature (Nonaka, 1994; Polanyi, 1966). Tacit knowledge is difficult to articulate because it develops as individuals interact with other people and environments. The pattern of interactions with people and environment is unique for each individual. This unique interaction is encoded in individuals' metacognitive structure and, therefore, is tacit in nature (Bereiter & Scardamalia, 1993). Consequently, individuals differ in their understanding of processes related to addressing novel

situations as they attach a different meaning to a situation at hand (Nonaka & von Krogh, 2009). Moreover, because individual attach their personal meaning (tacit) to a situation, they find it difficult to articulate. Lack of explicit representation of the differences in meaning makes it difficult to resolve these differences to attain effective knowledge integration (Grant, 1996b).

**Pragmatic Boundary**

Pragmatic knowledge boundary reflects the differences in individuals' goal. In this knowledge boundary, there is a conflict of interests in knowledge workers because of the lack of incentive alignment between them. Knowledge workers can negotiate their interests and form common interests so that they are willing to learn new and relevant knowledge and forgo irrelevant knowledge to solve a problem (Carlile, 2004). The presence of common interests ensures that members are willing to transform their knowledge that is at stake. The knowledge transformation can occur when all the employees are willing to invest additional time and resources to learn new knowledge, and discard knowledge that is irrelevant to solving a given problem. Moreover, the realization among employees that the knowledge developed in one area is useful in another provides an appropriate medium for employees to not only develop common interests but also sustain their relationship. For example, in a case study, Franco (2013) found a clear presence of competing interests between Whitbread, a UK based company seeking to refurbish its hotels to meet the standards of recently acquired Marriott franchise, and construction companies, including contractors, designers, quality supervisors, etc. The competing interests in partners got resolved when they conducted mutual dialogue and interactions. As a result, errors were resolved and partnership agreement was developed, which provided guidelines on a future course of actions.

One of the biggest challenges that actors face at a pragmatic knowledge boundary is not a technical one but developing shared reward structure, which motivates them to use new tools and

learn new knowledge. In Beta Motors example, which required four groups – vehicle styling, engine/powertrain, climate control, and safety – to design a new vehicle, actors were able to overcome their competing interest after realizing the interdependence between various groups for designing a vehicle. Moreover, because the outcome of one group has a consequence on another group, employees were willing to learn new knowledge even though it required them to lose control over their expertise (Carlile, 2004). They realize that joint contribution is the best way to receive a reward.

## Innovation

Innovation is a dependent variable used in this study. Innovation literature contains various types of innovation – administrative and technical innovation, product and process innovation, technological and architectural innovation, and incremental and radical innovation (Koberg, Detienne, & Heppart, 2003). In a dual core model of organizational innovation, Daft (1982) categorized organizational innovation broadly into two categories – administrative innovation and technical innovation. Swanson (1994) added a third dimension to innovation literature – information system innovation. Ettlie, Bridges, and O'Keefe (1984), Tushman and Romanelli (1985), and Dewar and Dutton (1986) empirically examined radical and incremental innovations. In the current study, the scope of innovation is limited to the development of a new product.

The rate of new product development signifies how intensely a firm is involved in its innovative activities. In the case of a mature organization, the introduction of a new product requires an organization to reconfigure its system to sustain the rate of innovation in future (Dougherty & Hardy, 1996). A firm must also recombine its relevant resources to produce a novel solution (Nerkar & Roberts, 2004). One of the important organizational resources is knowledge. Earlier researchers have examined the influence of the age of knowledge (Kalita,

2002), cohesion among knowledge workers (Guler & Nerker, 2012), sources of external knowledge (Chatterji & Fabrizio, 2014), characteristics of knowledge (old versus new knowledge; Xie & O'Neill, 2014) and combination of knowledge (Hargadon & Sutton, 1997) on new product development. The introduction of new products benefits organization because it helps to increase market share of a firm (Banbury & Mitchel, 1995), increase sales revenue (Nobeoka, & Cusumano, 1997), address customer demands (Ethiraj, Ramasubbu, & Narayan, 2012), and determine firms' innovative performance (Zhao & Chadwick, 2014).

Integration of knowledge of members belonging to various functional areas enhances social capital (Huang & Newell, 2003), stimulates creativity (Nemeth & Staw, 1989), and increases efficiency in new product development and effectiveness in product commercialization (Brettel et al., 2011). The reliable pattern of employee communication also helps to preserve mechanisms that foster such communication in organizational repositories. Regularly occurring communication of information is more reliable than newly generated knowledge or knowledge that is recently acquired from markets (Katila, 2002). Reliability of knowledge increases its legitimacy and perceived value, reinforcing its utility of refining existing products. With the increase in reliability, the knowledge also gets institutionalized, codified and stored in the organizational database, manuals, patents, etc. (Subramaniam & Youndt, 2005).

The relationship between knowledge workers is an important source of innovation because it indicates how well they are able to make the use of each other knowledge for achieving organizational objectives. As such, the communication between relational actors becomes a conduit for information exchanges (Subramaniam & Youndt, 2005). Therefore, relational view of a firm is used to examine whether or not the boundary spanning objects (common lexicon, common meaning, and common interests) enhance communication and joint

contribution to solving complex problems. The following sections present the relational view of a firm and its implication for developing the knowledge integration capability and relational rents in the form of innovation.

## Relational View of a Firm

The relational view of a firm presents that a firm can earn a competitive advantage not only from the presence of relational resources but also from the combination of those resources in a unique way of collaboration or partnership (Dyer & Singh, 1998). Dyer and Singh (1998) propose four key determinants of relational rents, which are relation-specific assets, complementary resources and capabilities, effective governance, and knowledge-sharing routines.

Relation-specific assets are those assets that are specialized in conjunction with the assets of relational partners. There are three forms of relation-specific assets – site specificity, physical assets specificity, and human assets specificity. Pertinent to this study is the application of human asset specificity. *Human assets specificity* refers to transaction specific know-how accumulated by relational actors through their long-term relationship. *Knowledge-sharing routines* refer to "regular patterns of interactions among relational actors that enables the transfer, recombination, or creation of specialized knowledge." *Complementary resource* endowments are idiosyncratic resources of organizations. These resources are synergy-sensitive and collectively generate returns, which is greater than the sum of returns obtained from the individual contribution of an organization. *Effective governance mechanisms* are of two types – 1) third-party enforcement of the agreement (e.g., legal contract); 2) self-enforcing agreement, in which the third party does not act as an arbitrator. Formal and informal self-enforcing safeguards monitor the behavior of relational partners. Formal self-enforcing safeguards control the possibility of opportunistic behavior of relational partners by aligning their economic

incentives. Informal self-enforcing safeguards are goodwill, trust or reputation, are socially complex and idiosyncratic to a particular exchange relationship. These informal self-enforcing safeguards also control the opportunistic behavior of relational partners (Dyer & Singh, 1998; p. 666).

In previous studies, researchers have used the relational view to explain the relationship between retailer and supplier. Relational partners formed their relationship by combining their relational specific assets in a unique way to generate capabilities that are inimitable by competitors (Hofer, Hofer, & Waller, 2014; Iyer, Srivastava, & Rawwas, 2014; Mesquita, Anand, & Brush, 2008). In the context of knowledge management, researchers have used relational view of a firm to examine how quality (Leischnig, Geigenmueller & Lohmann, 2014), trusts, proximity and collaboration between relational actors (Masiello, Izzo & Canoro, 2013; Kobayashi, 2013) support the generation of relational rent. They argue that by combining their idiosyncratic knowledge, relational partners can generate competitive advantage. The current study uses the relational view of a firm (Dyer & Singh, 1998) to examine how the boundary spanning objects enable relational partners to integrate their knowledge, and, therefore, generate organizational innovation.

The relational view of a firm, in the context of knowledge integration, builds around the concept of human asset specificity (relational-specific assets), knowledge-sharing routines, a combination of distinct and multiple knowledge domains (complimentary resource and capabilities), and informal self-enforcing mechanisms (effective governance).

**Human Assets Specificity**

Human assets specificity refers to the assets that a relational actor specializes in in conjunction with the other relational partners. Human asset specificity benefits organizations, as it enables the accumulation of specialized information, language, and know-how (Dyer and

Singh, 1998). A greater volume of human assets enhances the efficiency and effectiveness of relational partners when conducting a task. It allows them to exchange information quickly between each other with a lower degree of a communication error (Dyer, 1996). It also enhances employees' ability to produce products that require a coordination of multiple processes. Moreover, a higher frequency of communication between relational partners indicates that their communication is relevant; therefore, relational actors are sustaining their ongoing relationship. Such communication helps the organizations to generate ideas, stimulate creativity and solve complex problems, enhancing the likelihood of a project success (Ebadi & Utterback, 1984).

**Knowledge-sharing Routines**

Organizational knowledge-sharing routines are yet another source of relational rent in Dyer and Singh's (1998) framework. Knowledge-sharing mechanisms enable the transfer of superior knowledge. They also promote collaboration between relational partners. Previous research studies have revealed that knowledge sharing, rather than individual effort, is responsible for enhancing organizational innovation (Lin, 2007). In the case of knowledge workers, if they enjoy helping others, they are willing to not only contribute, but also to collect information from others in pursuit of solving complex problems, which enhances their knowledge-sharing capabilities, and ability to innovate (Lin, 2007).

Knowledge-sharing routines also enhance the absorptive capacity of relational partners (Dyer & Singh, 1998). It allows them to share information and know-how. The information is explicit and can be easily codified, whereas know-how is tacit, accumulates through experience and difficult to codify, explain and observe. But the greater degree of absorptive capacity of knowledge recipient enhances his or her ability to observe the tacit and unobserved knowledge and exploit it. The extent of the absorptive capacity of relational partners, in turn, depends on their overlapping knowledge and a frequency of communication. The greater degree of

absorptive capacity enables them to identify and assimilate valuable knowledge from each other for innovation (Cohen & Levinthal, 1990).

### Complementary Resources and Capabilities

Complementary resources and capabilities produce a synergistic effect, which makes the resources more valuable, rare, and difficult for competitors to imitate (Barney, 1991). Because not all resources of knowledge partners are complementary, it is important to identify the proportion of resources of knowledge partners that are synergy-sensitive. The greater proportion of synergy-sensitive resources produces relational rent that is sustainable (Dyer & Singh, 1998). Researchers have found evidence that complementary resources generate organizational rent that is sustainable. Information technology when embedded in the context of various cultures, planning, and network relationships, yielded sustainable performance advantage (Powel & Dent-Micallef, 1997). The relationship between complementary resources and sustainable competitive advantage relates to the resource-based view of a firm (RBV; Wernerfelt 1984; Barney, 1991). RBV presents that the combination of synergy-sensitive resources creates a unique bundle of resources that are difficult to imitate.

### Effective Governance

Effective governance determines the competitive potential of a firm (Dyer & Singh, 1998). Effective governance mechanisms emphasize two elements of transactions between relational partners: 1) the cost of sustaining the ongoing relationship, which is a transaction cost and 2) incentives provided to relational partners to sustain their ongoing relationship. Transaction costs relate to the cost of monitoring the behavior of relational partners and cost of bargaining when relational actors conduct transactions (Barney & Hansen, 1994). Informal self-enforcing safeguards such as goodwill and trust reduce such costs (Dyer & Singh, 1998). In the case of knowledge workers, the costs of the transactions may arise when knowledge partners

have to learn new knowledge and unlearn previous knowledge. The incentives that knowledge actors receive in the context of this study is their ability to solve complex problems only through knowledge integration (Dyer & Singh, 1998).

## The Theoretical Foundation

In this study, the relational view approach of a firm is applied in the context of knowledge management. Human assets specificity, complementary resources, and effective governance mechanisms resemble resources of knowledge actors who are representative of an organization. These resources are, respectively, the common lexicon, common meaning, and common interests. The basic argument is that the boundary spanning objects along with the knowledge integration capability are the determinants of relational rent – innovative capability.

### Common Lexicon and Human Assets Specificity

Human assets specificity (or relation specific human assets) is in the form of information and know-how that relational partners specialize through their repeated interactions. Dyer and Singh (1998) posit that human assets specificity develops through the repeated interactions between relational partners. Over time, relational actors are able to co-specialize as they accumulate more specialized information, language, and know-how (Dyer & Singh, 1998). As a result, relational actors are able to exchange quality information with a low degree of a communication error, the skill which is also necessary to quickly respond to changes in market demands. Similarly, common lexicon, which is in the form of printed forms, specifications, rules and regulations, enable knowledge actors to process and transfer information (Carlile, 2004). Repeated use of these lexicons makes knowledge actors more effective at processing and transferring information.

To illustrate the importance of common lexicon for effective processing and sharing of information, empirical evidence from the knowledge transfer literature is helpful. Such

illustration from the knowledge transfer literature is relevant also because the primary activity that common lexicon supports at a syntactic boundary is to process and transfer knowledge. Hoetker and Agarwal (2007) found that the use of a template, routines specifying subsequent actions of knowledge actors, supports replication of knowledge. Also referred to as recipe for the successful business model, a template can be a guiding example to others to follow (Nelson & Winter 1982), facilitating knowledge transfer (Winter & Szulankski, 2001). Moreover, the degree to which tacit capabilities can be written into comprehensible codes and taught to other employees influences the speed at which knowledge can be transferred (Zander & Kogut, 1995). Kogut and Zander (1995) measured the extent of codification of knowledge in an organization by using survey questionnaires that asked respondents regarding the presence of manuals or documentation used to store the process related to manufacturing.

**Common Meaning and Complementary Resources and Capabilities**

Common meaning refers the development of a shared understanding, which, in turn, facilitates actors to recognize the value of complementary knowledge of others. The complementary resources in Dyer and Singh (1998) framework are multiple and distinct resources present in a firm. A firm can leverage complementary resources by using its resources in conjunction with the resources of other firms. Although the common meaning is not a complementary resource, common meaning provides a foundation for relational actors to identify and realize the value of complementary knowledge through the development of a shared understanding. Development of shared understanding reduces the differences in interpretation related to a new or different knowledge bases (Cronin & Weingart, 2007).

**Common Interests and Informal Self-Enforcing Safeguards**

Effective governance in Dyer and Singh (1998) framework relates to common interests among knowledge actors. The effectiveness of governance structure is determined by two

factors. First, the cost of transactions between relational actors. Second, the incentive provided to relational actors to sustain their ongoing relationship. Relational actors minimize their transaction cost to increase transactional returns. Knowledge actors reduce their transaction costs by developing common interests that serve as self-enforcing safeguards. In the presence of competing interests among relational actors, the group members' willingness to use the negotiation as a tool to develop commonality in their "aspirations and expectations" helps to develop a joint agreement, which facilitates sustenance of relationship (Franco, 2013; p. 15). Common interests relate to informal-safeguards used to maintain effective governance. Just like informal-safeguard, which is socially complex and idiosyncratic to a particular relationship, common interests among parties develops through a negotiation of interests where actors involved in negotiation are willing to make trade-offs (Brown & Duguid 2001; Carlile, 2002, 2004). The resulting consensus is developed through the iterative process of negotiation and is idiosyncratic to the particular exchange relationship.

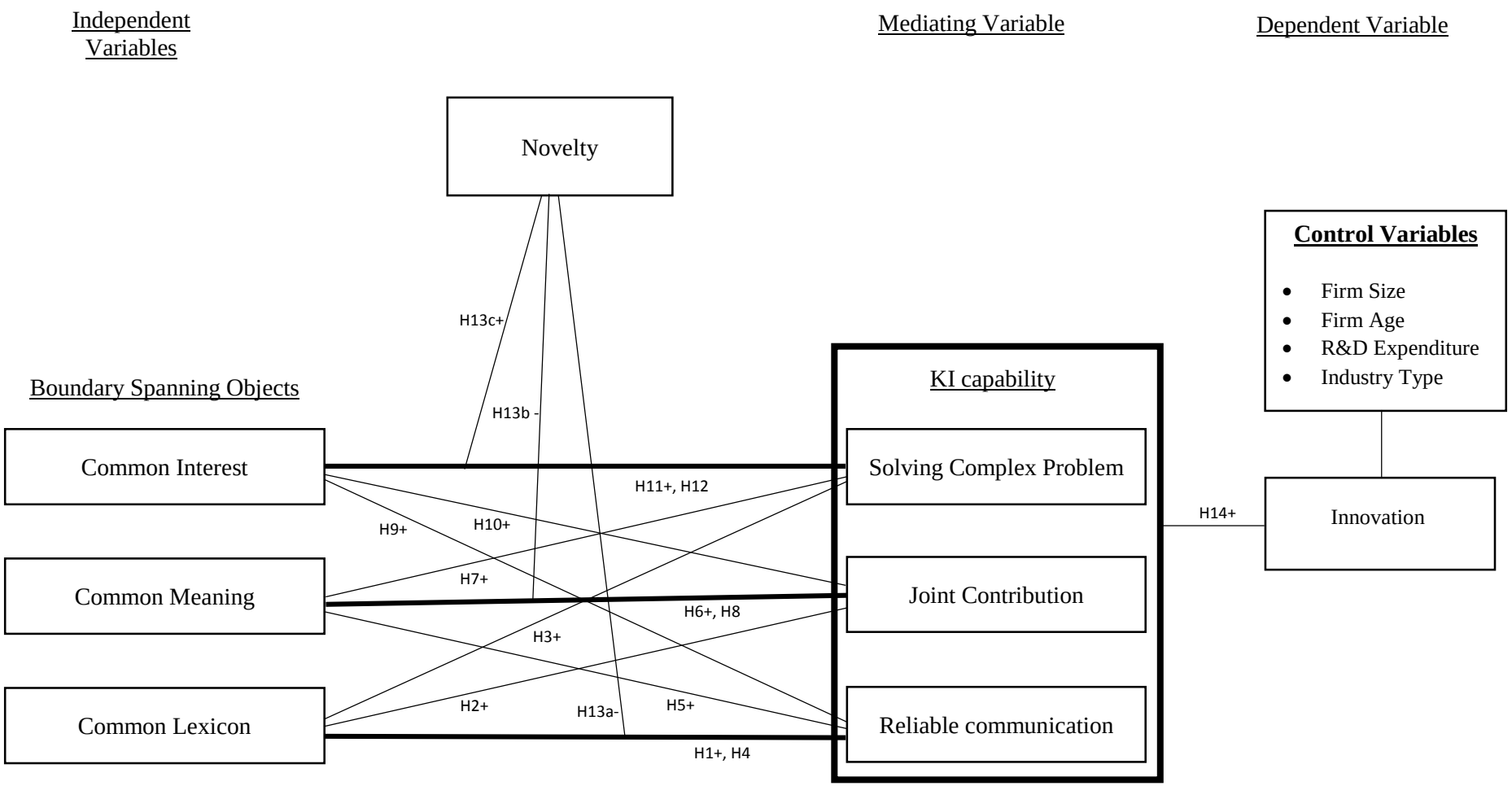
The common interests are different from common meaning as the former address challenges associated with the processes and political consequences of completing a task, whereas interpretive perspective (common meaning) does not address this challenge (Carlie, 2004). As a result, when they have common interests, members are willing to unlearn old knowledge and learn new knowledge to address a new problem. The members are willing to sustain their ongoing relationship by developing common interests because they get incentives when they use complementary knowledge in conjunction. The incentives that knowledge actors receive in the context of this study is their ability to solve complex problems only through

knowledge integration (Dyer & Singh, 1998).

### KI Capability and Knowledge-sharing Routines

Knowledge-sharing routines (Dyer & Singh, 1998) relate to the KI capability (Gardner et al., 2012) between relational actors. The interactions between relational partners to generate relational rent are similar to integrating knowledge of knowledge actors to innovate. In the case of knowledge-sharing routines, the underlying question about the characteristics of knowledge is important to mention. Dyer and Singh (1998) acknowledge that knowledge has two forms: information and know-how. Common lexicon such as standardized rules, specifications, and printed forms are information that is coded and explicit in nature. Such codified documents act as a template and enables knowledge transfer. On the other hand, a know-how of relational actors is tacit in nature. Exploitation of know-how depends on a prior shared work experience among members and their willingness to encourage transparency and discourage free-riding (Dyer & Singh, 1998). These properties of knowledge-sharing routine are closely associated with the properties of KI capability, which are reliable communication and joint contributions from relational actors. It also implies that reliable communication encourages transparency, and joint contribution discourages free-riding (Gardner et al., 2012). Figure 2.1 presents the association between boundary spanning objects, KI capability, and innovation.

**Figure 2.1: Association Between Boundary Spanning Objects, KI Capability, and Innovation**



## Hypotheses Development

### Common Lexicon and Reliable Communication

Reliable communication between relational actors is timely, concise, and in the right amount. Repeated use of symbols, words, and other communication tools enhances the reliability of communication. The recurring communication between organizational members provides them an opportunity to identify and rectify communication errors. As a result, accurate information, language, and know-how gets stored at organizational knowledge repository. Because these lexicons are accurate and error free, employees can depend on them for reliable communication in future (Dyer & Singh, 1998). The increase in the breadth of knowledge repositories also helps knowledge actors to locate appropriate lexicons the repositories.

The right amount of communication refers to avoiding excessive communication and obtaining enough information that facilitates the decision-making process. Lack of information creates a state of uncertainty, as enough information to complete a task is missing (Daft & Lengel, 1986; Galbraith, 1977). On the other hand, excessive information may overwhelm the receivers of information as they do not have sufficient time to make effective use of all information resources within a specific time (Bawden, Holtham & Courtney, 1999). Moreover, the review article in information overload literature presents that information overload, which may result from excessive communication, acts as a noise and distract employees, increasing their rate of errors (Edmunds & Morris, 2000). The presence of common lexicon prevents knowledge actors to get distracted from excessive and unnecessary information, reducing external noise during a communication process.

Concise communication refers to precise communication that is easy to understand (Daly, Barker, & McCarthy, 2002). Concise communication overcomes the problem of a bounded rationality of organizational members because it protects them from having to process

unnecessary information (March & Simon, 1958). The use of common lexicon keeps the information processing cycle clear and concise. For instance, developing standardized rules, routine, and specification helps to avoid equivocality of information (Daft & Lengel, 1986).

Timely communication requires the development of communication that emphasize the processing of rich information in an efficient manner. Information richness helps information processing mechanisms by clarifying ambiguous situations in a timely manner (Daft & Lengel, 1986). Timely processing of information is necessary because managers are bound by time constraints. Common lexicon such as standardized organizational rules and routines support information processing (Galbraith, 1973). Organizational rules and routines are in the form of codified information that is available for everyone for coordinate planning, scheduling, forecasting, and standardizing communication systems (Grant, 1996a). Organizational routines and subsequent employees' action serve as templates (Hoetker & Agarwal, 2007). Rules facilitate the integration of specialized knowledge in a timely manner and motivate knowledge partners to complete a project within a stipulated time (Okhuysen & Eisenhardt, 2002). Based on the discussion, the first hypothesis in the study is:

*H1: Common lexicon is positively related to reliable communication.*

**Common Lexicon and Joint Contribution**

Joint contribution refers to the interaction between members of an organization, enabling them to participate in a decision-making process by fostering communication that is supportive, truthful, non-confrontational (Gardner et al., 2012). To encourage joint contributions from all employees, feeling of psychological safety is essential, a state in which employees are confident to voice their opinion and a feeling of assurance that they will not be punished for presenting a different view. An organizational environment that fosters trust and teamwork among employees promotes such state. Moreover, employees who feel that they are psychologically

safe also seek feedback, discuss errors and jointly contribute toward solving a particular problem (Edmondson, 1999).

Supportive communication has two elements – informational support and emotional support (Ray & Miller, 1991). Providing informational support to organizational members clarifies their roles, responsibilities, and expectations, which also reduces a work uncertainty. Emotional support, on the other hand, encourages individuals to share their negative feeling and build self-esteem (Ray & Miller, 1991). Common lexicon fosters informational support as it helps to transfer information between knowledge partners (Carlile, 2004). Transfer of information reduces task uncertainty, which is the difference between the amount of information required to perform a task and the amount of information already possessed by knowledge actors (Daft & Lengel, 1986; Galbraith, 1977). In one of the review articles related to information sharing, Wittenbaum, Hollingshead, and Botero (2004) have documented that in most of the studies in information sharing literature, members are more willing to share common, rather than uniquely held information (unshared). Such result may attribute to lack of supportive environment, which may demotivate employees to share information (Edmondson, 1999).

A presence of strong network ties (Jackson, 1983), and a feeling of being supported (Beehr, 1985) instill a feeling of emotional support. The presence of a strong link between co-workers helps them to recall the instances when they have received support from others. Such relational ties may also be important when members have to adapt to a changing business environment as relational partners can count on the amount of support that they can expect from other during such situations (Miller & Jablin, 1991). Although one can propose that common lexicon provides informational support, the current literature remains silent on the association between common lexicon and emotional support.

The development of common lexicon may also foster non-confrontational behavior among individuals. Task clarity literature presents that the use of negotiation protocols (Ouelhadj et al. 2004), routines (Zollo & Winter, 2002), rules, and regulations act as guidelines for members to follow. These elements facilitate individuals to cooperate and coordinate for a task completion. Although rules can be explicit (e.g., directives) and implicit (e.g., social norms), written or oral, general (applicable to overall organization) or particular (specific to a department), positively worded or negatively worded, and stated or implied in nature, the one that is written and explicit helps to reduce about twenty-percent of communication-related problem (Gilsdorf, 1998). Rules regulate employees' behavior, informing them the acceptable and unacceptable behavior in a workplace (Grant, 1996a). For these reasons, guidelines and directions, which are written and explicit, may prevent a confrontational behavior among employees. Moreover, written rules also inform employees regarding communication expectancy (how we communicate here), providing all members a clear guideline on how to act in a given situation (Gilsdorf, 1998).

Common lexicon, with repeated use over time, are accumulated in an organization's knowledge repository as specialized information, language, and know-how (Dyer & Singh, 1998). These lexicons become fundamental to sustaining ongoing communication between organizational members (Grant, 1996a). Common lexicon also provides rules and directives for all the members of organizations to follow to achieve common objectives. Members use a common lexicon to plan future actions like assigning roles and responsibilities, establishing accountability, and prioritizing task completions (Risser et al., 1999). Therefore, the second hypothesis is:

*H2: Common lexicon is positively related to joint contributions.*

### Common Lexicon and Solving Complex Problem

To solve a complex problem, employees should combine their knowledge by communicating information that is relevant, objective, and clear. Such communication allows relational partners to discuss, evaluate, and apply their ideas (Gardner et al., 2012), ensuring the usefulness of a partner's contribution to solving organizational problems.

Complex problems have multiple and conflicting goals (Funke, 1991; e.g., a manager increases net profit by increasing marketing expenses to boosts sales revenue; but also cuts other costs). Therefore, specifications and guidelines (common lexicon) may not be sufficient to prioritize the goals of an organization. Complex tasks have a high degree of interconnection of processes. Highly interconnected processes make it difficult for individuals to discern all possible outcomes, as members who operate in a syntactic boundary receive training to operate in a stable condition, requiring them to primarily store and retrieve information for knowledge transfer (Carlile, 2004).

Because solving complex problems are fraught with challenges, a common lexicon is necessary but not the sufficient condition for solving a complex task (Carlile, 2002, 2004). Moreover, a common lexicon of relational actors may not be as effective for joint contributions and solve complex problems as it is for reliable communication. To explain this phenomenon, I borrow spiral view of knowledge (Nonaka, 1994). Spiral view of knowledge presents that knowledge creation occurs at an individual level, which then gets utilized collectively by a group, and finally gets stored in an organizational knowledge repository. The spiral view presents that once knowledge gets created at an individual level, it goes through an iterative process of mutual dialogue and interactions, gets refined, and is accepted for use by a wider community. Dialogue and interactions among knowledge actors are surrounded by the exchange of not only information, which are explicit and codified (common lexicon), but also know-how,

which is hidden and tacit. Therefore, to solve a complex problem, although processing and transferring of information is necessary, mutual dialogue and interactions are also important for developing the shared understanding of knowledge.

Although common lexicon may not be as effective as other boundary-spanning objects, these lexicons, along with other boundary-spanning objects, supports members' ability to solve complex problems (Carlile, 2004). The presence of a common language between knowledge actors, for instance, enables members from a diverse functional background to understand various terminologies and concepts related to solving complex problems (Mocnik, 2010). Because common lexicon is codified, it reduces the probability of confusion, and misinterpretation, enhancing a clarity of communication. Written and explicit rules, for instance, reduces communication-related problems or misinterpretation (Gilsdorf, 1998). Lexicons such as rules and directives support coordinating problem-solving efforts (Grant, 1996a). Based on the discussion, it follows that although common lexicon is important for solving complex problems, its importance is profound for reliable communication than for joint contributions and solving complex problems.

*H3: Common lexicon is positively related to solving complex problems.*

*H4: Common lexicon has more importance on reliable communication as compared to common meaning and common interests.*

**Common Meaning and Reliable Communication**

Common meaning refers to the development of shared understanding of a complementary knowledge of employees. Members create shared understanding related to various aspects of completing a task. These aspects are underlying assumptions, expected results, process, standardized rules, roles and responsibilities, and time-related to completing a task (Carlile 2004; Majchrzak et al., 2011). Employees are able to produce reliable results when communication

between them is efficient and does not overwhelm, confuse or distract the receivers of a message (Gardner et al., 2012).

When employees develop shared interpretation of their complementary knowledge, they can use their complementary knowledge in conjunction with that of other employees, which reduces individuals' burden of having to possess additional knowledge. A human mind is limited in its capacity to possess multiple elements of information, and process that information to solve a problem. Excessive information not only imposes a cognitive load, but also is detrimental to learning (Sweller, Van Merrienboer, & Paas, 1998).

The acquisition of additional knowledge also arouses multiple new concepts, which may create cognitive conflict and result in a state of confusion (Keltner & Shiota, 2003). It is likely that an individual acting alone may be required to possess multiple knowledge bases to complete a task, creating a state of cognitive conflict. When incoming information is relevant to knowledge workers who have the complementary knowledge and when the meaning of that information is clarified, the information becomes less confusing (Silva, 2010). The development of shared meaning also helps members to develop similarity in their interpretation of concepts, reducing the distortion of information and making the communication more reliable (Cronin and Weingart, 2007). The discussion leads to the next hypothesis.

*H5: Common meaning is positively related to reliable communications.*

**Common Meaning and Joint Contribution**

Knowledge workers collectively use complementary knowledge of each other for a joint contribution. Integrating complementary knowledge of all members is required when individuals are highly skilled (expert) in their knowledge domains but not well versed in other's knowledge domain. But the differences in knowledge domains may impede joint contribution when a task requires a contribution of all members (Cronin & Weingart, 2007). Moreover, when differences

in knowledge are not reconciled by creating common meaning among actors, they create a representational gap which adversely affects joint contribution. A representational gap exists when relational partners who are responsible for completing a task define a problem in different ways (Cronin & Weingarth, 2007).

Common meaning helps to create shared understanding of goals, assumptions, process, rules, and roles and responsibilities among relational partners, reducing the representational gap (Cronin & Weingart, 2007). The development of a common meaning can be task-related (Mathieu et al. 2000). The task-related common meaning enables individuals to develop a common understanding of the importance of the use of various processes, technologies and equipment, and the contribution of various members to complete a task. When a process related to a task completion is explicit and when members understand the importance of conducting a certain task, it is less likely that they get involved in confrontational behavior. The process facilitates coordination among employees, encouraging everyone in an organization to conduct activities directed at achieving a unified objective (Marks, Mathieu, & Zaccaro, 2001).

Members working in a cross-functional group will possess varieties of mental models, which may lead to conflicts (Hinsz, Tindale, & Vollrath, 1997). When a member's mental model does not match with that of others in a group, they may challenge each other assumptions, or even withdraw from a group (Bettenhausen & Murnighan, 1985; 1991). When individuals have compatibility in their decision-making process and operating procedures, then complementary knowledge resources can be used for joint contribution (Dyer & Singh, 1998).

Although a direct relationship between common meaning and truthful communication, an element of joint contribution, is not present in existing literature, the development of common meaning that facilitates recognition and identification of the complementary knowledge of

employees also provide incentives for relational actors to communicate in a truthful manner. In a negotiation environment, when negotiators do not realize that they have the same goal, they are likely to involve in misrepresentation of information by either manipulating or concealing the information. On a contrary, when both parties realize that they have a common goal and that the need and welfare of another party are important to oneself, a misrepresentation is less likely to occur (O'Connor & Carnevale, 1997). It is likely that, in such a case, negotiators realize the importance of complementary skills that could generate better outcome (incentive) through joint contribution. Based on the discussion, the next hypothesis is:

*H6: Common meaning is positively related to joint contribution.*

**Common Meaning and Solving Complex Problem**

The development of common meaning may also support individuals' effort to overcome communication-related challenges that may hinder their ability to solve complex problems. The development of shared understanding may help them to communicate in a relevant, objective and clear manner. These are the communication elements required to solve complex problems (Gardner et al., 2012).

Relevant communication refers to the exchange of verbal or written contents by group members among themselves that are appropriate and non-redundant. When employees have a common understanding of what elements of a problem to solve, the communication that occurs within a group is directed towards communicating in a relevant manner. In an intraoperative observational study, which identified the communication error based on predetermined criteria, Halverson et al. (2011) found that developing a common understanding among nurses and technicians helps to reduce the content of communication error, which refers to the extent to which relevant information was missing. The relevancy of communication may also increase when individuals question underlying assumptions to complete a task. For example, when

designing an accounting package for organizations, a software programmer should understand, rather than assume, the hardware configuration of computers of that organization and employees' existing computer literacy. It allows them to develop a user-friendly software (relevant).

The development of common meaning may also facilitate clear communication between members of an organization. Clear communication has four elements: 1) the sender of a message can reveal his or her opinion, 2) the meaning of a message is clear, 3) receivers understands the message clearly, and 4) the message solves a problem (Haley, 1959). By defining rules, regulations, roles, and a project expectation in a shared agreement, managers can establish predictability and openness with all members. This, in turn, adds clarity to the outcome of a project at the outset (Anantatmula, 2010). Accordingly, the next hypothesis is:

*H7: Common meaning is positively related to solving complex problems.*

**The Relative Importance of Common Meaning on Joint Contribution**

Most of the researchers ask the question regarding where does knowledge gets created – individual or an organization (Argyris & Schön, 1978; Nonaka, Toyama & Nagata, 2000; Choo & Bontis, 2002). To answer this question, Nonaka (1994) proposed a spiral view of knowledge. Spiral view of knowledge presents that knowledge creation occurs at the individual level, which then gets utilized collectively by a group, and finally gets stored in an organizational knowledge repository.

A simple combination of lexical of individuals (or the combination of information) may fail to amplify the value of knowledge for a wider organizational audience. The pure combination of knowledge facilitated by common lexicon without attaching a personal meaning to it fails to provide a deep interpretation of existing knowledge in contemporaneous situation and time (Nonaka, 1994). Some of the factors that allow the collaboration of knowledge for joint contribution are sharing a common experience and perspective (Schrage, 1990), and engaging in

mutual dialogue and trial-and-error process of learning. These factors provide a ground for knowledge actors to communicate hidden tacit knowledge among each other. These processes are quite different from simply transferring the information from one actor to other by the use of a common lexicon. Therefore, the presence of common lexicon is not a sufficient condition for attaining joint contribution.

When knowledge workers face semantic knowledge boundary, their primary job is to translate their knowledge and develop common meaning so that knowledge translation can occur (Carlile, 2004). Knowledge translation relates to the expression of new knowledge in a way that all relational partners understand. In the process of expressing their knowledge, individuals externalize their hidden tacit knowledge and combine it with knowledge externalized by other organizational members. This process is iterative and consists of mutual dialog, and trial and error. Through this process individuals share their experiences with each other, helping them to develop a shared meaning of a knowledge, and facilitating conceptualization and crystallization of a concept (Carlile, 2004). The externalization of tacit knowledge and its interaction with the explicit knowledge of others refine a concept, forming a shared understanding. Such concept is then, stored at the organizational repository for wider use across an organization (Nonaka, 1994). The translation of tacit meaning to an explicit one through day-to-day interactions and mutual dialogue by members who spans the boundaries of one's functional domain help to develop shared understanding among a greater number of employees (Nonaka, 1994). The discussion leads to the next hypothesis:

*H8: Common meaning has more importance on joint contribution than common lexicon and common interests.*

### Common Interests and Reliable Communication

Common interests enable group members to transform their knowledge and interests and provide adequate means of sharing and assessing knowledge at a pragmatic knowledge boundary (Carlile, 2004). The transformation of knowledge refers to learning new knowledge and giving up the knowledge that is irrelevant to solve a given problem at hand. To transform their knowledge, individuals develop a common understanding of a problem and agree on underlying assumptions and process related to solving that problem.

The development of common interests makes governance structure effective. Relational partners will realize that their complementary knowledge is more effective only when they are able to use their knowledge to solve a particular problem (Dyer & Singh, 1998). It also encourages them to sustain their ongoing relationship. The outcome interdependence, which refers to the extent to which organizational members are dependent on each other for attaining a common goal, literature presents that members of a group having a shared goal are more dependent if they realize that other members in an organization have complementary resources. As a result, they feel a need for more communication and are more committed to a group for completing a shared goal (Schippers et al., 2003). As discussed before, sustenance of relationship and recurrent communication between knowledge actors helps to rectify the communication error, increasing the reliability of communication.

*H9: Common interests are positively related to reliable communications.*

### Common Interests and Joint Contributions

The presence of competing interests in employees may have a potential for conflict as organizational members believe that knowledge developed in one area may have a negative effect on another area. As a result, employees may resist collaborating for solving a problem, despite developing shared understanding for dealing with differences and dependencies at a

semantic boundary (Franco, 2013). In the case study, Nicolini, Mengis, and Swan (2009) found evidence that divergence in interest between academicians and practitioners working on a project to create a bioreactor hindered joint contributions. Creating a bioreactor required a cross-disciplinary group of scientist and practitioners to develop a system capable of producing synthetic tissues for clinical application. In the observational study, results indicated that while academicians were concerned about validating concepts, practitioners were interested in commercializing the product.

In another case study, Franco (2013) examined the partnership between the construction companies of the United Kingdom. The partners were developing an appropriate model that comprises of systems and procedures for project management and review. There was a clear difference between partners' interests as they had conflicted views on aspirations and expectation of partnership work. There was also misunderstanding regarding the nature of problem and solution that was deemed appropriate for all partners. The negotiation among partners facilitated them to identify and modify the contents of the model. As a result, partners jointly agreed on common partnership philosophy (common interest). The new partnership ethos fostered the environment where partners showed their renewed interest to sustain their relationship through joint contributions (Franco, 2013).

*H10: Common interests are positively related to joint contributions.*

**Common Interests and Solving Complex Problems**

Common interests in individuals are difficult to establish when there is a disagreement regarding which individuals are and who are not responsible for solving a problem (Mortensen, 2004). Lack of common interests also arises when group members have a higher degree of functional personal identity. In such a case, they may disregard the importance of the

interrelationship between relational partners. Such behavior will give rise to a conflict of interest among them and has a negative impact on their problem-solving ability (Randel & Jaussi, 2003). Therefore, common interests are essential for supporting relevant, objective, and clear communication for solving complex problems (Gardner, et al. 2012).

Actors who have a greater amount of knowledge at stake are more likely to advocate strongly for solutions that benefit them, whereas those who have a low knowledge at stake are likely to acquiesce because the cost to advocate is more than the benefits of compliance (Baer et al., 2012). Members advocating for their benefit will divert their focus from solving a problem to exerting a dominance behavior, which reflects proposing solutions that are consistent with self-interests, disregarding the interests of others. The presence of dominance behavior in a relationship also causes members to formulate a solution before considering all possible alternatives. This limits members' ability to jointly comprehend and analyze problems (Baer et al. 2013), which adversely affects their ability to solve complex problems.

Development of common interests may encourage parties to communicate objectively, without bias and free of any personal feelings. Development of common interests implies that actors are willing to give up knowledge that they have acquired over time for benefits that result from solving a complex problem. As a result, individuals will not try to impose their personal biases and dominance behavior while communicating. They will cooperate because they believe that incentives generated from cooperation exceed the one generated by acting alone (Dyer & Singh, 1998). Therefore, when common interests exist, powerful actors will refrain from self-serving behavior (Baer et al., 2013), improving a group's ability to solve complex problems.

The presence of common interests implies that there is an agreement among relational partners about goals and processes related to a solving a problem (Carlile, 2004). The clear

communication among relational actors enhances goal clarity, which, in turn, helps to solve complex problems (Desmond, 2004). Lack of goal clarity creates a representational gap, which refers to the differences in individual's definition of a problem, making it difficult for them to integrate their knowledge for problem-solving. When a problem and a solution path (processes) of a problem are ill-defined, it becomes difficult for actors to solve complex problems, as their moves are not coordinated. Moreover, in such a case, the moves of individual actors can also work against the moves of others (Cronin & Weingart, 2007). Based on the discussion, the next hypothesis follows:

*H11: Common interests are positively related to solving complex problems.*

**The Relative Importance of Common Interests on Solving Complex Problems**

When relational actors encounter pragmatic knowledge boundary, their primary purpose is to transform their knowledge and develop common interests (Carlile, 2004). Knowledge transformation relates to actors' willingness to learn new knowledge and give-up knowledge that is irrelevant to solving a new problem.

When faced with a complex problem, members of a firm try to find a path to problem solution. To do so, they have to identify knowledge within or outside a firm that may be useful to solve a complex problem. Solution to complex problems is achieved through recombination of existing knowledge of a firm (Nickerson & Zenger, 2004). The need for recombination of individual knowledge sets for solving complex problems arises because of cognitive limits of individuals working in problem solution (Cyert & March, 1963).

Communication between boundedly rational knowledge actors creates a room for misunderstanding when they are required to solve a complex and unfamiliar problems. Moreover, when the complexity and unfamiliarity of a problem render existing rules and regulations insufficient, relational actors may have to develop a high level of agreement and

harmony. In the absence of clear rules and regulations, existing paradigms, which suggest what is in the best interest of an organization, enable members to take decisions. The paradigm helps relational actors to develop common frameworks, languages, and referents for solving an unfamiliar problem. As a result, they are able to develop a joint agreement regarding processes, assumptions, and solution to problems (Wilkins & Ouchi, 1983).

Moreover, to solve complex problems even the development of common meaning is not sufficient. For example, consider a fictitious situation where an automobile manufacturer faces the challenge of producing eco-friendly cars. In an effort to reduce greenhouse gas emission and to abate the rate of depletion of oil resources, a government introduces a policy that provides incentives to automobile manufacturers who produce eco-friendly cars. In such a case, employees (relational partners) working in an automobile company can develop a shared understanding regarding style, engine, and safety of a new vehicle. But the shared understanding may not be enough to solve a problem because a conflict of interests between relational actors may arise. While marketing manager may be excited about upcoming design because it has a potential to boost sales revenue, engineers may resist changes in design as they may lack the knowledge regarding designing an eco-friendly car. Their current knowledge may be irrelevant to this new situation. To develop eco-friendly cars (solve the complex problem), all the relational actors may have to learn a new and relevant knowledge, which will cost them additional time, effort, and money. In this example, despite the development of common meaning, the relational partners can still be demotivated to solve a complex problem.

Different individuals possess distinct knowledge elements, which are relevant to solving different components of a complex problem. This makes the recombination of individuals' knowledge necessary. Knowledge recombination involves developing a group cognitive map that

is critical to solving complex problems. To develop a cognitive map, individuals need to resolve the inherent conflicts surrounding their beliefs about knowledge (Nickerson & Zenger, 2004; Walsh & Fahey, 1986). Carlile (2004) argues that such conflicts of interests can be reconciled through the development of common interest, which allows knowledge possessing actors to transform their knowledge domain for a common good. Although the development of common interests may also support joint contribution and reliable communication of knowledge actors, the primary benefit of common interests is the willingness of knowledge actors to synthesize their knowledge through knowledge transformation to develop a solution landscape required to solve a complex problem.

Development of common interests also indicates that there is a goal congruence among relational actors. Wilkins and Ouchi (1983) used the term goal congruence to express the idea that there is a belief among organizational members that in a long-run, they will be treated fairly. The shared understanding among employees related to objectives, methods, and values of an organization reinforces their belief that the justice will be done in the long-run. As a result, relational actors are motivated to cooperate even at the expense of short-run inequities (Wilkins & Ouchi, 1983). Moreover, the actors will also realize that continued cooperation will generate incentives that are greater than the one generated by acting alone (Dyer & Singh, 1998). Taken together, the cooperation among relational actors and co-specialization that helps to generate more incentives increase the long-term sustenance of group communication.

*H12: Common interests have more importance on solving complex problems than common lexicon and common meaning.*

**Novelty at Knowledge Boundaries**

Novelty increases the complexity of problems. Complex problems are relatively opaque because underlying reasons for problems are not readily apparent. Moreover, because novel

situations also refer to changes in business environment, knowledge workers have to develop a new knowledge to address new situations. Generation of new knowledge makes the existing differences and dependencies between knowledge workers unclear, and their meaning ambiguous (Carlile, 2004). The existing lexicons (common lexicon) such as standardized rules, common designs, and specification may not provide guidelines as to how to tackle a new situation. As a result, the importance of common lexicon on the KI capability diminishes.

The development of common meaning suggests that it sets up a foundation whereby employees can jointly use complementary knowledge of knowledge partners. As novelty increases, actors operate in a semantic knowledge boundary where the development of common meaning is required for knowledge integration (Carlile, 2004). The importance of different boundary objects at a different level of novelty is made clearer by Nonaka's (1994) distinction of information into syntactic and semantic perspective. According to Nonaka, the syntactic perspective of information simply means the volume of information. For example, in the current study, the use of printed materials, standard specifications, designs, and tools are boundary objects which relate to a syntactic aspect of information. Syntactic aspects of information emphasize the volume, rather than content, of these objects used for communication. On the other hand, semantic aspects of information emphasize the meaning of information (Shannon & Weaver, 1949). As novelty increases, individuals create new knowledge to address novel situations. The newly developed knowledge which is tacit in nature gets accepted for wider use when knowledge actors interact with each other, a process referred to as "socialization" (Nonaka, 1994; p. 19). The socialization is self-organization activity that continuously creates the common meaning of new knowledge. When organizational members interact and work together, they develop shared experiences, which also allow them to develop common knowledge bases

(Nonaka, 1994). Therefore, during the presence of novelty, the development of common meaning through socialization enables members to integrate each other's tacit knowledge.

The development of common interests is a self-enforcing safeguard that may overcome the transaction costs, which are, in this context, giving up the knowledge that is at stake and time lost in discussing what more to learn to address new situation. As a result of the development of common interests as self-enforcing safeguards, employees do not have to develop new agreements and self-monitoring mechanisms. The development of common interests also protects members against opportunism just like trust and cooperation between relational parties protect them from opportunism (Hill, 1990). In this situation, rather than developing explicit rules and regulations for employees to follow, the emphasis is on developing shared values and beliefs, and rewarding and reinforcing appropriate values and beliefs (Perrone, Zaheer, & McEvily, 2003). On the other hand, when the situation is of lower novelty, the level of complexity and uncertainty of knowledge is low. Therefore, actors can use their existing knowledge to address that situation. Under stable and less complex transactional conditions, the cost of developing and maintaining a social agreement, in the form of common interests, far outweighs the benefits (Wilkins & Ouchi, 1986). Therefore, in fewer novel situations a bureaucratic form of governance proves to be a much more efficient option for achieving coordination for knowledge integration. Based on the discussion, the next hypothesis follows.

*H13: The importance of high level boundary objects on KI capability increases with the novelty.*

*H13a: The importance of common lexicon on KI capability decreases with the level of novelty.*

*H13b: The importance of common meaning on KI capability increases with the level of novelty.*

*H13C: The importance of common interests on KI Capability increases with the level of novelty.*

### KI Capability and Innovations

The KI capability may be critical to organizational innovations. Along with the presence of employees' knowledge, a firm must also have the capability to integrate and exploit its complementary knowledge (Dyer & Singh, 1998; Verona, 1999). This argument found support in Subramaniam and Youndt's (2005) research findings. Contrary to their expectation, they found that the presence of human capital is negatively associated with radical innovations. It is only when the knowledge workers were able to collaborate, interact and partner, and share and exchange information their knowledge positively influenced innovation (Subramaniam & Youndt, 2005).

The presence of knowledge-sharing routines, which also requires relational partners to collaborate, exchange and integrate knowledge foster innovation. The presence of such routines encourages all members to abstain from free riding by jointly contributing to the benefit of a firm (Dyer & Singh, 1998). Joint contributions of actors combine diverse ideas because members can exchange new ideas and valuable information among each other, which facilitates the acceptance of innovations for implementation (Dyer & Singh, 1998; Subramaniam & Youndt, 2005). Interactions among employees can also stimulate a climate that fosters innovation because such interactions provide organizational members to rely on each other for creative ideas, brainstorming, and moral support (Starbuck, 2014).

At the interfirm level, an alliance between firms is able to contribute more to a firm's knowledge base (Baum, Calabrese, and Silverman, 2000) because they are the source of resources (Ahuja, 2000). The presence of complementary knowledge-base is often required to attain innovative outcome (Arora & Gambardella, 1990; Makri, Hitt, & Lane, 2010; Nerkar & Roberts, 2004). Ahuja (2000) found the evidence that joint contribution between relational

partners in alliance network was able to increase the innovation output as these partners were able to bring together their complementary skills from various firms.

The communication that occurs, for example, for the purpose of introducing new products or services is not a one-time phenomenon. When a group member communicates his or her knowledge with others, the other members may not be familiar with knowledge that a group member share. The unfamiliarity with a new knowledge induces others to ask more questions, enhancing their understanding, and making a communication pattern frequent and bi-directional. The reliable pattern of communication, encompassed in the KI capability, supports this increased communication frequency. The increase in the frequency of communication between relational partners enhances their absorptive capacity (Dyer & Singh, 1998), which refers to members' ability to understand the value of new knowledge and apply it to commercial end (Cohen & Levinthal, 1990). The greater absorptive capacity of relational partners also suggests that their ability to generate relational rent, in the form of innovation, through knowledge integration increases (Dyer & Singh, 1998). Therefore, the knowledge integration capability becomes an essential capability for achieving organizational innovation (Tenkasi & Boland, 1996; West, 2002). Based on the discussion, the last hypothesis of this study is:

*H14: KI capability is positively related to organizational innovations.*

Table 2.2 provides the list of hypotheses of this study.

**Table 2.2. Table of Hypotheses**

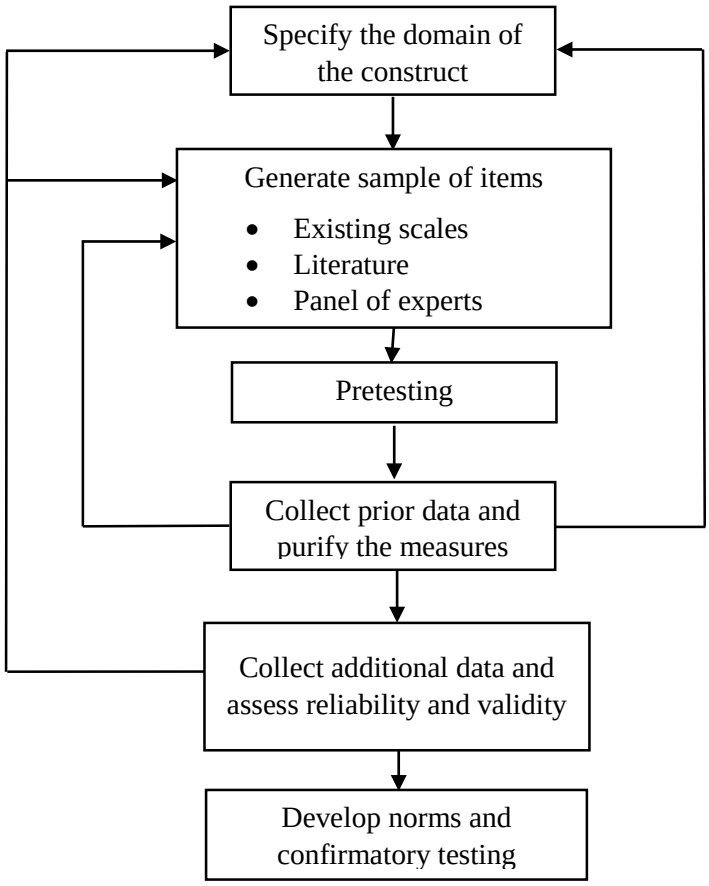
| | |
|---|---|
| Hypothesis 1 | Common lexicon is positively related to reliable communication. |
| Hypothesis 2 | Common lexicon is positively related to joint contributions. |
| Hypothesis 3 | Common lexicon is positively related to solving complex problem. |
| Hypothesis 4 | Common lexicon have more importance on reliable communication than joint contributions and solving complex problem. |
| Hypothesis 5 | Common meaning is positively related to reliable communications. |
| Hypothesis 6 | Common meaning is positively related to joint contribution. |
| Hypothesis 7 | Common meaning is positively related to solving complex problem. |
| Hypothesis 8 | Common meaning has more importance on joint contribution than common lexicon and common interests. |
| Hypothesis 9 | Common interests are positively related to reliable communications. |
| Hypothesis 10 | Common interests are positively related to joint contributions. |
| Hypothesis 11 | Common interests are positively related to solving complex problem. |
| Hypothesis 12 | Common interests have more importance on solving complex problems than common lexicon and common meaning. |
| Hypothesis 13 | The importance of high level boundary objects on KI capability increases with the novelty. |
| Hypothesis 13a | H13a: The importance of common lexicon on KI capacility decreases with the level of novelty. |
| Hypothesis 13b | H13b: The importance of common meaning on KI capability increases with the level of novelty |
| Hypothesis 13c | The importance of common interests on KI capability increases with the level of novelty. |
| Hypothesis 14 | KI capability is positively related to organizational innovations. |

# CHAPTER 3

# METHODOLOGY

This chapter discusses the methodology design, measures, and reliability and validity of measures. A survey based design was used to collect data and measure the constructs examined in this study. Constructs consist of multi-item (multiple questions) measures. Multi-item measures are closely related to the latent (unobservable) construct. At the same time, multi-items are also sufficiently unique so that they can capture different attributes of a latent construct (Malhotra & Grover, 1998). Following the Malhotra and Grover (1998) suggestions presented in Figure 3.1 of conducting pre-testing and pilot testing, measurement instruments are tested for reliability and validity.

**Figure 3.1. A Framework for Developing Measurement Scales (Adopted from Malhotra & Grover, 1998)**



## Research Design

This study uses survey methodology to collect information and test the hypotheses. Survey research technique is used to collect information in a structured way from individual respondents. Depending on the unit of analysis of the study, the individuals respond to questions about themselves, their expertise, or the projects/organizations they work for. Survey questionnaires contains multiple questions that are worded differently to capture the variance in variables. Researchers collecting information using survey questionnaires should be aware that the respondents represent different sub-sections of a population (Malhotra & Grover, 1998). Survey research can be cross-sectional or longitudinal in nature. Researchers could use a cross-sectional survey to collect information about different subsets of a population at a particular point in time. On the other hand, researchers could also use a longitudinal survey to collect data on more than one point in time.

The current study uses cross-sectional survey design to collect data to test *apriori* hypotheses presented in chapter 2. It is not possible to establish the causal relationship between variables studied using cross-sectional survey design. Given the scope of the study, a longitudinal survey design is also not feasible.

### Unit of Analysis

The unit of analysis of this study is *firm*. A *firm* is used as the unit of analysis because the research questions seek to examine factors that determine a firm's ability to innovate and to integrate employees' knowledge. Various researchers have also used *firm* as the unit of analysis to examine a firm's ability to innovate in the various contexts, such as network ties (Ozer & Zhang, 2015), firm size (Leiblein & Madsen, 2009), and strategic fit (Kim, Arthurs, Sahaym, & Cullen, 2013).

### Sample Frame

The population of interest in this study is manufacturing and service firms based in the United States of America (U.S.A). Both publically traded and private limited companies were included in the sample frame. Researchers who have used innovation as one of the constructs in their study have drawn the sample from both publically traded firms (Berrone, Fosfuri, Gelabert, & Gomez-Mejia, 2013) as well as private firms (Fabiani & Sbragia, 2014).

### Respondents

Previous studies related to innovation have also used a key informant approach for the data collection (Garg, Walters, & Priem, 2003; Li & Atuahene-Gima, 2002; Zhou & Li, 2012). The key informant approach ensures that the data is collected only from those individuals whose opinion and perception regarding organizational activities are the valid representation of other decision makers of that firm (Phillips, 1981). Previous researchers have also used the key informant approach to collect the data to examine strategic decision-making processes (e.g., Dickson & Weaver, 1997; Koufteros, Vickery, & Dröge, 2012; Li and Atuahene, 2002). This study also uses the key informant approach to collect data. To ensure that the respondents are key informants of a firm, screening questions are used in the survey questionnaire. Two questions are used to identify the key informants, which are 1) the amount of respondents' involvement in the strategic-decision making, and 2) the level of respondents' knowledge related to the strategic decision-making process. Only those respondents who are involved in the strategic decision-making of a firm and those who have some knowledge regarding such decision-making processes are included in the study.

**Response Rate**

A response rate of over 20% is appropriate to conduct the statistical analysis (Malhotra & Grover, 1998). To ensure the attainment of a desirable response rate, the elements of the social exchange theory of human behavior are followed (Dillman, 2000).

- ***Make the questionnaire interesting and short as it decreases respondents' perceived costs of responding.*** The total estimated time required to complete the questionnaire is 20-minutes.
- ***Assure confidentiality and anonymity.*** Respondents were told that the completion of the survey involves no foreseeable risks. Participation is voluntary, and they give consent to include their responses for data analysis by completing the survey. Moreover, the respondents were also informed that all of their answers would be kept strictly confidential. Hard copy data will be stored in locked cabinets with limited access and electronic data will be stored on a password-protected computer. Only aggregate statistics obtained from the answers provided by many respondents from different organizations will be published.
- To increase the response rate and the usability of data, respondents were reminded that an approximate answer is better than no answer, as incomplete questionnaires can not be used for analysis.
- To reduce the *social desirability bias,* respondents were informed that there are no "right" or "wrong" answers. Employees from different firms may respond in different ways to same situation.
- Respondents were promised that if they were interested, the results of the study would be provided to them after the study was completed.

**Data Collection Process**

*Controlling for the Common Method Bias*

Common method bias is the variance of a dependent variable that is attributable to the measurement method rather than to constructs a measure represents (Podsakoff et al. 2003). Method bias also causes errors in measurement, which, in turns, threaten the validity of conclusions drawn about the relationship between variables under study. The bias in methods results from various reasons. *Common rater effect* occurs when respondents who are providing the responses to predictors and dependent variables are the same. *Consistency motif* causes respondents to respond to questions by maintaining constancy in their responses to similar questions. As a result, such motifs may produce relationships which may not have existed. The s*ocial desirability* tendency of respondents causes them to present themselves in a way that is accepted in their social setting, regardless of their true nature. In sum, common method biases arise from having a common rater for all the constructs, common items, characteristics of raters, and characteristics of items (complex and ambiguous items; Podsakoff et al. 2003). Because the biases pose a serious threat to conclusions drawn, it is important to take necessary steps to reduce the common method variance to the largest extent possible. Podsakoff et al. (2003) recommended two primary ways to reduce common method biases: 1) procedural remedies related to the design of the study and 2) statistical remedies.

The procedural remedies relevant to the current study are:

a) ***Temporal, proximal, psychological, or methodological separation of measurement:*** This step involves the separation of the measurement of predictor and criterion variables. The separation reduces bias in the retrieval stage of response process. It also reduces respondents' ability to answer questions by inferring missing details to fill in gaps. The separation of measurement items was achieved by placing the measurement

of dependent and independent variables far apart in the questionnaires. The scale anchors for predictors and criterion variables were also different (Podsakoff et al. 2003). For measuring independent variables, which are common lexicon, common meaning, and common interests, the 5-point Likert scale was used. Whereas, for measuring mediator and dependent variables, which are KI capability and innovation respectively, a 7-point Likert scale was used.

***b) Protecting respondent anonymity and reducing evaluation apprehension:*** Before taking the survey, respondents were promised that their answers would be kept anonymous. They were also told that the answers to the questions are not socially desirable and there is no right or wrong answer to the questions. Following these steps increases the likelihood that respondents would not change their response, and, therefore, social desirability bias could be mitigated to some extent.

**c) *Improving scale items:*** Improving scale items affects the comprehension stage of the response process. Ambiguous items result in a problem related to methods bias which puts a cognitive load on respondents. Therefore, the scale items were improved based on the Tourangeau's et al. (2000) suggestions by 1) defining the constructs under study; 2) avoiding using vague concepts; 3) keeping the questions simple, specific, and concise; 4) eliminating double-barreled questions; and 5) avoiding the use of complicated language.

In addition to using procedural remedies to improve the scale items, the statistical remedy was also used. The statistical remedy is:

a) ***The use of marker variable:*** Marker variable technique was used to control the common method bias (Lindell & Whitney, 2001). This technique compares the difference

between fit indices of hypothesized research models with a marker variable and the one without a marker variable. If such difference is not statistically different then we can conclude that the common methods bias does not affect a study. The marker variable should be completely unrelated to other variables. In the current study, the respondents were asked to rate the statement of a marker variable on a 7-points Likert scale. The item used to measure the marker variable was "I am happy about the person I have become."

*Power Analysis*

To determine the sample size required for conducting the analysis for Linear multiple regression for a fixed model, effect size, confidence interval, power and number of predictors were used. The effect size was fixed at 0.15 (medium effect size), the confidence interval was 95% (alpha = 0.05), the required power was 0.80, and the number of predictors was set to five. G*Power 3.1.9.2 software was used to determine the required sample size. The total number of samples required to conduct the analysis at 0.80 power was 95.

*Pretesting*

To purify and pre-test items and to measure the three dimensions of boundary-spanning objects, Q-sort analysis was conducted. The Q-sort analysis consists of two stages. First, a panel of experts read the definition of a construct and place randomized items under their appropriate construct, a process called items sorting. Second, based on the results obtained from items sorting, researchers either delete or re-word the items that are ambiguous. The Q-sort technique is both simple and effective. The technique is applied during the pre-test stage. This technique helps to improve the face-validity of a construct (Nahm et al., 2002).

*Pilot Study*

The goal of a pilot study is to determine the feasibility of conducting a large-scale study. A pilot study informs researchers of the reliability and validity of scales. Screening questions and attention filters were used to identify the usable survey. Two screening questions were used to identify the valid responses: 1) the extent of respondents' involvement in the strategic decision-making process of their firm; and 2) the level of respondents' knowledge about the strategic decision-making process of their firm. The items were measured on a 9-points Likert scale, where 1 was "No Involvement," 5 was "Some Involvement," and 9 was "Extentive Involvement." Only those respondents who had, at least, some involvement (5 or above on a 9-point Likert scale) in a decision-making process and those who had, at least, some knowledge (5 or above on a 9-point Likert scale) of strategic decision-making processes were selected for the study.

**Operationalization of Constructs – Measures and Factor Structure**

Likert-type scales were used to collect data from respondents. Although Likert-type scales generate only the closed-ended questions and reduce the flexibility for answers, they are less affected by random influences. Likert scale items provide the assessment of individuals' attitude.

As opposed to an individual item measure, which is considerably unique and has a low degree of correlation with a latent construct, multi-items measures can better specify the construct domain, capture the fine distinction between people, and have a greater degree of reliability (Malhotra & Grover, 1998). Therefore, multi-item scales were used for most of the constructs used in this study. Only *firm size, industry type, R&D expenditure,* and *firm age* were measured using a single item measure. All these variables are control variables.

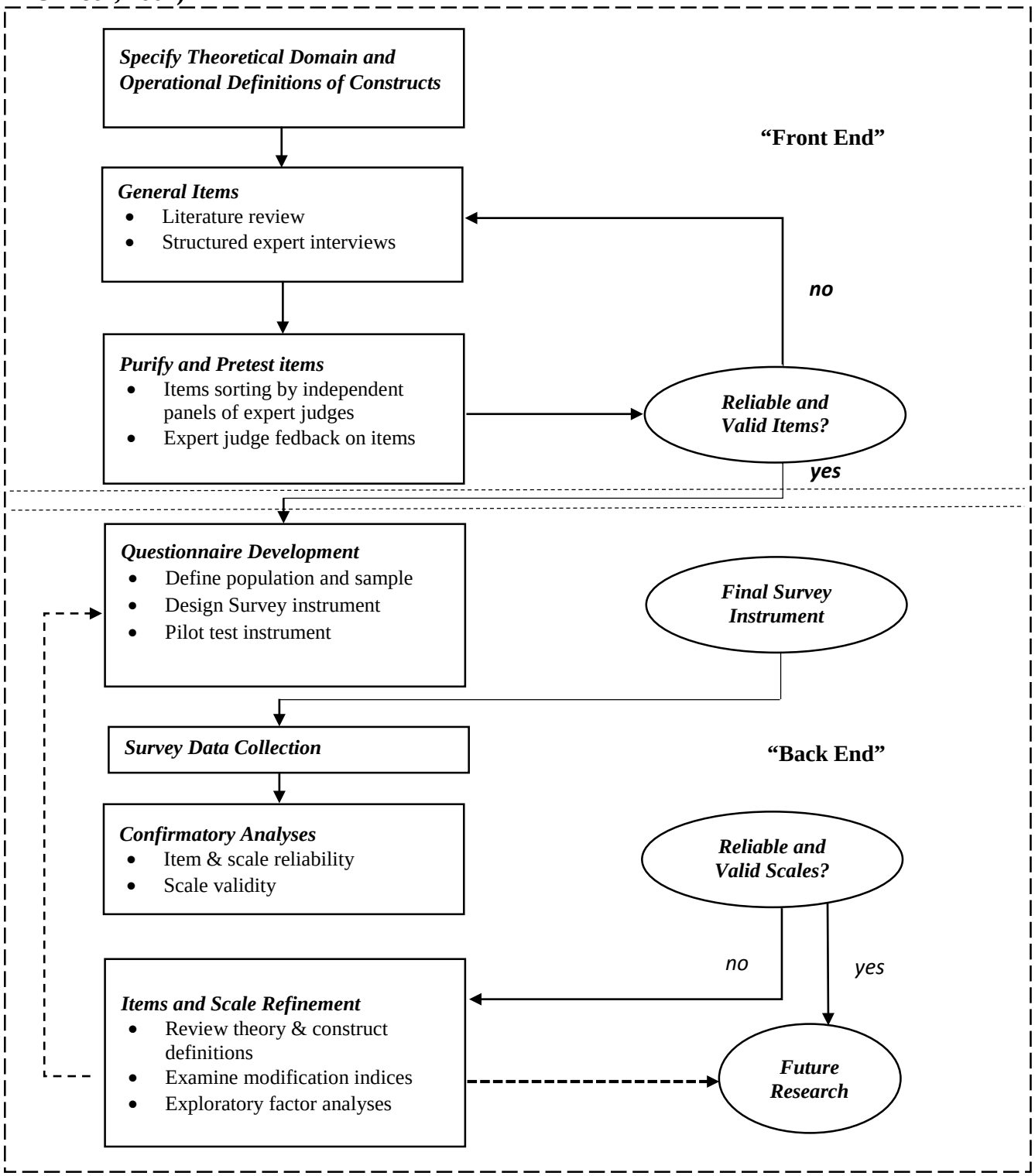
In this study, both the existing measures and the newly developed measures were used (see appendix for the measures of constructs used for the main study). Measurement items for the following constructs are borrowed from the existing studies:

1. KI capability is borrowed from Gardner et al. (2012). KI capability has three interrelated sub-dimensions, which are reliable communication, joint contribution and solving complex problems.
2. Innovations measure is adopted from Li and Atuahene-Gima (2002).

New scales were developed for the *common lexicon*, *common meaning*, *common interests* (boundary spanning objects), and *novelty*. The items for these scales were derived from Carlile (2002, 2004). Figure 3.2 presents the two-stage approach that was used to develop the new measures (Adopted from Menor & Roth, 2007).

As suggested by Menor and Roth (2007), the reliability and validity of items for all the scales were identified. The first step of the scale development process involved specifying the theoretical domain and developing operational definitions of the constructs used in this study. Prior established theories and existing studies were consulted to operationalize the variables. To ensure the reliability of instruments used in the survey questionnaire, established scales were used whenever possible. The use of established measures also ensures the accuracy of items (Kerlinger & Lee, 2000). For constructs that do not have measurement items, new items were developed. In the front-end portion of the scale development, the feedback regarding the validity of tentative measurement items was obtained from a panel of informed judges (Menor & Roth, 2007). Based on the feedback, some of the items were refined to improve the clarity of the questionnaire. Moreover, double-barreled questions were presented as two separate questions. In the back end portion of scale development, psychometric properties of multi-item scales were assessed by evaluating reliability and validity of scales, conducting confirmatory factor analysis, and evaluating dimensionality of measurement scales.

**Figure 3.2. Two-stage Approach for New Measurement Development (adopted from Menor & Roth, 2007)**



*Measures*

***Dependent Variable:*** Innovation is unidimensional construct with reflective indicators (Li & Atuahene-Gima, 2002). To measure innovation, respondents were asked about their firm's level of innovation relative to their firm's major competitors over the past three years. On the 7-points Likert scale, the respondents indicated the level of their agreement/disagreement regarding their firm's emphasis on a new product development, the introduction of varieties of new products in a market, and commitment to developing and marketing new products.

***Independent Variables:*** Boundary spanning objects is the multidimensional construct with reflective indicators (Carlile, 2004). This construct has three dimensions, which are common lexicon, common meaning, and common interests. The boundary spanning objects can be presented in a hierarchical representation such that at the most complex boundary common interests of all the knowledge possessing actors are required for sharing and assessing their knowledge. Common meaning is most effective at a semantic boundary, a less complex boundary; common lexicon is most effective at a syntactic boundary, a least complex boundary. Knowledge actors sharing and assessing their knowledge with each other at a complex knowledge boundary still requires the capacity of other boundary spanning objects, which are below it, for a task completion (Carlile, 2004). Based on Carlile's (2002, 2004) conceptualization of common lexicon, common meaning, and common interests, the new measurement items for these variables were developed.

All the boundary spanning objects were measured on a 5-point Likert scale. The *common lexicon* is measured using four items. These items included statements that

required respondents to provide their level of agreement/disagreement regarding the use of designs, standardized specifications, and tools such as sketches/prints to share and access their knowledge at a syntactic boundary. The c*ommon meaning* is measured using six items. Respondents were asked to provide the level of their agreement/disagreement with the common understanding of expected time, rules, roles and responsibilities, outcomes, and processes related to completing a task. Finally, the *common interests* are measured using five items. The respondents were asked to provide their level of agreement/disagreement regarding their willingness to learn new knowledge, invest additional time and resources to learn new knowledge, forgo their self-interests to develop consensus, and use only the relevant knowledge to solve a particular problem.

To measure *KI capability*, the scale developed by Gardner et al. (2012) was used. The scale was a ten items scale, measuring the reliable communication, joint contributions, and solving complex problems on a 7-point scale.

To measure the *reliable communication*, the respondents were asked to rate the timeliness, precision, and amount of communication among members. The *joint contribution* included four statements, which are related to the various elements of communication that foster joint contributions such as contents, approach and tone of communication, and assistance received while communicating with each other. Finally, *solving complex problems* was measured by asking respondents to rate the contents, objectiveness, and clarity of communication.

Novelty, which is the contextual variable, is measured using four items on a 5-points Likert scale. The items measuring novelty are related to the novel knowledge that members of a firm create to address the changes that occur in a business environment.

For example, these changes may be changes in customers' taste and preferences and technological advances in products/services. Table 3.1 presents the definitions and the operationalization of the constructs.

**Table 3.1. Definitions and Operationalization of the Constructs**

| Construct | Definition/ Operationalization | Sources |
|---|---|---|
| Innovation | Innovation refers to the rate at which a firm develops new products or services.<br>Rate the following statements regarding your FIRM's level of innovation relative to its major competitors over the last 3 years the extent to which it has … (1 = weaker than competition; 4 = similar to competition; 7 = stronger than competition).<br>Relative to our major competitors, our firm has…<br>• Placed significant emphasis on new product development through allocation of substantial financial resources<br>• Developed a large variety of new products<br>• Made dramatic changes in existing products<br>• Increased the rate of new product introductions to the market<br>• Increased its overall commitment to develop and market new products | Li and Atuahene-Gima (2002) |
| Boundary Spanning objects | Boundary spanning objects refers to common lexicon, common meaning and common interests that allow knowledge workers to share and access knowledge at a knowledge boundary. Boundary spanning objects are measured on a 5-point Likert scale, where 1= Strongly Disagree, 3 = Neither Agree nor Disagree, and 5 = Strongly Agree. | Carlile (2002, 2004) |
| Common lexicon | Common lexicon refers to the common means of communication that employees use such as repositories, standardized forms and methods, objects or models, and maps of boundaries to share and access knowledge at a syntactic boundary.<br>Given below are the statements related to the use of common lexicon (language, tools, designs, specifications, and rules) by employees across your FIRM. Please provide your level of agreement/disagreement with the following statements.<br>• We use common designs for communicating information related to completing a task.<br>• Use of standard specifications enable us to share information for completing a task.<br>• We use common tools such as sketches/prints for sharing information related to completing a task.<br>• We use similar tools for communicating information for completing a task. | Carlile (2002, 2004) |

*(table continues)*

| Construct | Definition/ Operationalization | Sources*(continued)* |
|---|---|---|
| Common meaning | Common meaning refers to the development of common understanding among employees that provide them adequate means of sharing and assessing knowledge at a semantic boundary.<br>Given below are the statements related to the development of common understanding among employees across your FIRM. Please provide your level of agreement/ disagreement with the following statements.<br><br>We have a common understanding of expected results from completing a task.<br>• We have a common understanding of time required to complete a task.<br>• Our interpretation of organizational rules is similar.<br>• We have common understanding of roles and responsibilities of organizational members.<br>• We have common understanding about outcomes of completing a task.<br>• We have shared understanding of processes required to complete a task. | Carlile (2002, 2004) |
| **Common interests** | Common interests refer to the willingness of employees to give up irrelevant knowledge and learn new knowledge that provides them adequate means for sharing and accessing knowledge at a pragmatic boundary.<br>Given below are the statements related to the existence of common interests across your FIRM. Please provide your level of agreement/ disagreement with the following statements.<br>• All members agree to use only the knowledge relevant to completing a particular task.<br>• We are willing to forego our self-interests to develop consensus for solving problems.<br>• We jointly agree to learn new knowledge required for solving problems.<br>• We jointly agree to invest additional time to learn new knowledge for solving problems.<br>• We develop consensus to use relevant knowledge to solve a particular problem.<br>• All members agree that knowledge developed in one area can be useful in another for solving problems.<br>• We jointly agree to invest resources to learn newknowledge for solving problems. | Carlile (2002, 2004) |

*(table continues)*

| Constructs | Definition/ Operationalization | Sources*(continued)* |
|---|---|---|
| Knowledge Integration Capability | Knowledge Integration capability refers to a reliable pattern of employees communication that generates joint contributions to the understanding and solving of a complex problem. | Gardner et al. (2012) |
| Reliable communication | Reliable communication is a degree to which members communicate in concise, timely, and in the right amount.<br>1. Concise communication refers to precise communication that is easy to understand.<br>2. Timely communication refers to the development of communication that emphasize the processing of rich information in an efficient manner.<br>3. The right amount of communication refers to the communication that is neither to excessive nor too less.<br><br>Please indicate your level of agreement with statements about the reliability of communication among members belonging to your FIRM<br>• **The communication is…**<br>***Delayed*** ***Neutral*** ***Timely***<br>**1 2 3 4 5 6 7**<br>○ ○ ○<br>***Digressive*** ***Neutral*** ***Concise***<br>**1 2 3 4 5 6 7**<br>○ ○ ○<br>***Too many/too few*** ***Neutral*** ***Right Amount***<br>**1 2 3 4 5 6 7**<br>○ ○ ○ | Gardner et al. (2012), and Apker, Propp, Zabava Ford, & Hofmeister, 2006); Daly, Barker, & McCarthy (2002); Daft and Lengel, 1986) |

*(table continues)*

| Construct | Definition/ Operationalization | Sources*(continued)* |
|---|---|---|
| | Please indicate your level of agreement with statements about the communication that encourages joint contributions among members belonging to your FIRM.<br>• **The communication is…**<br>***Inconsiderate*** ***Neutral*** ***Supportive***<br>**1 2 3 4 5 6 7**<br>○ ○ ○<br>***Deceptive*** ***Neutral*** ***Truthful***<br>**1 2 3 4 5 6 7**<br>○ ○ ○<br>***Confrontational*** ***Neutral*** ***Non-confrontational***<br>**1 2 3 4 5 6 7**<br>○ ○ ○<br>***Hampering teamwork*** ***Neutral*** ***Fostering teamwork***<br>**1 2 3 4 5 6 7**<br>○ ○ ○ | |
| Solving Complex problems | Solving complex problems refer to the recombination of ones and other people's knowledge by communicating in a manner that is relevant, objective, and clear.<br>1. Relevant communication refers to an exchange of verbal or written contents by members among themselves that are appropriate and non-redundant.<br>2. Objective communication refers to the communication that is not biased and not based on the personal feelings.<br>*3.* Clear communication occurs when a receiver of a message can understanding the meaning that the sender intended to send. | |

*(table continues)*

| Constructs | Definition/ Operationalization | Sources *(continued)* |
|---|---|---|
| | Please indicate your level of agreement with statements about the communication that helps members belonging to your FIRM to solve complex problems.<br>• **The communication is…**<br>***Irrelevant*** **1 2 3** ***Neutral*** **4 5 6** ***Relevant*** **7**<br>○ ○ ○<br>***Biased*** **1 2 3** ***Neutral*** **4 5 6** ***Objective*** **7**<br>○ ○ ○<br>***Confused*** **1 2 3** ***Neutral*** **4 5 6** ***Clear*** **7**<br>○ ○ ○ | |
| Novelty | Novelty refers to a situation in the external environment such as changing consumer taste and preferences that require a new knowledge from organizational actors to address that situation.<br>Given below are the statements related to novelty of business environment faced by your FIRM. Please provide your level of agreement/ disagreement with the following statements (measured on a 5-point Likert scale, where 1= Strongly Disagree, 3 = Neither Agree nor Disagree, and 5 = Strongly Agree).<br>• The changes in customers' tastes and preferences frequently make our knowledge obsolete.<br>• We often do not have immediate solutions to technological advances in products/services demanded by our customers.<br>• We often have to expand our knowledge base to meet the changing customers' need.<br>• We regularly update our existing knowledge domain to meet the changes in customers' requirements. | Carlile (2004), Amason, Shrader, and Tompson, (2006). |

***Control Variables:*** Four control variables were used in the study. They are R&D expenditure, firm size (number of employees), firm age, and industry type. R&D expenditure is measured by taking the percentage of a firm's annual sales contributed to research and development. Previous studies have demonstrated that the difference in the amount of investment made in research and development activities between innovative and non-innovative firms is huge. R&D expenditure of an innovative firm is more than that for non-innovative firms. R&D expenditure results in organizational growth and enhances a firm's performance (Shefer & Frenkel, 2005). Moreover, researchers have also found that larger firms tend to spend more on R&D expenditure than smaller firms (Shefer & Frenkel, 2005), and that larger firms are more innovative than smaller firms (Damanpour, 1992). The argument is that larger organizations have more financial resources, human resources, and physical resources than smaller firms. The greater resources support their innovating activities (Damanpour & Schneider, 2006). Therefore, firm size was also used as a control variable. A number of employees was used as a proxy for a firm's size.

*Firm age* may also determine a firm's ability to innovate (Sørensen & Stuart, 2000). As a firm gains more experience through learning by doing, the marginal cost of production decreases (Balasubramanian & Lee, 2008). As a result, a firm may have more freed up capital, which may be invested in innovative activities. *Firm age* is measured using one item, which asked respondents regarding the number of years a business has been in operation. Lastly, *industry type* is also used as a control variable. Saeed, Yousafzi, and Paladino (2015) grouped industry type into two categories – high-tech and low-tech. They argued that the companies belonging to the high-tech industry face

frequent changes in the technologies, resulting in a relatively shorter product life cycle. Therefore, to survive in these industries, companies have to innovate constantly.

**Analyses Technique**

Structural equation modelling (SEM) was used to test the direct relationship hypotheses. IBM SPSS AMOS 21 was used to conduct SEM analysis. First, the psychometric properties of scales were assessed by evaluating reliability and construct validity, identifying the dimensionality of factors, and conducting confirmatory factor analysis. Next, the direct relationship hypotheses predicted the relationship between 1) boundary spanning objects (common lexicon, common meaning, and common interests) and KI Capability, and 2) KI capability and innovation. Finally, the multi-group hypotheses were tested using the software IBM SPSS 22. The relationship between boundary spanning objects and KI capability at different levels of novelty (Hypotheses 13a, 13b, and 13c) were tested using 1) multi-group analysis using hierarchical linear regression, and 2) relative weight of each boundary spanning object determining KI capability at the different levels of novelty.

*Reliability*

Reliability analysis evaluates the psychometric properties of constructs. It answers question regarding the ability of scales to measure intended construct consistently and precisely. Reliability is a yardstick to test the accuracy of a construct measurement procedure in scientific research. The reliable measures are those measures that give us the same results when used to measure the same constructs at a different point in time. To establish the reliability of measures, composite reliabilities of the scales, statistical mean, and standard deviations were estimated.

*Construct Validity*

Construct validity refers to the extent to which measures of a construct adequately represent a construct. There are two ways of assessing construct validity, which are theoretical and empirical approaches. Theoretical validity informs us of how well operational measures of a construct represent a theory from which a construct was borrowed. Two approaches are used to evaluate theoretical validity. First, face validity indicates whether or not indicators used to operationalize a construct are a representative of a construct. Second, content validity refers to how well items measure a content domain of a construct that it is trying to measure. For both face validity and content validity, a panel of experts was consulted to examine the validity of constructs.

Convergent validity and discriminant validity of constructs were also evaluated. Convergent validity refers to the degree to which two or more indicators of a given construct that are supposed to be correlated are, in fact, correlated. Whereas, discriminant validity refers to the degree to which indicators or the measurements for given constructs that are not supposed to be correlated with other constructs in the study are, in fact, not correlated. Convergent validity was evaluated by examining average variance extracted (AVE) values of all the constructs. Discriminant validity was evaluated by examining the pairwise comparison of variables. Pairwise comparison is conducted by comparing chi-square differences between constructs. If the chi-square differences are statistically significant, there is evidence for discriminant validity (Anderson and Gerbing, 1988). Moreover, the square roots of the AVE for each construct were also compared with its correlation with the other constructs in the model (Fornell & Larker, 1981). If the square root of the AVE of a construct is greater than its correlation with other constructs, then it provides evidence for the discriminant validity. Lastly, chi-square difference

between constrained measurement model and unconstrained measurement model was identified. If such difference is statistically insignificant then it provides evidence for discriminant validity.

*Factor Structure*

The literature review was conducted on knowledge management and innovation management to determine the factor structures of the constructs used in the study (Table 3.2). The boundary spanning objects were conceptualized as consisting of three first-order dimensions, which are common lexicon, common meaning, and common interests (Carlile, 2002; 2004). To measure the KI capability of employees and its three dimensions, the existing scales developed by Gardner et al. (2012) were used. The KI capability is a higher-order construct with multiple reflective indicators (Gardner et al. 2012). The construct has three dimensions, which are reliable communication, joint contribution and solving a complex problem. These dimensions represent the three interrelated aspects of KI capability (Gardner et al., 2012). All the sub-dimensions of KI capability have to be present for employees to have KI capability. *Novelty* is a unidimensional construct with reflective indicators (Carlile, 2004, Amason, Shrader, & Tompson, 2006).

**Table 3.2. Constructs Structure**

| Constructs | Theorized Construct Structure | Sources for the Scales |
|---|---|---|
| Boundary spanning objects | Multi-dimensional construct with three dimensions, which are *common lexicon, common meaning,* and *common interests.* These dimensions are the first order factors. | Carlile (2002, 2004) |
| Knowledge integration capability | Multi-dimensional construct with three dimensions, which are *reliable communication, joint contribution* and *solving complex problem.* These dimensions are three interrelated aspects of KI capability. The KI capability is the second order factor and the dimensions represent the first order factors. | Gardner et al. (2012) |
| Innovations | Unidimensional reflective construct. | Li and Atuahene-Gima, (2002 |
| Novelty | Unidimensional reflective construct | Carlile (2004), and Amason et al. (2006) |

# CHAPTER 4

# RESULTS

This chapter presents the results obtained from the pre-test, the pilot study, and the main study. The chapter provides the results of the hypotheses presented in chapter 2. Before the results are presented, the descriptive statistics are presented. Moreover, the measurement model is evaluated by examining the composite reliability of the constructs, discriminant validity, and convergent validity. After evaluating the measurement model, the results of the hypotheses are presented in the order presented in chapter 2.

## Pretesting

In the pre-test, six Ph.D. students at the University of North Texas from the department of Management, and the Department of Marketing were selected as a panel of experts. They were provided with a Qualtrics link. Upon clicking the link, they were directed to a web page. The web page contained two columns. The first column consisted of 13 items. The second column consisted of three categories, which are common lexicon, common meaning, and common interests (boundary spanning objects). The panel of experts was also provided with the definition of boundary spanning objects. They were asked to familiarize with the definitions and place each item from the first column under one of the categories in the second column. Four respondents placed one of the statements from common interests in common meaning. The item was, “we jointly agree on processes related to completing a task.” For this reason, this item was reworded and was placed under the common meaning. The new item was worded as "we have shared understanding of processes required to complete a task." Moreover, two items were added to measure common interests. These items are “we develop consensus to use relevant knowledge

to solve a particular problem", and "all the members agree that the knowledge developed in one area is useful in another."

## Pilot Testing

The sample frame for the pilot study was the Amazon Mechanical Turk (MTurk). MTurk allows respondents from around the world to complete survey questionnaire. The respondents were located in the USA. Of the 196 respondents who completed the survey, only 135 sample were used for the pilot study. After deleting 61 responses that had missing data, and the ones where the respondents did qualify based on screening questions, the final sample size was 135, a net response rate of about 69-percent. The primary job titles of target respondents include the owner, chief executive officer, executive vice president, general manager, senior managing director, senior R&D manager, project manager, and branch manager. Respondents belonged to various industries – aviation/aerospace, educational services, electronics, healthcare, transportation, and technology. Respondents also belonged to the companies of various sizes, the ones that were employing less than 50 employees (n = 37), 50-100 employees (n = 16), 101-249 employees (n = 25), 250-499 employees (n = 17), 500-999 employees (n = 15), and 1000 or more (n = 25). Similarly, most of the companies were either corporation (n = 42), or a single division company (n= 31). 36 companies generated most of their sales revenue from the sales of products, whereas 99 companies generated most of their sales revenue from the sales of services. 59 companies were completely service based, whereas three companies were completely manufacturing companies. The average age of firm was 37.640 years.

The demographic data is presented in the tables 4.1 and 4.2. Tables 4.1 and 4.2 demonstrate that the sample is evenly distributed across small, medium, and larger firms.

Moreover, Table 4.3 demonstrates that the companies belong to various industries – educational services (14.8%), healthcare (14.1%), and technology (11.1%).

**Table 4.1. Number of Employees – Pilot Study**

| Range | Frequency | % | Cumulative % |
|---|---|---|---|
| Less than 50 employees | 37 | 27.407 | 27.407 |
| 50- 99 employees | 16 | 11.852 | 39.259 |
| 100-249 employees | 25 | 18.519 | 57.778 |
| 250-499 employees | 17 | 12.593 | 70.370 |
| 500-999 employees | 15 | 11.111 | 81.481 |
| 1000 or more | 25 | 18.519 | 100.000 |

**Table 4.2. Company Sales – Pilot Study**

| Range | Frequency | % | Cumulative % |
|---|---|---|---|
| Less than $5 M | 44 | 32.593 | 32.593 |
| $5 M to <$10 M | 29 | 21.481 | 54.074 |
| $10 M to <$20 M | 19 | 14.074 | 68.148 |
| $21 M to <$50 M | 9 | 6.667 | 74.815 |
| $50 M to <$100 M | 11 | 8.148 | 82.963 |
| $100 M or more | 23 | 17.037 | 100.000 |

**Table 4.3. Industry Composition – Pilot Study**

| Industry | Frequency | % | Cumulative % |
|---|---|---|---|
| Automotive | 5 | 3.704 | 3.704 |
| Aviation/Aerospace | 6 | 4.444 | 8.148 |
| Educational Services | 20 | 14.815 | 22.963 |
| Electronics | 7 | 5.185 | 28.148 |
| Entertainment | 4 | 2.963 | 31.111 |
| Healthcare/ Medical Devices | 19 | 14.074 | 45.185 |
| Food/Beverages | 11 | 8.148 | 53.333 |
| Transportation | 4 | 2.963 | 56.296 |
| Metal Fabrication | 4 | 2.963 | 59.259 |
| Technology | 15 | 11.111 | 70.370 |
| Pharmaceuticals/Chemicals | 2 | 1.481 | 71.852 |
| Others | 38 | 28.15 | 100.000 |

**Descriptive Statistics, Correlations and Reliabilities**

Table 4.4 presents the descriptive statistics, correlations of major variables, and composite reliabilities of the constructs. The composite reliabilities for most of the dependent and independent variables were more than 0.700, a level which is above an acceptable threshold (Fornell & Larker, 1981; Hair et al. 1998). The composite reliability of one of the independent variables, common lexicon, was 0.692. Therefore, to improve the composite reliability of common lexicon, two items were dropped, other items were modified, and one new item was added. Similarly, the composite reliability of novelty, which is a contextual variable, was 0.564. Therefore, to improve the composite reliability of novelty, the items were modified and one item was deleted. Table 4.5 presents the items measuring common lexicon, common interests, and novelty that were dropped, accepted, or modified. Most of the items used to measure common lexicon are modified to capture the ability of employees to communicate with each other using lexicon. Most of the items of novelty were modified to reflect actions that employee undertake to address changes in external business conditions. For example, one of the items used in the pilot

study to measure novelty was "our firm frequently encounters changes in customers' tastes and preferences." This item measures the changes in a business environment, but it does not capture the status of existing knowledge of employees because of changing business environment. Therefore, this item was modified as, "the changes in customers' tastes and preferences frequently make our knowledge obsolete."

**Table 4.4. Descriptive Statistics – Pilot Study**

| Variables | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Employee Size[1] | 3.237 | 1.850 | - | | | | | | | | | |
| 2. Industry type[2] | 7.496 | 3.717 | -.131 | - | | | | | | | | |
| 3. R&D Expenditure[3] | 19.806 | 19.802 | .093 | -.220* | - | | | | | | | |
| 4. Firm age[4] | 37.644 | 34.169 | .491*** | -.109 | .064 | - | | | | | | |
| 5. Common lexicon | 3.970 | 0.706 | .164 | .025 | -.038 | .154 | ***.692*** | | | | | |
| 6. Common meaning | 4.106 | 0.667 | .079 | .178 | -.058 | -.006 | .542** | ***.891*** | | | | |
| 7. Common Interests | 3.850 | 0.625 | .101 | .080 | -.039 | -.085 | .343* | .730*** | ***.736*** | | | |
| 8. KI capability | 2.860 | 0.471 | .002 | .227* | -.016 | -.098 | .327 | .787*** | .799 | ***.951*** | | |
| 9. Novelty | 3.910 | 0.748 | .104 | -.024 | -.104 | .113 | .521* | .617** | .542* | .398* | ***.564*** | |
| 10. Innovation | 5.128 | 1.183 | .291** | -.135 | .278** | .170 | .310* | .294*** | .424** | .339** | .575** | ***.904*** |

*Note. n* = 135; SD = Standard deviations; Coefficients for composite reliability are presented along the diagonal

*** Correlation is significant at the .001 level (two-tailed)

** Correlation is significant at the .01 level (two-tailed)

* Correlation is significant at the .05 level (two-tailed)

[1]*Employee size* was coded as follows based on number of employees: 1 = less than 50 employees; 2 = 50-100 employees; 3 = 100-249 employees; 4 = 250-499 employees; 5 = 500-999 employees; and, 6 = 1000 or more employees.

[2]*Industry type* was coded as follows: 1 = Automotive industry; 2 = Aviation/Aerospace; 3 = Educational Services; 4 = Electronics; 5 = Entertainment; 6 = Healthcare/ Medical Devices; 7 = Food/Beverages; 8 = Transportation; 9 = Metal Fabrication; 10 = Technology; 11 = Pharmaceuticals/Chemicals; and, 12 = Others.

[3]*R&D Expenditure* represents the percentage of firm's annual sales, on an average, contributed toward research and development expenditure.

[3]*Firm age* represents a number of years a firm has been in operation.

**Table 4.5. Modifications of Items Measuring Newly Developed Scales**

| Variables and Items | Dropped/Accepted/Modified |
|---|---|
| **Common Lexicon** | |
| We use shared tools such as sketches or prints. | Modified |
| We use common designs for completing a task. | Modified |
| We have standard specifications for completing a task. | Modified |
| We communicate in a language that we all understand. | Dropped |
| We have standardized organizational rules. | Modified |
| **Common Interests** | |
| All members agree to ignore knowledge irrelevant to completing a particular task | Modified |
| We jointly agree to learn new knowledge required to solve a problem. | Accepted |
| We jointly agree to invest additional time and resources to learn new knowledge. | Modified |
| We develop consensus to use relevant knowledge to solve a particular problem. | Accepted |
| All members agree that knowledge developed in one area is useful in another. | Accepted |
| **Novelty** | |
| Our firm frequently encounters changes in customers' tastes and preferences. | Modified |
| Our customers frequently demand technological advances in products/services. | Modified |
| We regularly update our existing knowledge domain to meet the changes in customers' requirements. | Modified |
| Our competitors constantly introduce a new category of products/services. | Modified |
| Our competitors constantly introduce products/services that are technologically advanced. | Modified |

## Construct Validity

In the pilot study, the discriminant validity was assessed by comparing the omnibus fixed (correlation between constructs was fixed to 1) and free measurement models. The result indicated that the free model is better ($\Delta\chi$ 2 (df) = 147.655 (10); $p \leq 0.0001$), providing the evidence of discriminant validity. Moreover, the pair-wise comparison of the scales of constrained and unconstrained models was conducted to access the discriminant validity of construct. Discriminant validity of two constructs can be assessed by performing chi-square

difference test on constrained and unconstrained parameters of two constructs. To constrain the parameters, estimated correlation parameter between constructs is set to 1.0. The values of the chi-square differences between constructs of constrained and unconstrained models were statistically significant (Table 4.6), providing evidence of discriminant validity (Anderson and Gerbing, 1988).

**Table 4.6. Pairwise Comparisons for Testing Discriminant Validity (Δχ2) – Pilot Study**

| | KIC | CI | CM | CL | INNO | NOV |
|---|---|---|---|---|---|---|
| **KIC** | --- | | | | | |
| **CI** | 41.233*** | --- | | | | |
| **CM** | 194.943*** | 64.819*** | --- | | | |
| **CL** | 72.941*** | 79.438*** | 85.347*** | --- | | |
| **INN** | 23.045*** | 36.296*** | 52.977*** | 39.245*** | --- | |
| **NOV** | 53.950*** | 52.979*** | 80.766*** | 63.543*** | 38.150*** | --- |

*Note.* KIC = Knowledge Integration Capability; CI = Common Interests, CM = Common Meaning; CL = Common Lexicon; INNO = Innovation; NOV = Novelty; Δχ2 = chi-square difference

*** Correlation is significant at the .001 level (two-tailed)

** Correlation is significant at the .01 level (two-tailed)

* Correlation is significant at the .05 level (two-tailed)

## Factor Structure

The construct structure are presented in Table 3.2. The comparison of the higher order model and the first order model for the KI capability in the pilot study is presented in Table 4.7. The results demonstrate that the chi-square difference between the second order model and the first order model was not statistically significant ($\Delta\chi^2 = 0.239$; p-value = .625). The degree of freedom indicated that the second-order model was a better model. Moreover, the fit indices also demonstrated that the second-order model was a better fit model (CFI = 0.961; RMSEA = 0.063; SRMR = 0.052). The data provides support for the hypothesized structure for the KI capability construct.

**Table 4.7. Comparison of Higher Order Model and First Order Model for KI capability – Pilot Study**

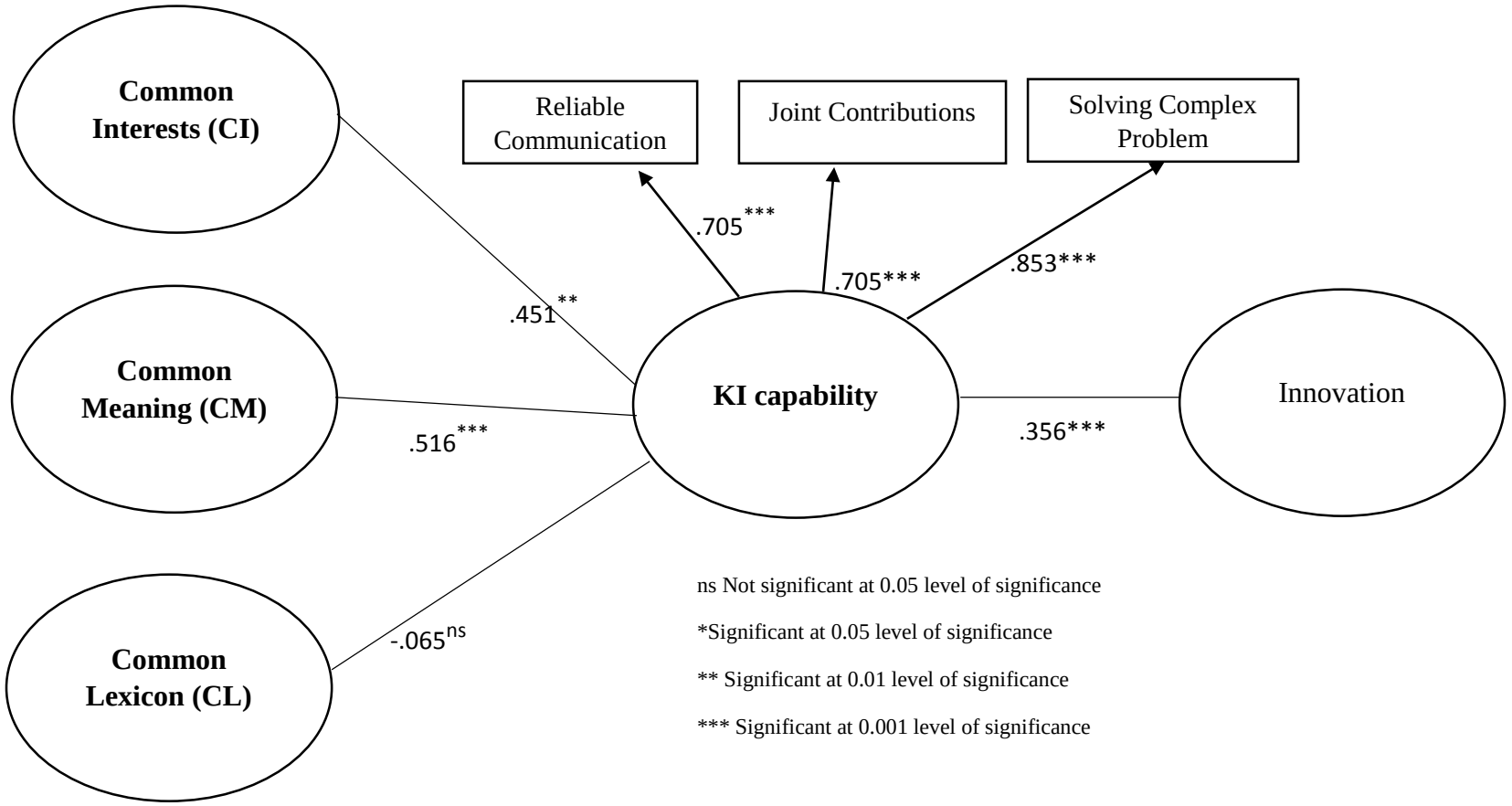
| Model | CFI | RMSEA | SRMR | $\chi^2$ | DF | $\Delta\chi^2$ | ΔDF | P-Value | $\chi^2$/DF |
|---|---|---|---|---|---|---|---|---|---|
| Second order model | 0.961 | 0.063 | 0.052 | 50.541 | 33 | | | | |
| First order model | 0.959 | 0.065 | 0.051 | 50.302 | 32 | 0.239 | 1 | 0.625 | 0.239 |
| Separate constructs | 0.616 | 0.192 | 0.283 | 208.07 | 35 | 157.529 | 2 | 0.000 | 78.765 |

*Note.* CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; DF = Degree of Freedom; $\Delta\chi2$ = chi-square difference

### Evaluation of Nomological Structure – Pilot Study

The fit indices of the measurement model ($\chi^2$ [*df*] = 623.337[392], $p$ = 0.001; CFI = 0.885; RMSEA = 0.066; SRMR = 0.069) were quite satisfactory. Moreover, the fit statistics for causal model ($\chi^2$ (df)=360.334(221)  CFI = .914; RMSEA = .069; SRMR = .076) were quite good, providing the support for the nomological structure of the research model (Kline, 2004). Figure 4.1 presents the results obtained from the test of hypotheses of the research model for the pilot study.

**Figure 4.1. Hypothesized Structural Model with Standardized Path Loading for the Pilot Study**




$\chi^2(df) = 360.334(221)$ CFI = .914; RMSEA = .069; SRMR = .078

Table 4.8 presents the regression coefficient and p-value for the effect of boundary-spanning objects on reliable communication, joint contribution, and solving complex problems. Hypotheses 1-3, which predicted that common lexicon was positively related to reliable communication, joint contributions, and solving complex problem. were not supported. There was a positive relationship between common meaning and 1) reliable communication, 2) joint contributions, and 3) solving complex problems, providing support to hypotheses 5-8. Hypotheses 9-11, which predicted that there was a positive relationship between common interests and 1) reliable communication, 2) joint contributions, and solving problem, were supported. Lastly, there was a positive relationship between KI capability and innovation, providing support to hypotheses 14.

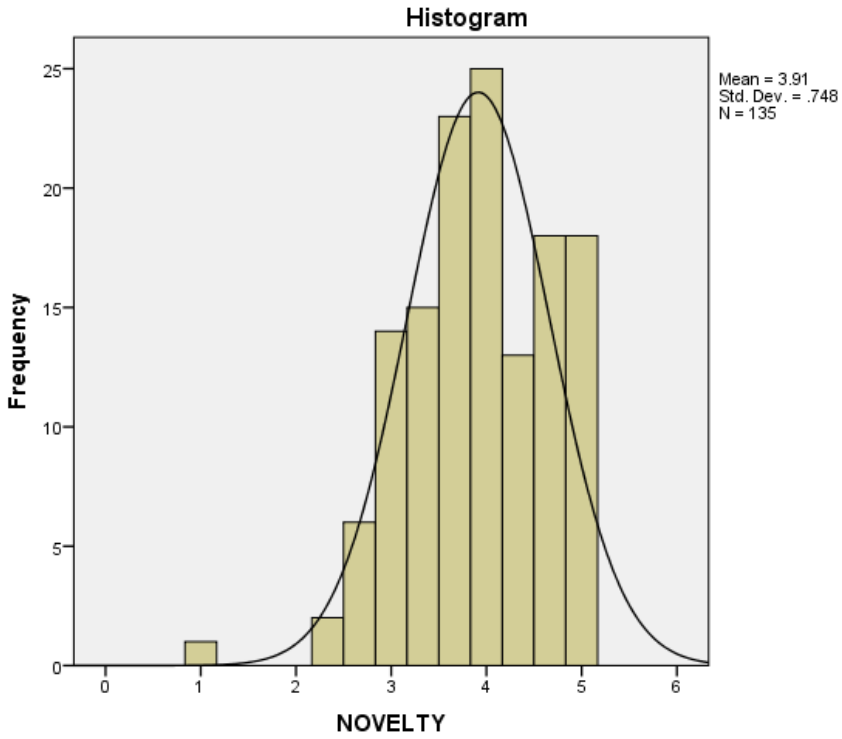
**Table 4.8. Direct Effect – Pilot Study**

| Hypotheses | Path | Regression Coefficient | p-value |
|---|---|---|---|
| 1 | CL → RC | -.087 | .341 |
| 2 | CL → JC | -.072 | .328 |
| 3 | CL → SCP | -.084 | .353 |
| 5 | CM → RC | .435 | .010 |
| 6 | CM → JC | .359 | .015 |
| 7 | CM → SCP | .421 | .012 |
| 9 | CI → RC | .418 | .035 |
| 10 | CI → JC | .345 | .019 |
| 11 | CI → SCP | .405 | .018 |
| 14 | KIC → Innovation | .356 | .000 |

*Note.* INNO = Innovation; CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; RC = Reliable Communication; JC = Joint Contributions; SCP = Solving Complex Problems.

Figure 4.2 presents the histogram representing the frequency distribution of the score of *novelty*, which was measured on a 5-point Likert scale. *Novelty* is a contextual variable in this study. The frequency distribution of novelty is skewed right with the mean of 3.910. It implies that most of the respondents were working in companies that are operating in a mid- to high-degree novelty. Therefore, this data set does not capture the variance in novelty to document its interaction effect.

**Figure 4.2. Distribution of Novelty Scores**




## Main Study

Data for the main study was collected from firms located in the North Texas region of the USA. Respondents were contacted for a face to face interview and they were requested to fill out the survey questionnaire at the time of the interview. The survey was administered to 164 firms. Eleven responses with missing values were deleted. Respondents were pre-screened to determine whether they had enough knowledge and involvement in the strategic decision-making process of their firm. Based on the screening question, one of the respondents was not involved in the strategic-decision making process of the firm. Therefore, this response was deleted. The final sample size was 152.

Before the results of the main study are presented, the results of descriptive statistics, multicollinearity analysis, common methods bias analysis, effects of control variables, reliability analysis, and constructs validity are presented. Descriptive statistics and correlations among variables are presented in Table 4.9. Most of the companies in the sample

belonged to food/beverages (n = 24), healthcare (n = 13), and automotive (n = 12; Table 4.10) industries.

**Table 4.9. Mean, Standard Deviation and Interrcorrelations of Variables – Main Study**
*Note.* SD = Standard Deviation

| Variables | Mean | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 1. Common Lexicon | 4.148 | .747 | --- | | | | |
| 2. Common Meaning | 4.444 | .627 | .430*** | --- | | | |
| 3. Common Interests | 4.234 | .691 | .542*** | .551*** | --- | | |
| 4. KI capability | 6.063 | .789 | .457*** | .664*** | .679*** | --- | |
| 5. Novelty | 3.599 | .909 | .132 | .399*** | .215* | .126 | --- |
| 6. Innovation | 4.074 | 1.065 | .237** | .241** | .353*** | .259** | .477*** |

**Table 4.10. Industry Composition – Main Study**

| Industry | Frequency | % | Cumulative % |
|---|---|---|---|
| 1. Automotive | 12 | 7.895 | 7.895 |
| 2. Aviation/Aerospace | 2 | 1.316 | 9.211 |
| 3. Educational Services | 4 | 2.632 | 11.842 |
| 4. Electronics | 3 | 1.974 | 13.816 |
| 5. Entertainment | 5 | 3.289 | 17.105 |
| 6. Healthcare/ Medical Devices | 13 | 8.553 | 25.658 |
| 7. Food/Beverages | 24 | 15.789 | 41.447 |
| 8. Transportation | 5 | 3.289 | 44.737 |
| 9. Metal Fabrication | 3 | 1.974 | 46.711 |
| 10. Technology | 4 | 2.632 | 49.342 |
| 11. Pharmaceuticals/Chemicals | 1 | .658 | 50.000 |
| 12. Others | 71 | 50.000 | 100.000 |

Most of the respondents belonged to companies employing less than 50 employees (n = 134). Some of the respondents were also working in companies of other sizes – 50-99 employees (n = 5), 100- 249 employees (n = 5), and 1000 or more (n = 6; Table 4.11). Similarly, most of the companies were either individual company (n = 107) or corporation (n= 27). 118 companies generated most of their sales revenue from the sales of services, whereas 34 companies generated most of their sales revenue from the sales of products. 60 companies were completely service based, whereas three companies were completely manufacturing companies. The average firm age was 13.05 years. Most companies had sales

revenue less than USD 5 million per year (Table 4.12). The demographics of respondents are presented Table 4.13.

**Table 4.11. Number of Employees – Main Study**

| Range | Frequency | % | Cumulative % |
|---|---|---|---|
| Less than 50 employees | 134 | 88.158 | 88.158 |
| 50-99 employees | 5 | 3.289 | 91.447 |
| 100-249 employees | 5 | 3.289 | 94.737 |
| 250-499 employees | 1 | .658 | 95.395 |
| 400-999 employees | 1 | .658 | 96.053 |
| 1000 or more employees | 6 | 3.947 | 100.000 |

**Table 4.12. Company Sales – Main Study**

| Range | Frequency | % | Cumulative % |
|---|---|---|---|
| Less than $5 million | 132 | 86.842 | 86.842 |
| $5 million to < $10 million | 6 | 3.947 | 90.789 |
| $10 million to < $20 million | 5 | 3.289 | 94.079 |
| $20 million to < $50 million | 0 | 3.289 | 97.368 |
| $50 million to < $100 million | 5 | 2.632 | 100.000 |
| $100 million or more | 4 | 86.842 | 86.842 |

**Table 4.13. Demographics of Respondents – Main Study**

| | |
|---|---|
| Job Title | Owner (n=132)<br>CEO (n=3)<br>General manager (n=5)<br>Senior Managing Director (n=1)<br>Project Managers (n=5)<br>Branch Managers (n=3)<br>Staff (n=3) |
| Average years of Experience with current firm | 9.527 years |
| Average overall Experience | 16.223 years |
| Manufacturing versus Service | Average revenue generated from sales of products = 24.669<br>Average revenue generated from sales of service = 80.241 |
| Average Firm's Age | 12.914 years |
| Research and Development (R&D) expenditure | On an average, 6.079% of sales revenue is contributed towards firm's R&D activities. |

### Test of Multicollinearity and Curve Estimation

To test if the relationship had a multicollinearity issue, variance inflated factor (VIF) and condition index were calculated. VIF values for all the relationship were below 10 (highest was 1.530), and the condition index for all the relationship was below 20 (highest 17.770), therefore, multicollinearity was not an issue (Hair et al., 1998). The curve estimation of all the relationship in the model was conducted and the results demonstrated that all the relationships were sufficiently linear to be tested using covariance-based SEM.

### Convergent and Discriminant Validity

The average variance extracted (AVE) values of all the constructs were above 0.50 providing support for convergent validity (Fornell & Larcker, 1981). The composite reliability of *innovation* was 0.905 and AVE is 0.659. Composite reliability of common lexicon was 0.808 and AVE was 0.514. The composite reliability and AVE of common meaning was 0.882 and 0.555 respectively. The composite reliability of common interests was 0.854 and AVE was 0.540. Lastly, composite reliability of KI capability was 0.772 and AVE was 0.532. The square root of the AVE for each construct was greater than its correlation with the other factors in the model (Fornell & Larcker, 1981; Table 4.14), indicating discriminant validity. Moreover, the Anderson and Gerbing's (1988) pairwise comparison of variables was used to test for discriminant validity. The chi-square difference between the constrained measurement model and unconstrained measurement model (freely estimated model) was satisfactory ($\Delta\chi 2$ [$\Delta$df] =72.395[8], $p \leq 0.001$), which also provided support for discriminant validity.

**Table 4.14. Validity and Reliability of the Constructs – Main Study**

| | CR | AVE | MSV | ASV | INNO | CM | CI | KIC | CL |
|---|---|---|---|---|---|---|---|---|---|
| **INNO** | 0.905 | 0.659 | 0.132 | 0.077 | 0.812 | | | | |
| **CM** | 0.882 | 0.555 | 0.493 | 0.293 | 0.215 | 0.745 | | | |
| **CI** | 0.854 | 0.540 | 0.510 | 0.324 | 0.364 | 0.578 | 0.735 | | |
| **KIC** | 0.772 | 0.532 | 0.510 | 0.336 | 0.261 | 0.702 | 0.714 | 0.729 | |
| **CL** | 0.808 | 0.514 | 0.321 | 0.238 | 0.249 | 0.545 | 0.567 | 0.521 | 0.717 |

*Note.* INNO = Innovation; CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; KIC = knowledge integration capability; CR = Composite Reliability; AVE = Average variance extracted; MSV = Maximum Shared Variance; ASV = Average Shared Squared Variance.

**Table 4.15. Pairwise Comparisons for Discriminant Validity (Δχ2) – Main Study**

| | KIC | CI | CM | CL | INNO | NOV |
|---|---|---|---|---|---|---|
| **KIC** | --- | | | | | |
| **CI** | 34.906*** | --- | | | | |
| **CM** | 37.028*** | 67.197*** | --- | | | |
| **CL** | 57.641*** | 47.600*** | 49.182*** | --- | | |
| **INNO** | 22.900*** | 22.125*** | 36.325*** | 28.510*** | --- | |
| **NOV** | 44.455*** | 48.255*** | 46.518*** | 56.777*** | 10.689*** | --- |

*Note.* INNO = Innovation; CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; KIC = knowledge integration capability; NOV = Novelty; Δχ2 = chi-square difference

Next, the confirmatory factor analysis (CFA) was conducted, using the measurement model where all the latent variables used in the study were freely correlated. The results demonstrated that all the items had statistically significant loadings on their respective factor (Table 4.16). The table presents the confirmatory factor loading of all the constructs. Also, it is evident from the result that the value of each item loading was above 0.649, indicating for convergent validity.

**Table 4.16. Factor Loading and Standardized Regression Weights – Main Study**

| Constructs | Items | Factor Loading |
|---|---|---|
| CL | CL_1 | .649*** |
| | CL_2 | .761*** |
| | CL_3 | .653*** |
| | CL_4 | .794*** |
| CM | CM_1 | .763*** |
| | CM_2 | .762*** |
| | CM_3 | .671*** |
| | CM_4 | .736*** |
| | CM_5 | .775*** |
| | CM_6 | .759*** |
| CI | CI_2 | .653*** |
| | CI_3 | .770*** |
| | CI_4 | .794*** |
| | CI_5 | .670*** |
| | CI_6 | .775*** |
| KIC | RC | .665*** |
| | JC | .701*** |
| | SCP | .813*** |
| INNO | INNO_2 | .725*** |
| | INNO_3 | .691*** |
| | INNO_4 | .815*** |
| | INNO_5 | .902*** |
| | INNO_6 | .901*** |

*Note.* CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; INNO = Innovation; RC = Reliable Communication; JC = Joint Contributions; SCP = Solving Complex Problem

### Factorial Validity

The current study uses two multi-dimensional constructs, which are boundary spanning objects and KI capability. Boundary spanning objects consist of three sub-dimensions, which are common lexicon, common meaning, and common interests. Similarly, KI capability has three sub-dimensions. These sub-dimensions are reliable communication, joint contributions, and solving complex problems. As mentioned before (Table 3.2), the three sub-dimensions of KI capability are complementary (Gardner et al. 2012). Therefore, the KI capability is conceptualized as a second order factor. The three sub-dimensions of boundary spanning objects can exist independently of each other. Therefore, the three sub-

dimensions of boundary spanning objects are conceptualized as a first order factors. The results of the analyses of the factor structure of the KI capability is presented in Table 4.17. The results demonstrate that second order factor, which was the hypothesized factor structure of KI capability, is the best fit for KI capability. Both CFI and RMSEA for the second order factor model is better than those of the first order model and separate construct factor.

**Table 4.17. Comparison of Higher Order Model and First Order Model for KI Capability – Main Study**

| Model | CFI | RMSEA | SRMR | $\chi^2$ | DF | $\Delta\chi^2$ | ΔDF | P-VALUE | $\chi^2$/DF |
|---|---|---|---|---|---|---|---|---|---|
| **Second Order Model** | **0.960** | **0.071** | **0.049** | **57.864** | **33** | | | | 1.753 |
| First Order Model | 0.958 | 0.073 | 0.049 | 57.843 | 32 | 134.532 | 3 | 0.000 | 2.054 |
| Separate constructs | 0.745 | 0.173 | 0.287 | 192.375 | 35 | 134.532 | 3 | 0.000 | 4.551 |

*Note.* CFI = Comparative fit index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; DF = Degree of Freedom; $\Delta\chi2$ = chi-square difference

Similarly, comparison of factor structure model for the boundary spanning objects was also conducted. As predicted, Table 4.18 demonstrates that the fit indices of the first-order factor model for the boundary spanning objects is better than that of the second-order factor model.

**Table 4.18. Comparison of Higher Order Model and First Order Model for Boundary Spanning Objects – Main Study**

| Model | CFI | RMSEA | SRMR | $\chi^2$ | DF | $\Delta\chi^2$ | ΔDF | P-VALUE | $\chi^2$/DF |
|---|---|---|---|---|---|---|---|---|---|
| Second Order Model | 0.924 | 0.081 | 0.066 | 143.185 | 87 | | | | 1.645 |
| **First Order Model** | **0.940** | **0.069** | **0.067** | **148.806** | **87** | **85.231** | **3** | **0.000** | **1.710** |
| Separate constructs | 0.859 | 0.103 | 0.241 | 234.037 | 90 | 85.231 | 3 | 0.000 | 2.600 |

*Note.* CFI = Comparative fit index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; DF = Degree of Freedom; $\Delta\chi2$ = chi-square difference

**Common Method Bias**

The presence of common methods bias was also evaluated in the current study. The fit indices of the hypothesized structural model with the marker variable ($\chi 2$ [df] = 383.192[244], p = 0.000; CFI = 0.924; RMSEA = 0.061; SRMR = 0.075) were not significantly different from the fit indices of the hypothesized model without the marker variable ($\Delta\chi^2$ [$\Delta df$] =33.33[22], $p$ = 0.057]; ΔCFI=0.003; ΔRMSEA=0.010; ΔSRMR=0.008). Therefore, we conclude that the common method bias was not a major concern in this study.

**Control Variables**

The effect of control variables was also assessed in the research model. The hypothesized research model with the controls was compared to the one without the controls. The fit indices of the model with the controls – industry type, company size (number of employees), research and development expenditure, and firm age –$\chi 2$ [df] = 438.316[316], p = 0.000; CFI = 0.933; RMSEA = 0.051; SRMR = 0.067, which were not significantly different from the model without the controls ($\Delta\chi^2$ [$\Delta df$] =88.454[93], $p$ = 0.614]; ΔCFI=0.003; ΔRMSEA=0.010; ΔSRMR=0.001). The results demonstrated that R&D expenditure ($\beta$ = 0.294, p = 0.000) and firm's size ($\beta$ = 0.159, p = 0.042) were significantly correlated with innovation, whereas path coefficients of the other two control variables, which are industry type ($\beta$ = - 0. 092, p = 0.224) and firm age ($\beta$ = - 0.128, p = 0.101) were statistically insignificant.

**Evaluation of Nomological Structure – Main Study**

The fit indices demonstrate that both the measurement model ($\chi 2$ [df] = 344.963[222], p = 0.000; CFI = 0.932; RMSEA = 0.061; SRMR = 0.065), and the proposed causal model ($\chi 2$ [df] = 438.047[316], p = 0.000; CFI = 0.933; RMSEA = 0.051; SRMR = 0.069) were quite satisfactory, providing support for nomological structure of the research model (Kline, 2004).

## Test of Hypotheses

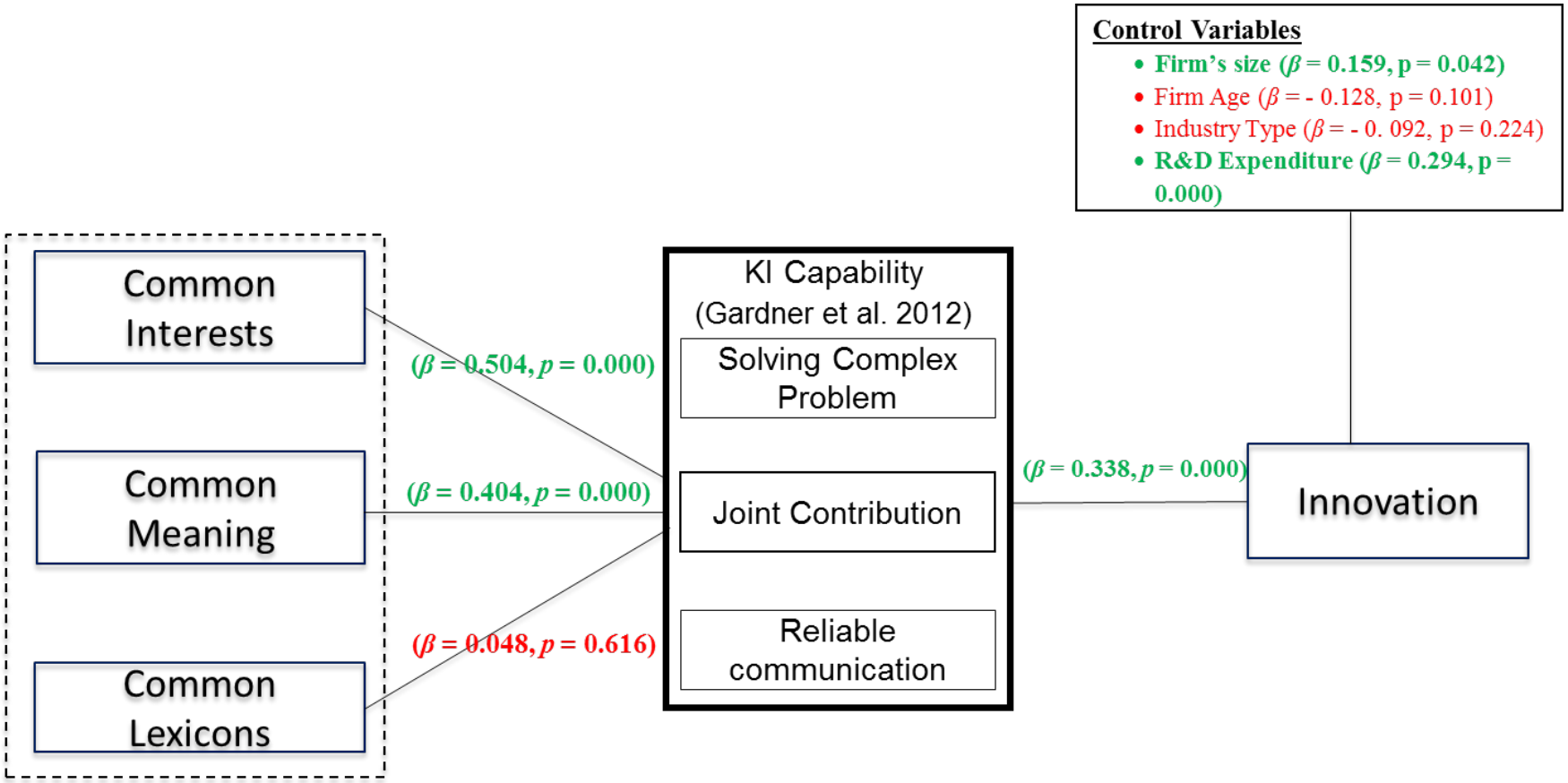
Structural equation modeling (SEM) was used to evaluate the research model. Hypotheses 1-3, which stated that there was a positive relationship between common lexicon and 1) reliable communication ($\beta$ = 0.034, p = 0.731), 2) joint contributions ($\beta$ = 0.033, p = 0.726), and 3) solving complex problems ($\beta$ = 0.038, p = 0.737) respectively were not supported. Hypotheses 5-7, which stated that there was a positive relationship between common meaning and 1) reliable communication ($\beta$ = 0.238, p = 0.013), 2) joint contributions ($\beta$ = 0.277, p = 0.011), and 3) solving complex problems ($\beta$ = 0.320, p = 0.014) were respectively supported. Similarly, hypotheses 9-11, which predicted that there was a positive relationship between common interests and 1) reliable communication ($\beta$ = 0.354, p = 0.006), 2) joint contributions ($\beta$ = 0.346, p = 0.008), and 3) solving complex problems ($\beta$ = 0.399, p = 0.009) respectively were supported. Hypothesis 14, which predicted that the KI capability (KIC) is positively related to organizational innovation, was supported ($\beta$ = 0.338, p = 0.000). In addition, bootstrapping technique was used to test the indirect effect of 1) CL → KIC → INNO, 2) CM → KI capability → INNO, and 3) CI → KIC → INNO. The indirect path of CL → KIC → INNO ($\beta$ = 0.023, $p$ = 0.673) was not statistically significant. On the other hand, the indirect path of CM → KIC → INNO ($\beta$ = 0.220, $p$ = 0.007) and CI → KIC → INNO ($\beta$ = 0.286, $p$ = 0. 004; Table 4.19) were statistically significant. Figure 4.3 presents the research model that was tested in the study.

**Table 4.19. Bootstrapping Test of Indirect Effects**

| | INNO |
|---|---|
| CL | 0.023 (0.673) |
| CM | 0.220 (0.007) |
| CI | 0.286 (0.004) |

*Note.* CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; results are presented in the format β(p-value).

**Figure 4.3. Direct Effects Model**




**χ2 [df] = 438.316[316], p = 0.000; CFI = 0.933; RMSEA = 0.051; SRMR = 0.0686**

### Relative Importance of Boundary Spanning Objects Dimensions for Reliable Communication, Joint Contribusions and Solving Complex Problems

The relative importance analysis (Lorenzo-Seva, Ferrando, & Chico, 2010) of each of the boundaries spanning objects on three dimensions of KI capability was used to examine the hypotheses H4 , H8 , and H12 . When multiple predictors variables are used to explain the variance in a criterion variable, identifying the relative importance of each predictor variable in determining a criterion variable is important (Tonidandel & LeBreton, 2011). In a social science research, most of the predictor variables are correlated. In the context of this study, common lexicon, common meaning, and common interests are also correlated, as is indicated by the descriptive statistics for the pilot study and the main study in Table 4.4 and Table 4.9 respectively. As a result, predictor variables may explain the same variance in a criterion variable. Therefore, when predictors variables are correlated, relative weight technique is useful in determining a relative importance of each predictor variable in determining the total effect size ($R^2$; Johnson, 2000; 2004). The range of relative weight is from 0 to 1.0.

Results of the relative importance of boundary spanning object dimensions for reliable communication, joint contributions, and solving complex problems are provided in the Table 4.20. Hypothesis 4 predicted that common lexicon has more importance on reliable communication than common meaning and common interests. This hypothesis was not supported as the relative contribution of common meaning was more on reliable communication was (w = 60.60%) than on common lexicon (w = 8.0% ), and common interests (w = 31.4%; Figure 4.4). The relative contribution of common meaning on joint contributions (w = 43.06%) is greater than that of common lexicon ( w = 18.1%) and common interests (w = 38.3%) on joint contributions. The results lend support to the hypothesis 8, that common meaning has more importance on joint contributions than

common lexicon and common interests . The relative weight analysis does not provide support to the hypothesis 12, which was common interests (w=33.6%) have a greater importance on solving complex problems than common lexicon (w = 9.8%) and common meaning (56.6%).

### 4.20. Relative Importance of Boundary Spanning Objects Dimensions for Reliable Communication, Joint Contribusions and Solving Complex Problems

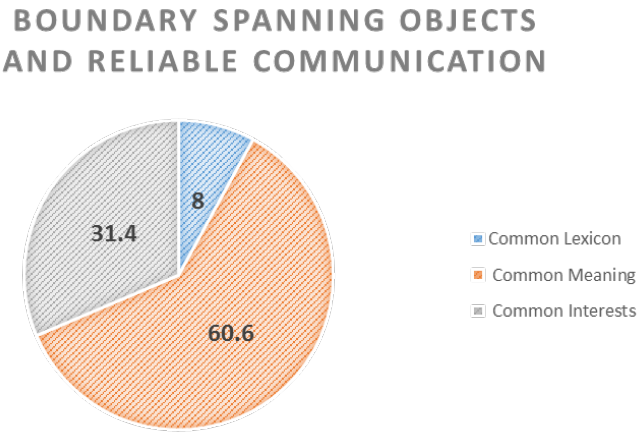
| | RC[1] | JC | SCP |
|---|---|---|---|
| **CL** | 8.0 | 18.1 | 9.8 |
| **CM** | 60.6 | 43.6 | 56.6 |
| **CI** | 31.4 | 38.3 | 33.6 |

*Note.* CL = Common Lexicon, CM = Common Meaning; CI = Common Interests; RC = Reliable Communications; JC = Joint Contributions; SCP = Solving Complex Problems.

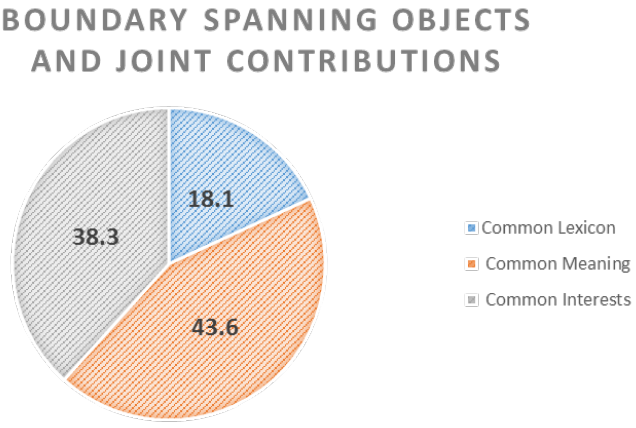
[1]Point-Estimate of Relative contribution to Multiple R (reported as percentages)

**Figure 4.4. Contributions (%) of Boundary Spanning Objects Determining Reliable Communication, Joint Contributions, and Solving Complex Problems**

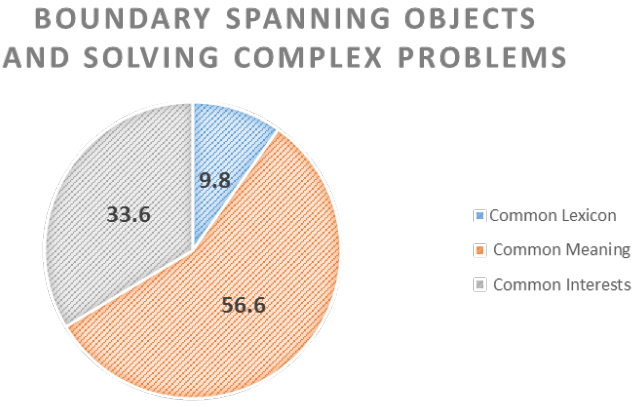
*Percentage Contribution of common lexicon (CL), common meaning (CM) and common interests (CI) on Reliable Communications*




*Percentage Contribution of CI, CM and CI on Joint Contributions*




*Percentage Contribution of CI, CM and CI on Solving Complex Problems*




*Note.* CL = Common Lexicon; CM = Common Meaning; CI = Common Interests

**Test of Multi-group Hypotheses**

The test of multi-group hypotheses was conducted using two methods: 1) hierarchical linear regression, and 2) relative weight of each boundary spanning objects determining KI capability at the different level of novelty. Because of the limited sample size, the use of SEM was not possible to test the relationship at the low (n = 10), medium (n = 81), and high level (n = 61) of novelty. Therefore, hierarchical linear regression using multi-group analysis was used to test the relationship at the medium and high level of novelty.

The mean of the novelty score was 3.60. The composite novelty score that was less than 2.00 was categorized as a low level of novelty (n = 10); composite novelty score that was between 2.00 and 4.00 was categorized as medium level of novelty (n = 81); the composite score for novelty that was more than or equals to 4.00 was categorized as high level of novelty (n = 61).

The multi-group hypothesis using hierarchical linear regression at the low level of novelty could not be tested because of small sample size (n = 10). To test the hypothesis 13a, the importance of common lexicon on KI capability at the medium and high level of novelty was examined. The relationship between common lexicon and KI capability was not statistically significant at medium ($\beta$ = 0.098, p = .317) or high level ($\beta$ = 0.018, p = .841) of novelty. Therefore, hypothesis 13a could not be statistically evaluated even though the $\beta_{medium}$ level was about nine times the $\beta_{high}$. The importance of common meaning on KI capability at the high level of novelty ($\beta$ = 0.508 p=.000) was greater than the strength of the relationship at the medium level of novelty ($\beta$ =0.460, p = .000). The results provided support for hypothesis 13b. The importance of common interests on KI capability on the high level of novelty was ($\beta$ = 0.385, p =.001), which was greater than that on the medium level of novelty ($\beta$ = 0.206, p =.004). Therefore, the hypothesis 13c was also supported.

### Relative Importance of the Individual Boundary Spanning Objects Dimensions in Predicting KI capability at the Different Level of Novelty

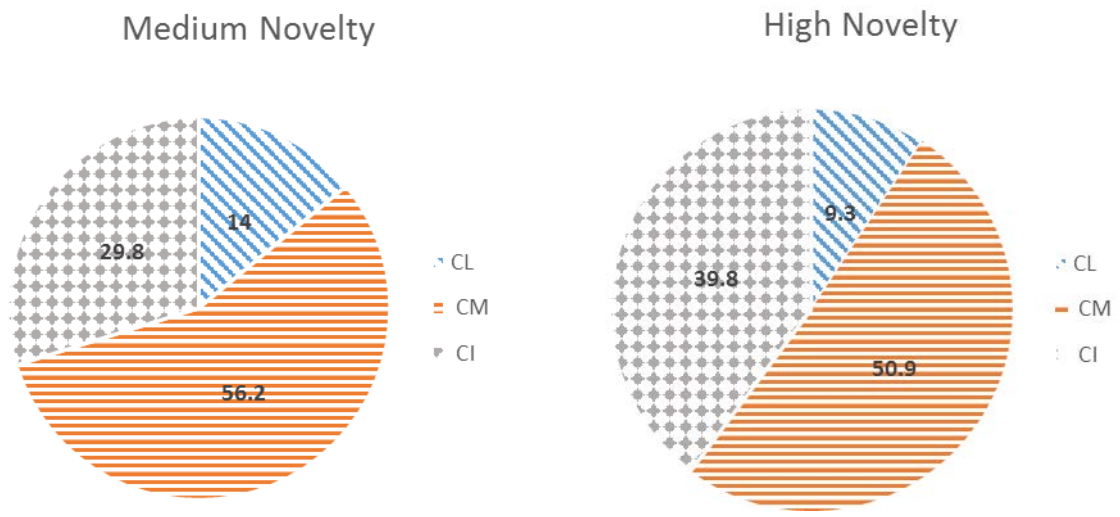
Additional analysis was conducted to test the relationship at medium and high levels of novelty. The relative importance of the individual boundary spanning objects determining KI capability at the medium and high level of novelty was examined (Table 4.21 and Figure 4.5). The relative importance of boundary spanning objects at a low level of novelty could not be identified because of small sample size. The results indicated that the relative importance of common lexicon in determining KI capability was low at a medium level of novelty (w = 14.0%), which further decreased (w = 9.3%) when novelty was at high. The relative importance of common meaning at a medium level of novelty was 56.2 percent, which decreased to 50.9 percent when novelty was at high level. Finally, the relative importance of common interests increased 10 percentage points from 29.8 percent at a medium level of novelty to 39.8 percent at a high level of novelty. The results concur with the hypotheses 13, which states that as the novelty increases the importance of higher level boundary spanning objects become more important. The overall results are presented in Table 4.22.

**Table 4.21. Relative Importance of Boundary Spanning Objects for KI capability**

| | **Knowledge Integration capability**[1] | |
|---|---|---|
| | Medium Novelty | High Novelty |
| CL | 14.0 | 9.3 |
| CM | 56.2 | 50.9 |
| CI | 29.8 | 39.8 |

*Note.* CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; [1]Point-Estimate of Relative contribution to Multiple R (reported as percentages)

**Figure 4.5. Contributions (%) of Boundary Spanning Objects Determining KI capability**




*Note.* CL = Common Lexicon; CM = Common Meaning; CI = Common Interests

**Table 4.22. Results of Hypotheses Testing**

| Hypotheses | Path Coefficients | p-value | Supported/Not Supported |
|---|---|---|---|
| H1: Common lexicon is positively related to reliable communication. | .034 | .737 | Not Supported |
| H2: Common lexicon is positively related to joint contributions. | .033 | .726 | Not Supported |
| H3: Common lexicon is positively related to solving complex problem. | .038 | .737 | Not Supported |
| H4: Common lexicon has more importance on reliable communication than common meaning and common interests. | CL$w_{rc}$ = 8.0%<br>CL$w_{jc}$ = 60.6%<br>CL$w_{scp}$ = 31.4% | | Not Supported |
| H5: Common meaning is positively related to reliable communications. | .283 | .013 | Supported |
| H6: Common meaning is positively related to joint contribution. | .277 | .011 | Supported |
| H7: Common meaning is positively related to solving complex problem. | .320 | .014 | Supported |
| H8: Common meaning has more importance on joint contribution than common lexicon and common interests. | CL$w_{jc}$ = 18.1%<br>CM$w_{jc}$ = 43.6%<br>CI$w_{jp}$ = 38.3% | | Supported |
| H9: Common interests are positively related to reliable communications. | .354 | .006 | Supported |
| H10: Common interests are positively related to joint contributions. | .346 | .008 | Supported |
| H11: Common interests are positively related to solving complex problem. | .399 | .009 | Supported |
| H12: Common interests have more importance on solving complex problems than common lexicon and common meaning. | CL$w_{scp}$ = 9.8%<br>CM$w_{scp}$ = 56.6%<br>CI$w_{scp}$ = 33.6% | | Not Supported |
| H13: The importance of high level boundary objects on KI capability increases with the novelty. | | | Supported |
| H13a: The importance of common lexicon on KI capability decreases with the level of novelty. | $w_{mediumnov}$ = 14%<br>$w_{highnov}$ = 9% | .317<br>.841 | Partially supported |
| H13b: The importance of common meaning on KI capability increases with the level of novelty. | $w_{mediumnov}$ = 50.9%<br>$w_{highnov}$ = 56.2% | .000<br>.000 | Supported |
| H13c: The importance of common interests on KI capability increases with the level of novelty. | $w_{mediumnov}$ = 29.8%<br>$w_{highnov}$ = 39.8% | .063<br>.001 | Not Supported |
| H14: KI capability is positively related to organizational innovations. | .338 | .000 | Supported |

*Note*. CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; $w_{rc}$ = percentage of contribution made to reliable communication; $w_{jc}$ = percentage of contribution made to joint contributions; $w_{scp}$ percentage of contribution made to solving complex problems

## Generalizability of Results

Table 4.23 – 4.25 present the comparison of the results of the main study and the pilot study. Table 4.23 presents the comparision of the path coefficient of the relationship between boundary spanning objects and KI capability. Table 4.24. presents the comparison of path coefficient between KI capability and Innovation. Finally, Table 4.25. presents the results of multi-group hypotheses that examines the relationship between boundary spanning objects and KI capability when novelty is high, medium, and low. Comparison of the results of the pilot study and the main study suggest that the results are similar across these studies, suggesting that the results are generalizable to various settings. For instance, the data for the main study was collected primarily from the entrepreneurship context. Out of 152 data, a total of 132 respondents were owners; most of the companies were small companies, employing less than 50 employees (n = 134). Most of the respondents for the pilot study were supervisors (n = 39), senior managers (n = 27), and branch managers (n = 21). Moreover, the firms in the pilot study were much more diverse in terms of their demographics (Table 4.1).

**Table 4.23. Comparison of Path Coefficients between Boundary Spanning Objects and KI capability**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | **Predictors** | **B** | **Std. Error** | **Beta** | | |
| **Main Study** *n = 152* | (Constant) | 1.789 | .368 | | 4.858 | .000 |
| | CL | .048 | .071 | .045 | .671 | .503 |
| | CM | .483 | .088 | .384 | 5.466 | .000 |
| | CI | .456 | .081 | .399 | 5.636 | .000 |
| **Pilot Study** *n = 135* | (Constant) | 1.095 | .498 | | 2.201 | .030 |
| | CL | .056 | .130 | .032 | .433 | .666 |
| | CM | .726 | .133 | .487 | 5.466 | .000 |
| | CI | .441 | .128 | .277 | 3.444 | .001 |

*Note.* Dependent Variable: KI capability; CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; KIC = Knowledge Integration Capability

**Table 4.24. Comparison of Coefficient Paths between KI capability and Innovation**

| | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | **Predictors** | **B** | **Std. Error** | **Beta** | | |
| **Main Study** | (Constant) | 2.342 | .659 | | 3.555 | .001 |
| n = 152 | KIC | .286 | .108 | .211 | 2.650 | .009 |
| **Pilot Study** | (Constant) | 3.335 | .607 | | 5.495 | .000 |
| n = 135 | KIC | .300 | .100 | .252 | 3.005 | .003 |

Dependent Variable: Innovation
*Note.* CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; KIC = Knowledge Integration Capability

**Table 4.25. Comparison of Multi-group Hypotheses**

| **Levels of Novelty (Low, Medium, and High)** | **Predictors** | **Main Study (n = 152)** | | | **Pilot Study (n = 135)** | | |
|---|---|---|---|---|---|---|---|
| | | **Std. Beta Coefficients** | **t** | **Sig.** | **Std. Beta Coefficients** | **t** | **Sig.** |
| **Low** *n* for main study = 10 *n* for pilot study = 1 | (Constant) | | .284 | .786 | | | |
| | CL | .483 | 2.216 | .069 | | | |
| | CM | -.119 | -.544 | .606 | | | |
| | CI | .781 | 5.806 | .001 | | | |
| **Medium** *n* for main study = 81 *n* for pilot study = 60 | (Constant) | | 3.280 | .002 | | .580 | .564 |
| | CL | .098 | 1.007 | .317 | .055 | .520 | .605 |
| | CM | .460 | 4.283 | .000 | .546 | 3.823 | .000 |
| | CI | .206 | 1.884 | .063 | .232 | 1.776 | .081 |
| **High** *n* for main study = 61 *n* for pilot study = 74 | (Constant) | | 1.346 | .183 | | 2.007 | .049 |
| | CL | .018 | .202 | .841 | .017 | .162 | .872 |
| | CM | .508 | 5.202 | .000 | .441 | 3.676 | .000 |
| | CI | .385 | 3.625 | .001 | .296 | 2.651 | .010 |

Dependent Variable: KI Capability
*Note.* CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; KIC = Knowledge Integration Capability

## Post hoc Analyses

Two-step cluster analysis was performed to identify the number of clusters of boundary spanning objects (BSO). The 2-step cluster analysis revealed the existence of the three clusters. Cluster 1 (n = 21) was characterized by a medium level of common lexicon, common meaning, and common interest. Therefore, this cluster was named as *equal*

*emphasis medium companies.* Cluster 2 (n = 63) was characterized by the medium level of common lexicon, common meaning, and common interests but the common meaning was dominant predictor of Cluster 2. Therefore, the cluster 2 was named as *common meaning dominant companies*. Cluster 3 (n = 68) was characterized by high level of common lexicon, common meaning, and common interests. Therefore, this cluster was named as *equal emphasis high companies.* Table 4.26 provides the cluster distribution, and Table 4.27 provides the mean and the standard deviation of three clusters.

**Table: 4.26. Cluster Distribution**

| Clusters | N | % of Combined |
|---|---|---|
| Equal emphasis medium | 21 | 13.816 |
| Common meaning dominant | 63 | 41.447 |
| Equal emphasis high | 68 | 44.737 |
| Combined | 152 | 100.0% |

**Table 4.27. Results of the 2-step cluster procedure performed with common lexicon (CL), common meaning (CM), and common interests (CI) as variables**

| Clusters | CL | | CM | | CI | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Equal emphasis medium | 3.167 | .700 | 3.310 | .727 | 3.248 | .626 |
| Common meaning dominant | 3.853 | .569 | 4.458 | .377 | 4.041 | .559 |
| Equal emphasis high | 4.724 | .303 | 4.782 | .277 | 4.718 | .304 |
| Combined | 4.148 | .7472 | 4.444 | .627 | 4.234 | .691 |

*Note.* CL = Common Lexicon; CM = Common Meaning; CI = Common Interests; SD = Standard Deviations

Figures 4.6-4.8 demonstrate that the companies that emphasize highly on the development of all the three subdimensions of boundary spanning objects (aka *equal emphasis high companies;* n = 68) are better able to develop all the three dimensions of KI capability. The mean of reliable communication ($\mu_{RC}$= 6.47), joint contributions ($\mu_{JC}$ = 6.51), and solving complex problems ($\mu_{SCP}$ = 6.58) for companies belonging to *equal emphasis high companies* are respectively more than that of reliable communication ($\mu_{RC}$ = 4.94), joint contributions ($\mu_{JC}$ = 5.23), and solving complex problems ($\mu_{SCP}$ = 5.06) for companies

belonging to *equal emphasis medium companies*. The mean scores of three dimensions of boundary spanning objects indicate that companies that emphasize moderately on the development of the boundary spanning objects (n = 21) are less reliable in terms of developing KI capability. Figure 4.9 presents the relationship KI capability and innovation for each of the three clusters of companies. The results demonstrate that equal emphasis high companies are clustered together, which implies that they are more reliable in terms of innovativeness. Common meaning dominant companies are comparatively more dispersed than equal emphasis high companies. It means that common meaning dominant companies are less reliable in terms of innovativeness. Lastly, equal emphasis medium companies are least reliable in terms of innovativeness.

**Figure 4.6. Boundary Spanning Objects and Reliable Communication - Cluster Analysis**

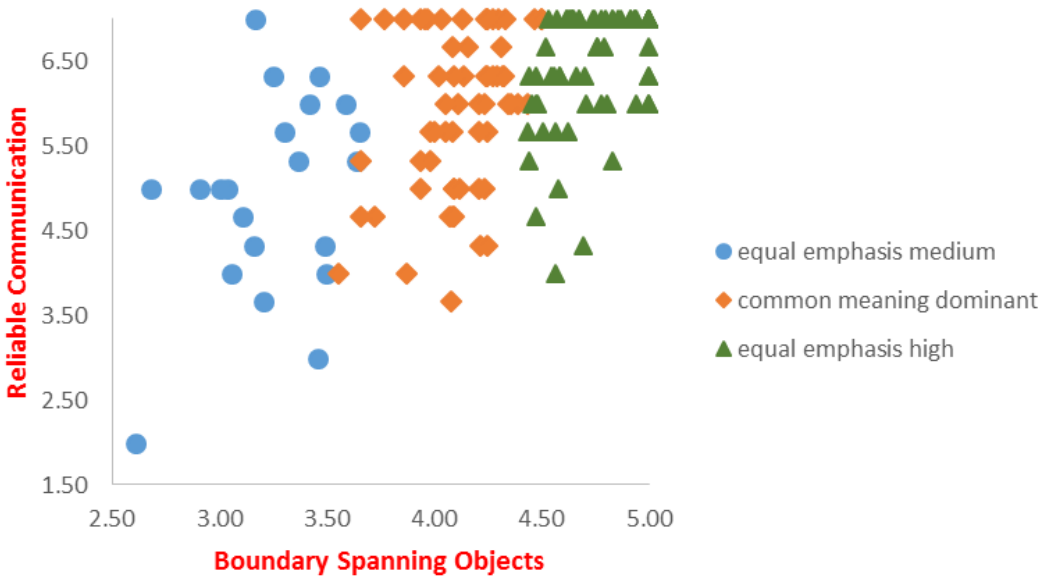


**Figure 4.7. Boundary Spanning Objects and Joint Contributions - Cluster Analysis**


**Figure 4.8. Boundary Spanning Objects and Solving Complex Problems - Cluster Analysis**

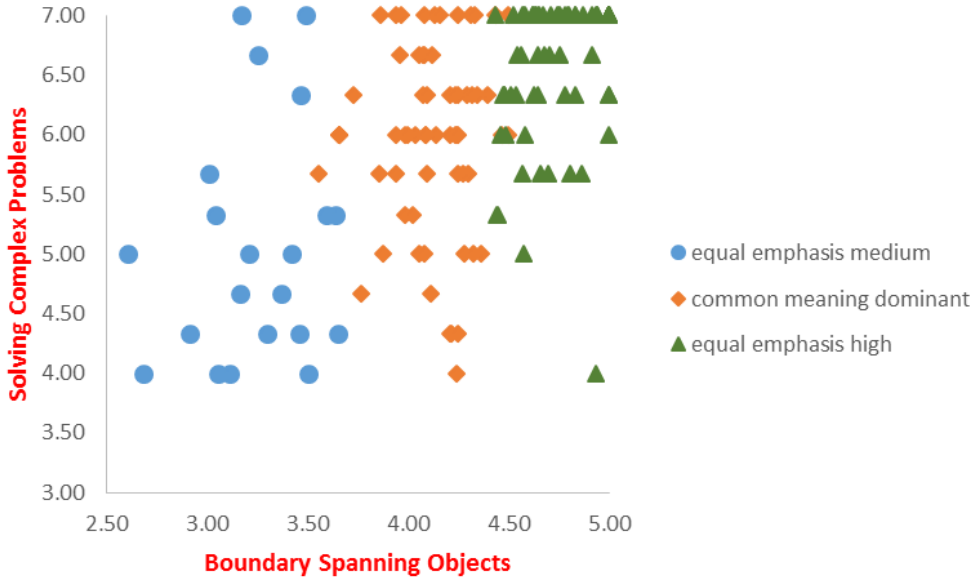
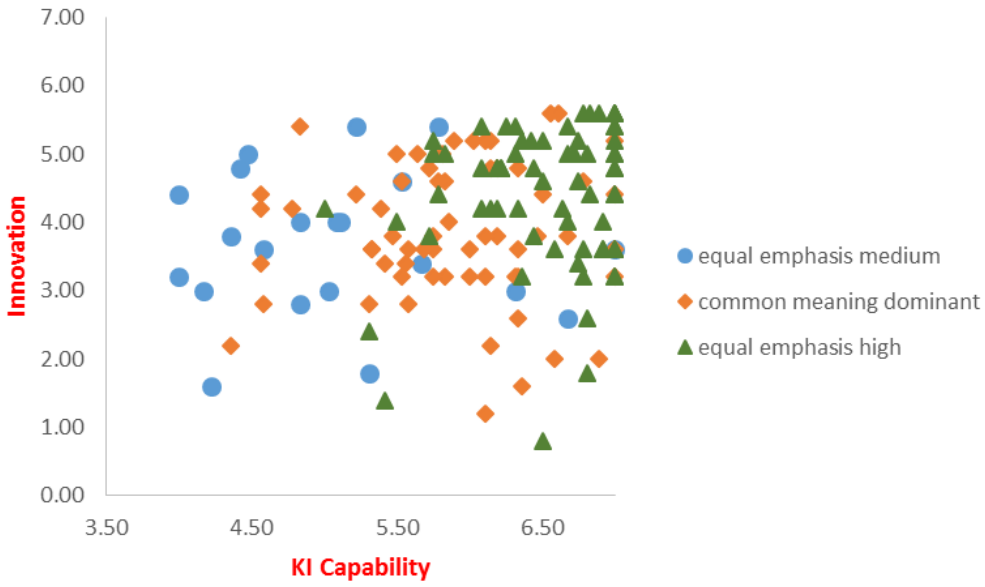


**Figure 4.9. KI Capability and Innovation – Cluster Analysis**



# CHAPTER 5

# DISCUSSION AND CONCLUSION

The importance of knowledge integration in organizational innovation has been gaining traction over the past two decades. After Grant (1996a) theorized that knowledge integration is required for the production of goods and services, many studies have found evidence that knowledge is an important source of organizational innovation. Realizing that the functional distinctiveness and complementary knowledge of organizational members give rise to knowledge boundaries presenting difficulties in knowledge integration, Carlile (2002; 2004), Franco (2013), and Nicolini et al. (2009) conducted case studies to identify the sources of knowledge integration. The underlying theme of their studies was that the knowledge boundary spanning objects – common lexicon, common meaning, and common interests – act as integrating devices for knowledge integration. These case studies were relevant because they introduced newer topic areas in the field of knowledge management (Eisenhardt, 1989). But more than a decade after the introduction of the boundary spanning objects, the knowledge management literature still fails to operationalize these boundary spanning objects. Moreover, despite the presence of prior studies that have emphasized the importance of knowledge integration of various knowledge sources (e.g., Berry, 2014; Tiwana, 2007; Zhou & Li, 2012) for innovations, examinations of sources of the KI capability of employees remain limited (Edmondson & Nembhard, 2009). Motivated by the results of the case studies and recognizing the need for the scale development to measure boundary spanning objects, this study was conducted.

Grounding this research in the relational view approach (Dyer & Singh, 1998), the importance of relational resources for enhancing the KI capability and organizational innovation was examined. Results provided support for most of the hypotheses. The results indicated that the boundary spanning objects play an important role in developing the KI

capability of employees and revealed that the strength of such relationships is different at the medium and high level of novelty. The results also indicated that the KI capability is important to organizational innovation.

Contrary to the hypothesis 1b, the results did not provide the evidence of a positive relationship between common lexicon and KI capability. One of the reasons for this unexpected finding may be explained by the mean of the composite score of the variable *novelty*, which was 3.60 in the five-point Likert scale. The mean score indicated that the respondents were working in an organization that was already facing the medium to high degree of novelty. In such situations, the effectiveness of common lexicon in knowledge integration declines (Carlile, 2004).

Moreover, the coefficient path of common interests in the KI capability suggests that the relationship between common interests and KI capability is stronger when novelty is high, supporting the hypothesis 13c. Not only the strength of the relationship increased, but also the relationship became statistically significant at the high level of novelty. The relationship between common interests and KI capability is statistically insignificant at the medium level of novelty. Carlile (2004) theorized when the novelty is higher at a pragmatic knowledge boundary, there are differences in interests in relational actors. As a result, when organizations face a the higher level of novelty, the development of common interests become more effective for knowledge integration. Carlile (2004) presented that the presence of novelty gives rise to differences in interests, which, in turn, results in the need for the development of common interests between relational actors. In addition to this result that concurs with the Carlile's theory, it is important to note that common interests are not so important when novelty is at the medium level.

## Theoretical Implications

The first contribution of this study arises out of the use of relational view approach to examine the importance of boundary spanning objects as relational resources for developing the knowledge integration capability. The relational resources act as a thread that integrates knowledge, most likely complementary knowledge, of employees. The use of relational view approach as a theoretical framework allows us to address the pressing issues related to knowledge management: Do the boundary spanning objects (relational resources) used by relational partners fosters the knowledge integration capability of employees? Do the knowledge integration capability fosters innovation? Does the novelty of one's knowledge make knowledge integration an arduous task?

Second, new scales were developed to measure common lexicon, common meaning, and common interests. Several steps were taken to ensure that the newly developed scales are both valid and reliable. As such, steps were taken to improve the composite reliability, face validity, content validity, discriminant validity and convergent validity of *common lexicon, common meaning,* and *common interests*. Data analysis was conducted in a series of studies. A pre-test, a pilot study, and a full study were conducted to test the hypotheses. The series of studies helped to refine the scales used to operationalize the constructs. Carlile (2004), whose study was followed by other case studies (e.g., Franco, 2013; Nicolini et al., 2012), highlighted the importance of the boundary spanning objects for knowledge integration. The analysis of cross-sectional data further validated the importance of the boundary spanning objects in attaining the knowledge integration capability of employees. Because the respondents were working in companies of various sizes (specifically pilot study) belonging to various industries, the results obtained from this study are relatively more generalizable.

Third, the study contributes to innovation literature by identifying types of knowledge required to address challenges related to innovation. The finding from this study concurs

with Carlile's (2002; 2004) argument that boundary spanning objects are important to developing KI capability. Although researchers have found the positive effect of cross-regional knowledge integration (Singh, 2008), a team's knowledge integration (Gebert et al., 2010), and alliance's knowledge integration (Tiwana, 2008) in innovation, this study adds to the innovation literature by presenting the importance of employees' knowledge integration for innovation.

Fourth, the results obtained from the current study contributes to the representational gap theory (Cronin & Weingart, 2007). Representational gap relates to the lack of shared understanding regarding the goals, assumptions of problems, elements of a problem to be solved, and rules to follow to solve a problem. Cronin and Weingart (2007) maintained that the inconsistencies in the definition of a problem by organizational members limit their ability to process information and integrate their knowledge. Although this study does not examine consequences of representational gaps, it examines whether or not shared understanding is important to bridging the representational gap. One of the underlying questions that Cronin and Weingart call for future researchers to address is what impact does employees' motivation have on their willingness to develop shared understanding and bridge their representational gaps. The results of the current study indicate that the ability of employees to innovate through collaboration and by developing shared understanding is one of the motivational factors that relational partners have to bridge their representational gap.

Fifth, the results of the study also contribute to the resource management theory. Resource management theory is an extension of resource-based view theory. The critics of resource-based view argue that the characteristics of resources, which are valuable, rare, inimitable, and nonsubstitutable, are not enough for an organization to gain competitive advantage. The critics maintain that it is not only about which resources an organization possesses, but also what an organization does with those resources (Hansen, Perry, & Reese,

2004). Sirmon, Hitt, and Ireland (2007) present the framework of resource management. In their framework, Sirmon et al. (2007) present that managers are key actors who manage resources by *structuring* (acquiring, accumulating, and divesting) the portfolio of resources, *bundling* (or integrating) those resources to develop capability, and *leveraging* capabilities to create value (Sirmon, Hitt, Ireland & Gilbert, 2011). The findings of the study indicate that the presence of relational resources of knowledge partners help to bundle the resources and capabilities in the form of the knowledge integration capability of employees. Employees can leverage their KI capability, which may add value to their organizations. The resultant organizational value is examined by a firm's ability to innovate.

## Managerial Implications

Nonaka (1991) presented the concept of a knowledge-creating company. According to this concept, companies survive if they are able to embrace the opposite end of knowledge continuums – tacit and explicit knowledge, existing (obsolete) and new knowledge, transferring and integrating knowledge, and an individual and common knowledge. In order to innovate, individuals not only think in a dialectical manner, but also embrace, cultivate, and use the opposites to find novel solutions to newer problems (Takeuchi and Nonaka, 2004).

The findings from the current study suggest that there is a need for managers to think in a similar manner. While the common lexicon (explicit knowledge or information) may be enough for knowledge sharing when novelty is low, common meaning (seemingly tacit knowledge) and common interests take precedence when a firm faces a higher level of novelty. Similarly, while developing a common meaning requires employees to develop shared understanding of what is already known or what is newly known, common interests require employees to develop a consensus regarding what new knowledge is relevant and important to learn. The findings provided evidence that when employees were willing to

learn new knowledge, forego self-interest, and develop a consensus regarding how a problem has to be solved, the knowledge integration facilitates innovation.

If novelty is unavoidable, as suggested by the analysis (mean of novelty score on a 5-point Likert scale was 3.60), albite based on limited sample size, it is important to managers to invest time and resources to develop boundary spanning objects. The use of common information and the development of shared understanding are even more important to managers who are assigned a task of managing individuals from different functional departments. The functional distinctiveness may create a barrier to communication between employees to effectively integrate their knowledge. To complicate the situation, the complementary knowledge coupled with novelty makes it even more difficult to develop the collaborative workforce. Therefore, the managers must also develop mechanisms to gauge the amount of novelty of an environment, as it will allow them to understand which boundary spanning objects is more relevant in a given time and situation.

## Limitations and Future Research Directions

The current study has several limitations. First, the study suffers from the lack of substantial data in attaining enough power to conduct the analyses at the different level of novelty. The sample size of the low level of novelty was 10. To overcome the challenges to data collection, it is recommended that researchers collect the data using stratified random sampling, where the pool of companies operating in industries that face a low degree of novelty would be created and the sample would be drawn randomly from that pool. This technique will ensure that there are enough samples to examine the relationship between common lexicon and knowledge integration capability of employees at the low level of novelty.

The study would also benefit if the information about employees existing knowledge domains is obtained. Such information would help us to understand the presence of

complementary knowledge of employees. In essence, we would know whether the boundary objects are equally effective when there is a presence of differences in employees' knowledge domains. Future researchers can identify the number of functional departments within an organization to track the presence of functional distinctiveness, which may be used as a proxy for differences in knowledge domains of employees.

## Conclusions

Realizing the importance of developing the knowledge integration capability of employees for organizational innovation, the sources of the knowledge integration capabilities were examined. The integration of knowledge of employees gets complicated when employees possess different knowledge bases and when their knowledge is relatively new. The differences and newness of knowledge create three types of knowledge boundaries, which are a syntactic knowledge boundary, a semantic knowledge boundary, and a pragmatic knowledge boundary. At each knowledge boundary, employees face difficulties sharing and assessing their knowledge with each other. As a result, they use boundary spanning objects (common lexicon, common meaning, and common interests) to integrate their knowledge at the knowledge boundaries. The results demonstrate that the use of boundary spanning objects help to overcome the boundary of knowledge and develop knowledge integration capability of employees. Knowledge integration capability of employees also helps to develop organizational innovation. The findings from the current study contribute to knowledge management literature.

# APPENDIX

# SURVEY SCALES AND ITEMS

| Constructs and Items |
| --- |
| **Common Lexicon** |
| A) We use common designs for communicating information related to completing a task |
| B) Use of standard specifications enables us to share information for completing a task |
| C) We use common tools such as sketches/prints for sharing information related to completing a task |
| D) We use similar tools for communicating information for completing a task |
| **Common Meaning** |
| A) We have a common understanding of expected results from completing a task |
| B) We have a common understanding of time required to complete a task |
| C) Our interpretation of organizational rules is similar |
| D) We have a common understanding of roles and responsibilities of organizational members |
| E) We have a common understanding about outcomes of completing a task |
| F) We have a shared understanding of processes required to complete a task |
| **Common Interests** |
| A) All members agree to use only the knowledge relevant to completing a particular task (DELETED) |
| B) We are willing to forego our self-interests to develop consensus for solving problems |
| C) We jointly agree to learn new knowledge required for solving problems |
| D) We jointly agree to invest additional time to learn new knowledge for solving problems |
| E) We develop consensus to use relevant knowledge to solve a particular problem |
| F) All members agree that knowledge developed in one area can be useful in another for solving problems |
| G) We jointly agree to invest resources to learn new knowledge for solving problems (DELETED) |

**Constructs and Items** *(continued)*

**Innovation**

(Requires respondents to rate the statements regarding their FIRM's level of innovation relative to its major competitors over the last 3 years the extent to which it has … (1 = weaker than competition; 4 = similar to competition; 7 = stronger than competition).

Relative to our major competitors, our firm has…

A) Placed significant emphasis on new product development through allocation of substantial financial resources

B) Developed a large variety of new products

C) Made dramatic changes in existing products

D) Increased the rate of new product introductions to the market

E) Increased its overall commitment to develop and market new products

**Novelty**

A) The changes in customers' tastes and preferences frequently make our knowledge obsolete

B) We often do not have immediate solutions to technological advances in products/services demanded by our customers

C) We often have to expand our knowledge base to meet the changing customers' need.

D) We regularly update our existing knowledge domain to meet the changes in customers' requirements (DELETED)

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