Investigating the Impact of Firm Embeddedness in a Complex
Upstream Supply network

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Declaration

I certify that, where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, either in whole or in part, to qualify for any academic award; the content of the thesis is the result of work of which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged and ethics procedures and guidelines, as well as all other necessary procedures, have been followed.

Signature:

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Date:
Acknowledgement

Berakit Ke Hulu Berenang Ketepian, Bersakit Dahulu, Bersenang Kemudian

“Weeping may endure for a night, but joy cometh in the morning”

Although only my name appears on the title page of this thesis, I could not have completed this PhD project without the help, encouragement, guidance, prayers and love of other important individuals and organizations. I take this opportunity to thank them for their patience and inspiration during this long, arduous PhD journey; I believe nothing in this world could even come close to what they have given me throughout these years.

To my dear wife, Tina, thank you for your strength, love, and patience. Had you not been there in every single, arduous step, I could not have faced the pressures, difficulties, and demands of this laborious journey. To my son and daughters, Daniel, Dhia, and Imani, thank you for patiently staying beside me through these last few years.

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1 Malay proverb
Appreciation equally important goes to Associate Professor Malcolm Alexander of ASPRI 2011 for helpful insights on Social Network Analysis for this project.

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ABSTRACT

Inter-organizational network literature has confirmed that relational capital exists in a network of informal, horizontal inter-firm relations, i.e. a decentralized network structure. However, the upstream supply network is structurally different from the decentralized network. The upstream supply network is a centralized network structure. Transactions and activities in the upstream supply network are often administered and managed by a centralized manufacturing firm through formal inter-firm relations such as contractual requirements. In such conditions, the interactions of the firms that are embedded in the upstream supply network may or may not alter the implication of relational capital upon the embedded firms. Thus, this study examines the implication of firm embeddedness in the centralized upstream supply network on firms’ relational capital outcomes. This research is significant as it adopted a different perspective of the upstream supply network as a centralized network structure rather than a decentralized network structure. Accordingly, it provides a micro investigation into the structural aspects of the upstream network implications. Consequently, this research would contribute to limited research in the field of centralized network study as well as to the context of operation and supply chain management.

Through the application of Social Network Analysis (SNA) methodology, as well as two modes of network data analyses (i.e. the exploratory network analysis and the exponential random graph ($p^*$) model on network data of $N=37$ firms), results revealed two important findings in the context of the centralized upstream supply network structure. Most importantly, this research found that firm embeddedness in the centralized upstream supply network has an impact on two items of relational capital outcomes, specifically: firms’ level of trust and the level of influence. In addition to that, this study also found that firms’ embeddedness in the centralized upstream supply network structure is influenced by the type of inter-firm relation coordination mechanism. Firms in the centralized upstream supply network were found to be more embedded or involved in informal inter-firm relations than in formal inter-firm relations.
The findings of this research have had a significant impact upon the body of knowledge and managerial contributions. Theoretically, this researcher contributed to the relational capital literature by testing and confirming the argument that relational capital does exist in a centralized network structure. In addition, this study also contributed to the inter-firm network literature as it confirmed that a firm’s embeddedness in formal and informal networks of inter-firm relations affects its relational capital outcomes. Third, this research contributed to the ongoing debate in embeddedness literature regarding the role of formal and informal inter-firm relations in the network. This study found that formal commercial transaction and the web of informal social exchanges complement instead of substitute each other. Managerially, the findings of the Exponential Random Graph Modeling (ERGM) specifically highlights and warns managers against the application of a reductionist approach to the issues of inter-firm relations complexity in the supply chain, as this may result in removing firms that are highly connected to more innovative or resourceful firms in the network, but not visible through good accounting measures. Managers are advised to adopt the embeddedness findings in this thesis to complement existing strategies of supplier management.
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<td>Represents actors in network maps</td>
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<td><strong>Network</strong></td>
<td>A network consists of actors and the ties connecting them</td>
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<td><strong>Actor</strong></td>
<td>Actor can be an individual, team or firm in a network relationship</td>
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<tr>
<td><strong>Tie/Edge</strong></td>
<td>Represents the relationship among actors in networks</td>
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<td>Tiers of suppliers that supply materials and services to the focal firms for the production of products and services</td>
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<td>Refers to the central firm that administers and manages the transactions and activities of suppliers in the supply chain</td>
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<td>The centre of network structure</td>
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<td>A group of more than two actors connected by direct and indirect ties</td>
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CHAPTER ONE
INTRODUCTION

The aim of this chapter is to provide an overview of this thesis, as well as the thesis structure. In addition, this chapter sets out the following: the goals of this study, the theoretical background, the justification of this research, some key research assumptions as well as the significance of this research.

1.1 INTRODUCTION

This research is a study of the impact of firms’ embeddedness in a centralized inter-firm relationship network structure. More specifically, this research investigates the implications of a firm’s embeddedness or involvement in a centralized upstream supply network structure on relational capital outcomes.

The last decades have seen an increase in managerial concern regarding the complexity of the supply chain, more specifically the upstream supply network. The upstream supply network refers to the firms that reside in the upstream flow of the supply network. These firms which are the suppliers of materials and services to the focal firms are connected or involved with each other directly or indirectly through the supply of materials to the focal firms or manufacturer. This involvement among the firms in the upstream supply network is essentially the firm embeddedness in the upstream supply network structure.

Over the years, the upstream supply network has become more complex due to the increase interactions and interrelations among the suppliers’ firms as well as the number of the firms. One of the main strategies of managing these inherent complexities that is often adopted by supply chain managers include the consolidations of these suppliers in an attempt to reduce the resources requires
to manage this complex upstream supply network structure. These strategies may prove to be effective in the short term, but may negatively impact the focal firms in the long run. These negative effects may emerge as the upstream supply network is embedded in a network of inter-firm relation, which creates an important element of intangible capital, which is the relational social capital. Firms’ level of embeddedness in a network structure has been known in the network literature to impact the level of social capital that a firm may acquire through its network relationships. Due to the intangible nature of the social capital, thus, as focal firms consolidate its upstream supply network structure base on the acute accounting measures; it may, unintentionally, remove partners in the upstream supply network that possessed higher relational capital such as trustworthiness or influence (developed through its continuous inter-firms relations in the upstream supply network) that also has an impact on the overall performance of the focal firm and the supply network as a whole.

Issues regarding inter-firm relations have increased concern regarding the problem of supply chain complexity (Choi and Krause, 2006). Beyond the direct implications, it has far-reaching consequences for firms in a supply network which originated from disrupted interactions and communications. One disruption in the communications and interaction system could cause bullwhip effects (Lee et al., 1997) that can create havoc throughout the network.

One important example of the bullwhip effects would be the case of Nokia/Ericsson mobile phone chips. As much historical evidence has shown, focal firms often rely upon its trustworthy partners to assist it in time of needs. On March 17 2000, a lighting bolt strike hit electric poles causing a brief ten-minute fire in the Royal Phillips semiconductor plant in Albuquerque, New Mexico, United States (Li, Min and Kin, 2009). The fire was quickly put of by the staff in the plant. After the clean-up, process was completed, it was estimated that the fire had caused damage to a tray load of semiconductors, which was estimated to produce over 50,000 chips for its customers. It was considered a small loss to the plant. Nevertheless, that was not the end of it.
A semiconductor plant requires a clean environment, cleaner than a hospital. Fire plus smoke plus foam and water are a formula for a filthy, wet and muddy plant. The aftermath of the fire left the plant so dirty that the plant production had to be shut down for nearly a month. The stoppage of production of the chips for a period of one month can ultimately spell disruption of production of products that utilized the chips from the Royal Phillips plant. Nokia and Ericsson were two main customers of the semiconductor plants. Upon hearing the news of the fire, Nokia executives quickly scoured through its network of suppliers in its upstream supply chain structure to determine other suppliers who could be trusted and relied upon to continue supplying them with the necessary chips if the New Mexico plant were not able to begin production of chips sooner than expected. Nokia found three other reliable sources in America and Japan that they believed could supply them with the components if the need arose.

Reliably, throughout the stoppage of production in the New Mexico plant, the three suppliers were able to supply Nokia with a continuous flow of chips, which ensured that Nokia could continue meeting the needs and wants of its customers. Ericsson, on the other hand, was stuck with a single source strategy throughout the incident and was unable to meet the needs and requirements of its customers. According to The Wall Street Journal (January, 2001), it was estimated that Ericsson sustained an integral loss of 500 million dollars of total revenue and a three per cent loss of market share. Nokia’s profits for the same year rose by three per cent, and its market share increased by four per cent. Ericsson never recovered (Li, Min and Kin, 2009).

Nokia was able to prevent a catastrophic loss because it understood which suppliers in its supply network structure could be trusted and relied upon in a time of need through its involvement or embeddedness with the other firms in the integrated supply network. In short, it understood how its suppliers’ embeddedness in the complex upstream supply network structure could be a source of competitive advantage.
There is an extensive amount of literature in the field of operation and supply chain management indicating that the supply network and, more particularly, the upstream supply network has become more complex (e.g., Bozarth et al., 2009). Scholars such as Choi and Krause (2006) have concluded that the inter-firm relationship is one of the drivers of the upstream supply network complexity, and deeper understanding is needed to elucidate and comprehend the complexity of these inter-firm relationships.

The literature on operation and supply chain management indicates that there has been extensive research carried out concerning complexity in the supply chain. Many scholars in operations and supply chain management have adopted both a system perspective (Anderson, 1999) and a complex adaptive system perspective (Gell-Mann, 1995) in order to comprehend, describe and understand the complexity in the supply network (e.g., Li et al., 2010; Pathak et al., 2007). The literature also indicates that there has been a great advance in the drivers of the complexity (e.g., Bozarth et al., 2009; Wilding, 1998; Milgate, 2000; Vochan and Klassen, 2000; Choi and Krause, 2006). Furthermore, this previous research had largely concentrated on the attributes of the system elements, but less on the relations between the firm’s organizations (the terms organizations and firms are used interchangeably throughout this thesis) (Borgatti and Li, 2010; Choi and Kim, 2008) that formed the basic, important components of an integrated network of firms (Mueller, 2000).

Putnam (1993; 2000) has argued that a decentralized, integrated network of firms generates social capital or relational capital that can be an important source of competitive advantage to the related firms when facing complexity in the market environment (Zaheer et al., 1998).

Clearly, complexity in the upstream supply network arising from the extensive inter-firm relations offers a unique source of competitive advantage that can be accessed by the embedded firms in the integrated network structure. However, a supply network or, more particularly, an upstream supply network is a centralized network structure because of the existence of a focal firm which is involved in administering and managing transactions in the upstream supply network. This important structural characteristic might have an implication for the firm’s relational capital.
outcomes. Thus, this research is an examination of the impact of a firm’s network involvement or its embeddedness in a complex upstream supply network on relational capital outcomes.

1.2 BACKGROUND OF THE PROBLEM CONTEXT

Oliver and Weber (1982) are believed to be among the first scholars to use the term supply chain to describe the flow of resource and materials from the suppliers to the end users. In the early 1980s, the focus of many scholarly works centered on understanding the integration of business processes throughout the supply chain (Ragatz, Handfield and Petersen, 2002; Vyas and Woodside, 1984; Zenger and Lawrence, 1989). Emphasis was given on the structure of the supply chain in order to deliver goods and services that meet the end users’ needs.

Scholars then began to integrate different frameworks and views of SCM and, thereby, better define the domain of Supply Chain Management (SCM). As a result, several frameworks have been developed to guide research and practice (Carbonara, Giannoccaro and Pontrandolfo, 2002; Kersten et al., 2006; Peck, 2005; Perona and Miragliotta, 2004; Piramuthu, 2005) SCM research has since evolved to encompass a combination of trends in the management literature, such as industrial markets, integrated materials’ management, system integration, the “quality” revolution, management of relationships, and business process integration and management.

Despite the varying and progressive perspective of the supply chain, each of the notions of the supply chain management relies on terms such as coordination and integration and emphasizes the harmonization of operation among organizations in the supply chain (Bowersox, Closs and Cooper, 2002). In addition, the focus of this early conceptualization of the supply chain focus on their cross-functional business processes with the objective of providing value for the entire supply chain (Lambert and Cooper, 2000; Lambert, Cooper and Pagh, 1998).

These days, supply chain management (SCM) involves adapting to changes in a complicated and complex global network of organizations (Choi and Krause, 2006; Hoole, 2004; Li et al., 2010; Masson et al., 2007; Sivadasan et al., 2010; Sivadasan et al., 1999; Vickers and Kodarin, 2006;
Zhou, 2005). Since the early 2000, scholarly work began to conceptualize supply chain as supply network to better illuminate the complexity of the organizations' inter connectivity (Harland et al., 2001; Lamming et al., 2000). A typical supply network consists of inter firm relationships that may connect numerous industries. As a result, supply network management often requires consideration of a large number of factors from various dimensions and perspectives.

As mentioned in the earlier section, the upstream supply network, otherwise known as the supply base, refers to the upstream part of a supply network consisting of suppliers who supply materials to the focal firm for the production of products and services (Choi and Krause, 2006). Choi and Krause (2006) stated that a source of supply base complexity naturally arose from the fragmented, yet extensive inter-firm relationships existing between firms in the upstream supply chain. It is also instructive to note that the downstream supply network refers to the distribution channels that distribute and deliver the product, and services produce by the focal manufacturer to the end consumers.

Managing the complex upstream supply network can be a difficult task for managers of the supply chain. To visualize a complex supply network, this research adopts the description by Beamon (1999), Choi (2008) and Choi and Kim (2010). Structurally, supply network is virtually formed by the connectivity or links between firms where the integration progressively forms the ultimate structure, which is the supply network itself. The relationship is also known in the literature as the buyer-supplier relationship (Beamon, 1999). According to Choi and Kim (2010), a buyer–supplier relationship represents a dyad, or two nodes and one link, in network terms. Each node can be conceptualized as an actor performing activities for generating value Choi (2008). The firms need resources from its supplier organization, and the supplier needs contracts and payments from the buyer. On top of that the firms also interact with each other to share information regarding market opportunities and new threats (Choi, 2008). As a consequence, these phenomena create a link and form a dyad or a buyer–supplier relationship. Because a firm in the supply network often has links to other firms, the firm is then impliedly linked to the new indirectly connected
organizations. Similarly, with the supplier organization, this will also bring to the dyad their links with other organizations either directly or indirectly (Lamming et al., 2000). Conclusively, a buyer–supplier relationship is not only a dyad. It is also part of a network that has come to bear on individual nodes to the relationship through each other’s extended business relationships. This form of inter-firm relations or connectivity created the complexity in the supply network structure.

The traditional reductionist arguments state that firms opted for the removal from the complex upstream supply chain of partners who are not meeting the performance requirements of the supply chain in an attempt to manage the complexity arising from extensive inter-firm relationships (Choi and Kim, 2008).

However, recent arguments suggest that simply removing these under performing firms may not be the best way, as firms may remove partners who are resourceful or more influential, but these characteristics are not visible through good accounting measures. In this vein, Cockburn and Henderson (1998) in addition to Putnam (1993; 2000) posited that approaches that value and appreciate these complex inter-firm relations may be better alternatives as firms have been found to benefit through relations with other firms in a network structure.

An integrated network of services and processes may be one of the effective approaches for handling issues of complexity arising from inter-firm relations (Womack, 1990). It is argued that, within network structures, the embedded organizations are socially and economically inter-dependent (Granovetter, 1985).

In inter-organizational studies, the concern with management of inter-relationships has shifted the perspective of organizations from the rational system perspective to the open-system perspective, and more recently into the network form of organizations (Powell, 1996). The prevailing assumption behind the adoption of an integrated network is that: compared to the rational and open system perspective form of organizations, the network is richer (Powell, 1996) due to the involvement of the parties in those social relationships (Uzzi and Gillespie, 2002). The richness of
network lies in the generation or development of social capital among the embedded network entities (Putnam 1992).

Network involvement constitutes an important element that Putnam (1992) identifies as being the relational capital (Cousins et al. 2001). Cousins et al. (2006) stated that relational capital was the configuration of relationships within the network structure, as well as with the broader network structure of the firm. It has been documented that the intensity of involvement increases relational capital such as trust and motivation from the interactions (Cousins et al., 2006). More specifically, organizational researchers have confirmed that organizational involvement in a decentralized network structure impacts upon organizational relational capital outcomes such as the level of trust and reputation (Gulati and Gargiulo, 1999; Podolny and Page, 1998). Thus, a firm’s embeddedness or involvement in the network structure may produce relational capital such as influence, trust and reputation that may then have the potential to generate other benefits such as reduced costs and greater flexibility (Reagans, Zuckerman and McEvily, 2004). As such, the adoption of the network form of organizations may lie in the empirical fact that networks bring in these relational capitals, such as trust and influence; thereby creating an ease of interaction for the firms that are embedded in the network structure.

Clearly, the integrated-network approaches can be the alternative to the reductionist approach in managing complexity in the upstream supply network structure. For example, through the exchange of resources, i.e. information with trustworthy firms, a firm may ascertain discoveries of unknown competition or potential threats coming into the market. These early detections of threats can help a firm to create new movers’ blocks to protect its interests within the market. In addition, Burt (1992) argues that the structure of an actor’s network (an actor can be an individual or a firm) determines the access to information that a firm may experience in the network. A firm’s connectedness to others in the network structure determines the level of information it receives from others as or when it is required. Thus, a firm may instead benefit from its connectedness or involvement in inter-firm relations with other firms in the complex network structure.
Grannoveter (1985) refers to this connectedness or involvement as embeddedness. Embeddedness relates to the degree of involvement that a firm has with other firms in the network, which is a direct reflection of the organization’s degree of inter connectivity with other organizations in a network structure such as in an upstream supply network (Granovetter, 1985a; Uzzi, 1997; Moran, 2005).

Embeddedness theory predicts that formal transactions are embedded in webs of informal social exchanges (Poppo and Zenger, 2002). Firms exchange valuable resources through their commercial transactions and relations, which are vital to both competing and meeting the end users’ requirements (Simsek et al. 2003). For example, suppliers in the Toyota Production System (TPS) are connected to each other through their network of inter connectivity for the supply of materials for the production of automobiles. Tangible and intangible resources are exchanged within this system. The outcome of this has resulted in improved comprehensive performance of Toyota (Womack et al. 2007). Hence, one may conclude that organizational performance in the upstream supply network may also be influenced by the organization’s embeddedness within the overall supply network structure.

Even though the integrated network form (or more specifically being embedded in the upstream supply network) provides a venue for managers to attend to the issue of the complexity (since firms’ embeddedness in a network creates the relational capital necessary to smoothen inter-firm relations), it is not without its issues.

First, a network structure is unstable. Because many relationships in a network are essentially formed voluntarily (Powell, 1996), the ‘building’ and ‘dismantling’ of the relationships that are at the center of the network may merely be the subject of use and occasion of the related parties, thus creating the delicate nature of the network structure. Therefore, voluntary participation alone can be the cause of disruption of the network structure, i.e. when one party decides to opt out from the network leaving gaps in the connected network structure.
Second, the decentralized and horizontal communication structure of networks causes opportunistic acts to become an imminent threat. Opportunism may emerge when parties in the network relationship have issues of goal incongruence. In addition, connectivity may have its costs too, as a firm may lose some control of its operations and administrations.

Naturally, to guard against the instability of the network structure and threat of opportunism, while at the same time acquiring high levels of integration among firms in the supply network structure, stakeholders in the network structure often introduce a focal or central firm to administer and manage the activities in the network structure (Huang, 2007). This is the case that we are investigating.

The upstream supply network is essentially a centralized network structure. It is a centralized structure through the existence of the focal firm that monitors and administers transactions in the upstream supply chain for the production of the finished goods and services. This centralized coordination often involves a focal firm or manufacturer, typically operating in the center of the transformation process (Choi and Krause, 2006). Since relational capital outcomes emerge through interactions in a free flow, decentralized, network structure (Gulati and Gargiulo, 1999; Podolny and Page, 1998), application of the integrated network to the issues of centralized upstream supply network complexity may require deeper understanding of the impact of the centralized network structure. This research raised this concern following the argument of Putnam (1992) which posited that relational capital emerged largely in a decentralized network structure.

This is because; a centralized coordination such as the focal firm in the upstream supply network may introduce effects unknown, or remove potential benefits to the firms in the upstream supply network. For example, since the central coordinator (i.e. the focal firm), is often the most powerful firm in the supply base having arms-length control that monitors actions of the network member, it is also a profit-driven entity with the most investment in the supply network. Occasionally albeit unintended, a Machiavellian portrayal may affect the level of relational capital among the firms in the centralized network structure.
In addition, the centralized nature of network governance has been found to reduce the horizontal connection which is prominent for the creation of relational capital in a network structure (Poppo and Zenger, 2002). Since these horizontal connections are significant for generating the relational capital posited by Putnam (1992), a key question would be: will firm involvement or embeddedness in the centralized upstream supply network produce the same relational capital outcomes?

The chief objective of this research is to determine the impact to which the relational capital implications can be ascertained in the context of a centralized upstream supply network. This principal objective is further divided into three sub-objectives, which are, namely: to determine the role of firm embeddedness in the centralized upstream supply network on trust; to determine the role of firm embeddedness in the centralized upstream supply network on reputation; and, finally, to determine the role of firm embeddedness in the centralized upstream supply network on influence.

1.3 RESEARCH QUESTION

Choi and Kim (2001) present the initial platform for operations and supply chain management researchers to adopt the embeddedness concept into the supply of input in the supply network. Using the Social Network approach, the authors present the embeddedness concept from the perspective of the supply chain. The authors posit the importance of framing organizations in the supply network (i.e. suppliers) as being embedded in a larger supply network than in isolation. Such framing provides organizations in the supply network with better basis in developing policies and long-term strategies. The authors went on to posit that the embeddedness of organizations in the supply network influence its performance, a statement in tandem with previous network research findings that found the configuration of network of relations can facilitate or impede an organization’s behaviors and performance (Granovetter, 1985; Burt, 1992; Nohria, 1992).

Dyer (2002) studied how being embedded in a supply network increases the accumulation of knowledge among organizations in the network. The author conducted interview and archival
review of the Toyota Production System within the manufacturing in the North America. One particular characteristics of the Toyota Production System is that the suppliers or organizations in the network are embedded in a large knowledge sharing network with other suppliers to Toyota. This organizational embeddedness contributed to some critical competitive advantage to the Toyota Supply Network, mainly: (1) motivate members to participate and openly share precious knowledge (while preventing undesirable spillovers to competitors), (2) reduce the costs associated with finding and accessing different types of prized knowledge and (3) restrain free riding in the supply network.

Gulati (1999) empirical study indicated how the degree of embeddedness of organization in a network determines the amount of network resources it can obtain. Through a longitudinal data analysis of inter-firm collaboration in North America, Japan and Europe from year 1981 to 1989, the author found that the more embedded an organization is in its alliance with other organizations in the network the higher is the amount of network resources it can acquire. This evidence is vividly portrayed in one of the interview transcriptions that the researcher conducted for the study.

“Our network of partners is an active source of information (….). We are in constant dialogue with our partners, and this allow us to find many new opportunities with them and also with other firms out there” (Gulati, 1999 p. 401)

Literature of inter organizational study also indicated the impact that organizational embeddedness has on the innovation development. Researchers such as Burt (1980), Ibarra (1993) and Ahuja (2000) provide empirical evidence on how organization's position in a network would impact to the organization's overall innovation capability.

For example, Ibarra (1993) investigated what are the network factors that would influence the creation of administrative innovation and technical innovation. Using a survey instrument of professional staffs in advertising and public relationship, the author determines that organizations
that are embedded centrally in a network structure would create more administrative innovation than its counterparts. This finding shows how organization that occupies a central position in the network generates more innovations compare to the organizations that are in the periphery.

Ahuja (2000) stated how strong ties and weak ties that exist between organizations contributed to development of new products. Using a longitudinal analysis of a cluster of bio technology firms, the author could proof that organizations that are embedded in strong ties are able to file for more patents than organizations that are embedded in weak ties.

Burkhard and Brass (1990) found that the degree of centrality of an organization is a source of power for the particular organizations. The authors concluded that the more central the organization is in the network the more power that the organization conceived. Although, Choi and Kim (2001), Dyer (2002), Gulati (1999), Ibarra (1993) article illuminate the essence of embeddedness and that these network elements provide the organization in the network with resources relevent to the degree of embeddedness. One could argue that organizational embeddedness is an important source of social capital and the reason behind the adoption of the network perspective.

However, even though an integrated network of services and flows may be the best solution to the problem of complexity driven by inter-firm relationships in the upstream supply network, the question remains, will the effects of a firm’s embeddedness on reputation, trust and influence to be similar when firms are embedded in a centralized network such as the upstream supply network? This question is valid because the existence of a powerful focal firm in the upstream supply network may introduce an unknown impact on relational capital outcomes in the context of the upstream supply network structure. Thus, the first main research question for this research seeks to investigate the relationship between firms’ embeddedness in the centralized upstream supply network and firms’ relational capital outcomes and reads:

*Is the embeddedness of firms in the centralized upstream supply network related to the firms’ relational capital outcomes?*
This research question is further divided into three specific sub-questions, namely:

A)  *Is the embeddedness of firms in the upstream supply network structure related to trust perceived from other network members?*

B)  *Is the embeddedness of firms in the upstream supply network structure related to reputation perceived from other network members?*

C)  *Is the embeddedness of firms in the upstream supply network structure related to influence perceived from other network members?*

Overall, network embeddedness or involvement in inter-firm relationships may benefit firms through the generation of significant relational capital elements, such as influence, trust and reputation. An important caveat to this is that relational capital mostly exists in a decentralized network structure and requires informal horizontal relations between the network actors for the generation of relational capital influence, trust and reputation respectively. However, the upstream supply network is a centralized network structure indicating the strong existence of a formal form of inter-firm relation, such as contractual relations between the firms. As such, the second main research question for this study aims to investigate the perplexity regarding the pattern of firms’ embeddedness in the centralized upstream supply network structure and reads:

*Is the embeddedness of firms in the centralized upstream supply network related to the type of inter-firm relation coordination in the centralized upstream supply network structure?*

This research is significant since it demonstrates that the impact of firms’ network embeddedness or involvement with relational capital is strong even in a centralized upstream supply network structure. It also demonstrates that a firm’s network involvement, or its embeddedness in the upstream supply network or supply base, is generally related to the firm’s key relational capital resources. More specifically, this study in addition, sheds light into the existence of relational capital in the context of a centralized network (such as the upstream supply network structure). Moreover, firms that acknowledge and are involved in the centralized upstream supply network or
the supply base will generally experience increased levels of competition through relational capital outcomes. Even though it is not the goal of this study to explore the impact of network involvement on accounting or financial indicators, it is important to note that Reagans et al. (2004) argued that relational capital facilitates transactions, thus consequently reducing costs, as well as increasing performance and innovativeness of the related parties.

In addition, the focus of this study is not only on firms’ attributes but also on the relationships among them. This presents an added richness into the understanding of the impact of complexity arising from inter-firm relationships in the upstream supply network and subsequently into the management of the supply base. Consequently, this sheds light into the ‘myth of downsizing’ in the context of inter-organizations. Since it is a known empirical fact that downsizing does not improve performance of intra-organizations, findings from this study demonstrate a similar effect. It also explains in part why, in the context of inter-organizations, a ‘reductionist’ approach (based on accounting measures) to suppliers’ management may not be the answer. It follows that it seems ill-guided reductionist may remove the influential, resourceful firms that do not appear on the firm’s radar of good accounting measures.

This study also highlights the need for managers and firms to have the ability to examine and understand other firms’ patterns of embeddedness. This may be the key to capturing the dynamics of firm relationships that might be beneficial or lead to future concerns. As firms are able to objectively understand this concept, it will assist an organisation to avoid the danger of dismissing a certain firm solely based on poor accounting measures, when in fact this firm is connected to other highly powerful or resourceful ones.

1.4 METHODOLOGY

According to Wasserman and Faust (1994), the traditional statistical method is not adept with regard to the measurement of relations. This is because the standard statistical method disavows the existence of relations between entities in a network which is itself the center of
network research (Lusher, 2000). Because the focus of this study is not only concentrated on attributes of firms but also on the relations between firms, this study has consequently, adopted the social network analysis (SNA) methodology strategy for data collection and data analysis by which to obtain valid results for this study.

Social network analysis is a research method which has its origins in the field of sociology, anthropology and politics (Scott, 1998; Borgatti and Li, 2010). SNA focuses on the relationships or ties between network entities, not just the attributes of the network entities (Wasserman and Faust, 1994). According to SNA scholars, a network is made up of actors who could be either individuals or organizations, which are interconnected to each other through the different kind of social interactions (Scott, 2000; Hanneman and Riddle, 2005). The interactions can be in the form of formal ties or informal ties (Borgatti and Li, 2010). The objective of a social network analysis is not to determine the attributes of the actors that impact upon the network, but rather on how the interconnectivity between the network actors influences network performance (Mueller, 2000).

Hence, social network analysis allows the researcher to investigate how firm embeddedness in the centralized upstream supply network structure would influence the organizational social performance.

A network of firms operating in an upstream supply network of a small maritime industry company formed the population of this study, i.e. the APMMHQ-1 (pseudonym provided for anonymity). The APMMHQ-1 is a manufacturing company in the Malaysian shipbuilding industry involved in ship repairs, maritime works and engineering. To date, the company has awarded contracts to local vendors and suppliers totaling RM31 million for the development of small vessels in the region.

In network studies, all actors who are located within a pre-determined boundary are included for analysis. Consequently, unlike the conventional sampling strategy, social network analysis seeks to include all the actors in the network under consideration (Hanneman and Riddle, 2005). The sample of this study includes 37 firms involved in the production of Rigid Hull Inflatable Boats
(RHIB) for APMMHQ-1. Through a network survey, data was collected from a total of 36 out of 37 firms in the APMMHQ-1 upstream supply network with an overall response rate of over 90 per cent.

Network data was analyzed using the two analytic techniques, namely: exploratory network analysis and exponential random graph ($p^*$) model (ERGM). Exploratory network analysis was applied to explore patterns of interactions among firms, which used to interpret the overall pattern of embeddedness of firms in the APMMHQ-1 upstream supply network. This analysis was performed using social network software packages, i.e. UCINET (Borgatti, Everett and Freeman, 2002), NetDraw, Mage and Pajek (Nooy, Mrvar and Batagelj, 2005). ERGM was adopted to investigate the social relations phenomena (Shumate and Palazzolo, 2010) by simulating a social network to determine other possible ways that a network with the given number and size of social relations can be configured (Lusher, 2001). The simulated outcomes provide insights into the patterns of individual firms’ relational structures in the APMMHQ-1 upstream supply network, as well as providing answers to the specific research questions (Wang, Robins and Pattison, 2006). ERGM analysis was conducted using the program PNet of Wang et al. (2006).

1.5 STRUCTURE OF THESIS

This thesis contains seven chapters, detailed as follows:

Chapter one provides an introduction and overview of this research within the context of operation, supply change management and inter-organizational study, as well as outlining the major conceptual ideas and guidelines of this thesis.

Chapter two reviews the literature of the major concepts of this thesis, in particular: supply chain complexity, upstream supply network, network governance, embeddedness as well as relational capital. This chapter seeks to identify gaps in the previous research in an attempt to formulate the question.
Chapter three discusses the theoretical background of this study and the development of the hypotheses to answer research question one of this study.

Chapter four explains and justifies the methods used for this thesis. This study adopts a quantitative research method design underpinned in a social network analysis method to explore the research framework. Social network analysis approaches and measures were applied to assess the research model presented in chapter two. This chapter includes: the research design, instrument development, sampling plan, data collection procedures, data analysis techniques, as well as the validity and reliability of the instruments adopted for this thesis. It also reviews the context of this research, which is the upstream supply network of the APMMHQ-1 for the product Rigid Hull Inflatable Boat (RHIB).

Chapter five discusses the findings of the exploratory network analysis of the network data gathered in this thesis. The results of the exploratory network analysis combined with the descriptive data presented in this chapter will explain the pattern of firms’ embeddedness or involvement in the centralized upstream supply network structure.

Chapter six describes the results of the statistical network model, namely, ERGM analysis. The ERGM analysis results will provide the description of how an individual firm’s level of embeddedness in the upstream supply network structure affects its level of relational capital such as influence, trust and reputation respectively.

Chapter seven discusses the findings of this research based on the exploratory network analysis results, and the quantitative data obtained. It discusses how the research question has been answered, as well as providing confirmation of the hypotheses. The discussion of results is contextualized with the literature review of this thesis.

Chapter eight draws conclusions from the thesis. In addition, chapter eight provides the thesis recommendations and the implication for future studies. This chapter also reviews what this research finding has added to existing research in the area of inter-organizational study and the operation and supply chain management.
The following chapter examines the literature review conducted for this study as well as the development of the research questions.
CHAPTER TWO
LITERATURE REVIEW AND BACKGROUND

2.1 INTRODUCTION

In this chapter, the researcher provides a literature review of three streams of research related to this study which lead-up to the formation of the research questions presented in Chapter One, section 1.3.

First, the researcher presents literature reviews relating to the rise of networks formed in a supply chain. In this section, the researcher focuses on drivers and factors of the adoption of integrated network of firms in the context of the supply chain. Although there are several reasons behind the surge of interest of networks in the supply chain, it's undeniable impact is that network has become an integral part of the supply chain management.

Second, the researcher reviews the literature of network analysis applied to inter-organizational studies. In this section of the literature review, the researcher discusses the streams of literature concerning the important developments of a specific researcher stream, i.e. network analysis. For this particular discussion, the researcher will focus on the origins and application of network analysis in the operation and supply chain management research.

Third, the researcher discusses literature pertaining to firm embeddedness in network structure. In this section, a review is given of the literature studies concerning the implications of firm embeddedness in a network structure, particularly on its relational capital outcomes. Finally, the researcher summarizes the results obtained from the discussion of the literature review and determines any gaps in the literature. Consistent with the urgency from scholars to develop network-based supply chain theories, this study proposes a model of relational capital outcomes based on firms’ network embeddedness.

Graphically, the overall structure of this chapter is visualized in the following Figure 2.1:
2.2 THE ANTECEDENTS OF NETWORK FIRMS IN THE UPSTREAM SUPPLY NETWORK

In this section, it is argued that the rise of network firms in the supply chain, more specifically the upstream supply network, are driven by several important elements such as: the incomprehensiveness of linear perspective of the supply chain, arising complexities from inter-firm relations and the assertion of network form by organizational study scholars.

2.2.1 LINEAR VERSUS NETWORK SUPPLY CHAIN PERSPECTIVE

The case of Nokia and Ericson in Chapter One, section 1.1, highlighted the importance of understanding the correct inter-firm relationships' management strategy, particularly in the context of the upstream supply network. Prudent management of the inter-firm relations in the upstream of the supply network is an important goal of many supply chain managers, as any interruption to the flow of materials and resources may disrupt the whole structure of the supply chain and consequently, the firm’s overall economic performance.

An upstream supply network is defined as being the supplier’s portion of a supply network that is actively managed by a focal company (Choi and Krause, 2006). The following depictions of the upstream supply network are adopted from Choi and Krause (2006). In the upstream supply network, the focal firm initiated formal inter-firm relationships with its suppliers or firms in the upstream supply chain through its contracts. At the same time, other firms or suppliers in the upstream supply network may form further types of relationship between them, either known or unknown to the focal firm (Choi et al., 2001). Choi and Krause (2006) described the overall relationship arrangement between the focal company and the upstream firms in Figure 2.2. The black arrow lines indicate the coordination and control of the focal firms upon the upstream firms. The blue lines indicate the relationships among the suppliers, known or unknown to the focal firm, such as information-sharing, referral activities and other commercial relations (Choi and Krause, 2006).
Figure 2.2 Upstream Supply Chain
Source: Choi and Krause (2006)

Literature in the field of operation and supply chain management has addressed inter-firm relationships such as supplier–supplier supplier relationships (Wu, 2003) and buyer–supplier relations (e.g., Helper, 1991). At different stages of the transformations process, values are added to the process. Thus, in its essence, these concept models the upstream supply chain as a linear series of value adding stages that transfer raw materials and services to the focal firm.

Although previous studies have contributed significantly to the understanding and development of the supply chain management, some scholars proposed that a linear view of the supply chain is insufficient to uncover the holistic structure of the supply chain inter-firm relations and its implications (Borgatti and Li, 2010; Choi and Kim, 2008). For example, Cooper and Elram (1993) studied the characteristics of supply chain management and investigate the impact on strategy development in an organization. Lee and Billington (1993) developed the material management guides in a supply chain. In a later work, Lee, Padmanabhan and Whang (1997) investigate information distortion phenomena in the supply chain and coined the term bullwhip
effect to illustrate how a small variation in information from downstream (e.g. distributors or final consumers) of the supply chain would have a huge implication for the upstream section (e.g. second tier or third-tier supplier) of the chain. Wilding’s (1998) seminal work studied how three interacting factors, namely: the uncertainty, demand variation and parallel interaction at the various stages of the value adding process can contribute to increasing complexity in managing the supply chain. More recent works adopted a linear perspective in explaining how internal and external complexity factors among firms in the supply chain (such as supply input, lead time and demand variations) would impact upon manufacturing plant production capacity (Bozarth et al., 2009).

Scholars posited that the linear view of the interconnected firm, one which is argued to be insufficient, disregards the natural ways in which interactions or inter-firm relations in the supply chain are formed and evolved (Dooley, 1997; Harland et al., 2001; Lamming et al., 2000; Li et al., 2010; Pathak et al., 2007; Surana et al., 2005)

The sceptics of the linear model are not without their just groundings. Figure 2.3 displays a simplified, common interpretation of the supply network depicting a uni-directional, linear flow of materials and services in the supply chain from the raw material suppliers to the end consumers. This refers to raw materials transferred from the upstream suppliers to the focal manufacturing firm to be transferred into finished products and services. They are then ultimately distributed to the downstream customers through the distribution agents and retailers. However, Figure 2.2 also depicts a representation of the formal interactions of firms in the supply chain, i.e. the flow of materials (Ritchie and Brindley, 2000).
Over the years, various structures of the supply chain have evolved. One important finding of Womack (1990) is that, in a supply chain, the exchanges between the firms not only concern the formal exchanges of materials from the upstream suppliers to the downstream customers. Most importantly, it also involves informal forms of relations such as other commercial transactions, including information-sharing and referral activities, which create a significant competitive advantage to the firms embedded in such relationship structures (Lazzarini, 2000; Borgatti and Lie, 2010).

Choi and Krause (2001) study the flow of materials in three automobile manufacturers in North America. The authors mapped the network of flow of parts and materials for the assembly of the center console for several models. Based on the mapping of the network, it shows that the flows of materials are not linear as commonly perceived. Furthermore, in a supply network of the center console parts and materials, it could be assumed that the other organizations or suppliers in the

**Figure 2.3 Linear Supply Chain**
Source: Ritchie and Brindley (2000)
supply network are connected to other organizations through some indirect connections. This indirect connectivity could mean that organizations in the supply network are communicating with each other without the knowledge of the other organizations or suppliers. This seminal work of Choi and Krause (2001) has led two further analysis of the network mapped by the authors, i.e. the work of Kim (2010) and Kim (2011). These two studies both studied the network structure of the supply network and adopted particular social network measurements to explain the precise phenomena in the supply network. Kim (2001) adopted the structural holes’ concepts (structural holes relate to how an organization in a network can be connected or tie to other organizations in the network through indirect connections) to explain the flow of information in the supply network. Kim (2011) conceptualized several supply network concepts such as material supply using social network elements such as in-degree centrality to explain how materials flow from the upstream suppliers to the focal organizations in the supply network. Scholars from the social network analysis field also contributed to the conceptualizing the supply network elements using the social network analysis. Among others, Borgatti (2009) posited the strong structural similarities to certain kind of supplier–buyer parallels with the source of key centrality concepts in social network analysis. Similarly, Lazzarini (2002) study tried to visualize the adoption of the social network concepts for the supply network study using what is termed net chain analysis. The authors conclude that a supply network consists of a number of hierarchical layers, and each layer contains many other firms that are connected to other organizations in the network either through horizontal connections or vertical connections.

In addition, the embeddedness theory argues that these interactions or inter-firm relations can be in the form of formal commercial transaction activities, such as: contractual relations of a web of informal social exchanges, including information-sharing and referral activities (Poppo and Zenger, 2002; Borgatti and Li, 2010). These two types of inter-firm relations can be either complementary or substitutes of the other. Consequently, a more accurate interpretation of the supply network is required in effort to manage the supply network more efficiently.
Network terminology introduces a new perspective into the understanding of the supply network management strategy. It highlights that consolidation of the upstream supply network and disregarding the element of interactions or connectivity between the firms in the supply network - an approach that known as the reductionist strategy may not be the best strategy to manage a supply network. In the following section, this research discusses the reductionist strategy of the supply network management.

2.2.2 The Reductionist Strategy

Since the early 1990s, large manufacturers have been focusing on a reductionist strategy of removing suppliers who are consequently reducing the amount of relations in the upstream supply chain or the supply base (Asan, 2009), primarily with the objective of reducing costs. The reductionist strategy is in concert with the lean manufacturing strategy that was gaining popularity at the time. Through reductionist strategy, focal firms or firms in the supply network would evaluate its partners based on good accounting measures and decide which partners should stay and which partners whom service no longer required. However, focusing only on the number of suppliers in the upstream supply network without taking into account other aspects of upstream supply chain complexity is both short-sighted and ill-advised (Choi and Krause, 2006). Choi and Krause (2006) argued that such an ‘ideal’ approach could lead to firms missing out on other important dimensions in the upstream supply chain complexity. These include issues such as: how distinct the firms are and how the firms are connected to each other.

The differentiation between the firms is important because it alleviates the complexity in the upstream supply chain. For example, if a manufacturer has 20 firms in its upstream supply chain, each of these firms would certainly possess distinctive operational practices, technical capabilities, culture and resources, which increase the complexity in managing these firms. What makes this more complex is that these distinct entities are connected to each other through various means of relations or interactions. What this means is that firms are bound to make a mistake when relying
on reducing the number of suppliers in the upstream supply network whilst at the same time ignoring the other consequential dimensions of the upstream supply chain as a means of cutting transaction costs and improving the efficiency and effectiveness of the supply chain. Even though reducing complexity by removing firms or suppliers in the upstream supply chain does reduce costs involved in managing and administering the relations, there are other significant issues that the reductionist approach may unintentionally or unknowingly disregard. For instance, reducing firms in the upstream supply chain can increase supply risk and cause firms to give up a degree of potential resources. This situation occurs because the firms which have been removed from the upstream supply chain may be connected to other firms in the upstream supply network that are more technologically advanced, innovative and informative but, which are invisible through the standard accounting measures adopted for the evaluation of performance of firms in the network (Choi, 2008). One clear example of such a case is how Toyota and Honda obtain new innovative ideas for improving manufacturing via a different way of configuring sub-assembly or using less-expensive materials that function the same way. This procedure originated from its tiers of suppliers in the upstream supply network (Womack, 1992). Thus, adopting the reductionist strategy to manage the upstream supply chain complexity may not be the best solution to the problem (Choi, 2006).

An important alternative to the reductionist strategies is in line with the research of Bhattaacharya et al. (1996) which stated that the effective and efficient management of complex inter-firm relations in the supply network can be achieved through a network of integration of relations among firms.

Ritchie and Brindley (2000) proposed a network perspective to be employed when analysing the inter-firm relations in the supply chain. Figure 2.4 represents a more complex upstream supply network of multi-tiered entities involving the formal commercial transaction and informal web of social exchanges in the supply network mimicking the true nature of a supply chain model.
In Figure 2.4, firms in the supply chain are pictured interacting with each other in the supply chain despite the distinct formal role of the firms such as: the raw material suppliers, distribution agencies or even the focal firms in the supply chain.

Thus, it is argued that the upstream supply network now contains a mix of more formal and informal inter-firm relationships, thereby creating a much more complex network structure (Choi and Kim, 2008). This inevitably creates a complex structure of relationships between the entities in the supply chain. It also indicates that the supply chain has become a more complex network because of the activities and exchanges that have increased over the years.

For example, one study that attempted to map the actual map of an upstream supply network structure was conducted by Choi and Krause (2006), as well as a study by Li and Choi (2010). In
2006, Choi and Krause (2006) set off on a research project to map the actual form of a supply network structure for a component in Honda Acura in the North America manufacturing facility. The network data from this initial study was later transformed (using the Social Network Analysis tool i.e. UCINET) by Li and Choi (2010) to map the actual interaction pattern of suppliers. More specifically, the authors mapped out a full upstream supply network structure for a simple centre console assembly for the Honda Acura model. What developed from the research was a complex upstream supply network map of the flow of materials from the upstream suppliers to the focal firm (see Figure 2.5)

![Upstream Supply Network of Honda Acura](image)

**Figure 2.5 Upstream Supply Network of Honda Acura**  
Source: Lin et al., (2011)

In Figure 2.5, we can see the lines representing the formal commercial transaction flow of materials and resources from the suppliers to the main manufacturers and the red nodes that represent the firms involved in the supply of materials for the Honda Acura components.

The map of the upstream supply chain structure in Figure 2.5 shows a complex network structure. A factor that makes this network more complex is the line representing the relation, i.e.
material flow, from the suppliers to the focal manufacturer. However, this line only represents the material flow among firms in the upstream supply network structure. In actual fact, according to the embeddedness theory, inter-firm relations are embedded in formal commercial transactions and the web informal social exchanges. Other relations such as information-sharing activities may occur in the upstream supply network. For example, in a typical supplier-supplier or firm’s relationship, information such as: demand forecast, production developments, competition running capacity and other context rich data may be exchanged in a cooperative supplier–supplier or firm’s relationship (Choi et al., 2002). These inter-firm relations may be rewarding or risky depending on the perspective of the firms.

From a linear view of the exchanges in the upstream supply network, the perspective of the upstream supply chain has evolved into a network perspective involving multiple forms of relations among the entities in the network structure. Thus, arguably, the upstream supply network has become a complex network of firms embedded in webs of informal social exchanges and formal commercial transactions, rather than just a linear transformation flow of raw materials into finished goods and services. The evolution of inter-firm relations perspectives has given rise to the antecedents of network for the management of the supply chain.

2.2.3 COMPLEXITY IN THE SUPPLY CHAIN

The objective of this section will be to determine the driver and factor of the supply chain complexity and how it relates to embeddedness. However, the researcher first describes the nature of complexity, following a review of both the literature of system study and interactive physics to comprehend the underlying elements of complexity. A summary of the complexity concept is given in Table 2.1.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Definitions of Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hall et al., (1967)</td>
<td>Complexity is defined as a structural condition which itself contains a number of components. Components refer to the number of separate parts of the organizations, as reflected by the various divisions, differentiation and dispersions.</td>
</tr>
<tr>
<td>Blau and Schoenherr (1971)</td>
<td>Complexity relates to the number of components of an organization.</td>
</tr>
<tr>
<td>Perrow (1973)</td>
<td>Complexity arises from the different components and the connections between components.</td>
</tr>
<tr>
<td>Mileti et al (1977)</td>
<td>Complexity relates to the number of places at which work is performed (spatial complexity), number of services offered (horizontal complexity), as well as the number of hierarchical ranks performing different tasks (vertical complexity).</td>
</tr>
<tr>
<td>Bak and Paczuski, (1995)</td>
<td>Complexity originates from a system’s tendency to organize into a critical state.</td>
</tr>
<tr>
<td>Price (1997)</td>
<td>Complexity is the number of social units that have contact with a focal organization. A large organization, for instance, will have a much more complex environment than will a small one.</td>
</tr>
<tr>
<td>Rechtin (2004)</td>
<td>Complexity refers to interconnected parts in the system that are interdependent of each other in performing their functions.</td>
</tr>
<tr>
<td>Sussman (2007)</td>
<td>A system is complex when it consists of a group of related units and the nature of the relationships is not fully understood.</td>
</tr>
</tbody>
</table>

**Table 2.1 Complexity and System**

Complexity is increased from the heightening of inter-firm relations contributing to the antecedent of network firms in the supply chain management. In Table 2.1, which refers to the origin of complexity, the researcher’s data largely originated from the field of computation physics and system study. Hall et al. (1967) refer to complexity as being the different components that together make a whole. Similarly, Blau and Schoenherr Perrow (1971), Mileti et al. (1977), Bak and Paczuski (1997) and Deshmukh et al., (1998) concluded that complexity is the result of the patterns of interactions among components and the strength of the respective interactions. Perrow (1973) characterized complexity as being the number of components, components’ attributes and mode of connections between components in a system. Rechtin’s (2004) view of complexity is
similar to that of Perrow (1973). Rechtin (2004) views complexity in a system as the interconnected parts in the system that are interdependent of each other in performing their functions. There are three important elements regarding the respective descriptions by Perrow (1973) and Rechtin (2004) of the complexity: i.e. many parts, interconnectedness and the interdependency of the parts. On a similar note, Sussman (2007) defines complexity in a system as being complex in instances where the system consists of a group of related units and the nature of the relationships is not fully understood.

Overall, the literature indicates that complexity arises from the fragmented yet extensive inter-connectivity between the varied elements in the system structure towards achieving consensus goals. Because the supply chain is also a composition of varied yet inter-connected firms that work together to produce finished goods and services, the supply chain represents a system, or more specifically, a complex system of interrelated firms. Thus, when referring to the supply chain as the system, it can be argued that the complexity in a supply chain arises from the fragmented yet extensive inter-firm relations between the varied firms in the network structure (Choi and Krause, 2006). These descriptions of complexity would justify the argument that the supply network is also complex, and the inter-firm relations represent the inter connectivity between the elements in the system (Choi and Krause, 2006; Mason-Jones and Towill, 1998; Sivadasan et al., 1999; Vickers and Kodarin, 2006). Using this lens from the literature studies concerning system complexity, the researcher reviews the complexity phenomena in the context of the supply network. A review of the description of the complexity inherent in the context of the supply network highlights a similar source of complexity in the supply network (see Table 2.2).

In Table 2.2, the researcher reviews the complexity research in the context of the supply chain in order to determine the underlying drivers and factors of the complexity. By adopting the earlier definitions of complexity and the extant literature findings in Table 2.2, the complexity in the upstream supply network can be identified into three elements, as follows.
First, one source of complexity in the supply chain arises from the sheer number of firms operating in the supply chain (Bozarth et al., 2009; Choi and Krause, 2006; Milgate, 2001). The number of firms has been identified in earlier literature to influence the performance of the supply network (Beamon, 1999a) The argument is that, as the number of firms within the supply network increases, this, consequently, increases the managerial and operational requirements needed to maintain the relationship with the other firms across many boundaries (Vachon and Klassen, 2002). Choi and Krause (2006) refer to complexity in the supply network as “the degree of differentiation of the focal firms’ suppliers, their overall number and the degree to which they interrelate” (p.643). On a similar note, Bozarth et al.,(2009) put forth (and empirically tested) a model of supply chain complexity that includes the high number of suppliers and customers (both upstream and downstream of the supply chain) as components of the complexity. The result shows that the supply of a high number of firms increases the operational burden and subsequently, the performance of the focal firm in the supply chain.

The second dimension that spurred complexity in the supply chain is the differences of the respective firms in the supply chain (Choi and Krause, 2006). Variety between firms in the supply chain can result from the differences that exist between firms as a result of capacity, organizational culture, geographical location and years of operation and size (Adobor and McMullen, 2005; Choi, 2009; Gibson and Gibbs, 2006; Harrison and Klein, 2007; Mayo and Pastor, 2005; Reagans and Zuckerman, 2001; Van Knippenberg and Schippers, 2007).
<table>
<thead>
<tr>
<th>Author</th>
<th>Supply network Complexity Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beamon (1999)</td>
<td>Number of tiers and the number of firms in the tiers signifies the complexity of the supply chain.</td>
</tr>
<tr>
<td>Beamon (1999)</td>
<td>Number of suppliers contributes to the complexity of the supply chain.</td>
</tr>
<tr>
<td>Milgate (2001)</td>
<td>As the number of product parts and interconnection increases, the impact of supply chain complexity correspondingly increases.</td>
</tr>
<tr>
<td>Sharon and Eppinger (2001)</td>
<td>Adding more components to coordination is needed to ensure development and eventually increases complexity.</td>
</tr>
<tr>
<td>Vachon and Klassen (2002)</td>
<td>Number of firms and relationships with other firms across many boundaries.</td>
</tr>
<tr>
<td>Sharon and Eppinger (2001)</td>
<td>The more interconnected are the parts in a system, the more complex it is to coordinate.</td>
</tr>
<tr>
<td>Pant, Sethi and Bhandari (2003)</td>
<td>Involvement of a large number of customers and suppliers, the company also has equally complex external operations.</td>
</tr>
<tr>
<td>Perona and Miragliotta (2004)</td>
<td>A variety of components increase coordination and management, i.e. supply chain complexity.</td>
</tr>
<tr>
<td>Adobor and McMullen, Choi, (2009); Gibson and Gibbs (2006); Harrison and Klein (2007)</td>
<td>Differences that exist between firms such as organizational culture, geographical location, years of operation and size.</td>
</tr>
<tr>
<td>Masson et al. (2007)</td>
<td>The number of players and interactions in the supply chain.</td>
</tr>
<tr>
<td>Daft (2009)</td>
<td>Number of layers, communication and departmental interaction within a firm provide a general measure of the organizational level of complexity.</td>
</tr>
<tr>
<td>Bozarth et. al. (2009)</td>
<td>A high number of suppliers and customers both upstream and downstream of the supply chain appear as components of the complexity.</td>
</tr>
<tr>
<td>Johnson (2010)</td>
<td>Large numbers of firms and functions across which these operational activities must be coordinated, each of which has its own information, objectives, capabilities and circumstances.</td>
</tr>
<tr>
<td>Basole and Rouse (2010)</td>
<td>Complexity depends on the number of actors involved in delivering the products and services to the consumer.</td>
</tr>
</tbody>
</table>

**TABLE 2.2 DRIVER OF COMPLEXITY IN THE SUPPLY CHAIN**
Third, other than the number of firms and the differences, the supply chain complexity also results from the degree of inter-relationship between firms in the supply chain (Choi and Krause, 2006; Wilding, 1998). Inter-relationship between firms in the supply chain could be in the form of physical goods exchanges (Ding, Sun and Kallaus, 2007) or information exchanges such as market data or financial flows (Sivadasan et al., 1999).

In the context of the upstream supply network structure, particularly, Choi and Krause (2006) have stated that the upstream supply network or the supply base has been experiencing increased complexity through this fragmented yet extensive inter-firm relationship. For example, in an upstream supply chain of car manufacturers, a supplier may supply parts to a manufacturer, while this manufacturer may at the same time supply other parts to the same supplier company. One intriguing fact is that many of these working relations between suppliers in the upstream supply network often exist beyond the knowledge of the focal firm.

A firm in the upstream supply network may welcome the inter-firm relations if the information exchanged promotes better coordination of the supply network. However, it may be unwelcome if the inter-firm relations contribute to leakage of information in the upstream supply network. Consequently, a firm’s perceptions regarding a good partner may change abruptly. Therefore, inter-firm relations among firms in the upstream supply network are an important aspect of the upstream supply chain complexity. The inter-firm relations among firms in the upstream supply network (no matter whether the firms compete or cooperate with one another) have been found to impact upon the economic performance of the focal firm or manufacturer (Choi et al., 2008).

These previous studies indicate that the evolution of a supply chain creates a more complex structure arising from the inter-firm relations existing for the production of finished goods and services. Choi and Krause (2006) have concluded that the inter-firm relationship is one of the drivers of complexity in the supply base, and deeper understanding is needed to overcome the complexity resulting from these inter-firm relationships. More specifically, the fragmented yet
extensive relations between them create a level of complexity, which demands effective and efficient management strategies from managers. Managing these complexities has become an integral part of a supply chain manager’s activities. What makes the upstream supply network more complex is that, to date, current studies in the operation and supply chain management literature have only been focusing on the formal materials flow type of relations between the firms in the supply chain. However, in fact, there are other forms of inter-firm relations, which contributed to the overall complexity in the supply chain. Nevertheless, as indicated by the embeddedness theory and the studies of scholars such as Borgatti and Li (2010), the formal commercial transactions in the supply chain are embedded in a web of informal social exchanges (Grannovetter, 1985).

In the following section, the researcher discusses the concept of embeddedness and its implication in network relationships.

2.3 EMBEDDEDNESS

In this section, the researcher will focus on the stream of literature regarding the nature of firm embeddedness. The focus will concentrate on the impact of firm embeddedness and the antecedents of firm embeddedness or involvement in networks.

The adoption of network firms in the upstream supply network structure relates to the assertion of network forms of organization in an inter-organizational or inter-firm relationship as conducted by an organizational study researcher. For example, Powell’s (2003, p. 113) statement described the overall transition of organization form over the years as follows:

...firms are no longer structured like a medieval kingdom, walled off and protected from hostile outside forces...but....involved in an intricate lattice work of collaborative ventures with other firms, most of whom are ostensibly competitors’
In the statement, Powell (2003) traced back the development of the organization form in order to understand the nature of the integrated network form of organizations; in particular, its benefits and limitations.

According to the rational model of organizations, an organization is a self-contained system with high coordination instruments to achieve well transmitted and known goals (March and Simon, 1958). In contrast to the rational model, the open system form of organization argues that organizations are mutually beneficial parts (Anderson and Narus, 1990). Under this school of thought, organizations are viewed as interdependent because every organization both contribute and receive something from the system as well the larger environment (Adler, 2001). Scott (1988) describes the open system model as a system of interdependence of the system elements. The interdependency is driven by different interests that are highly influenced by the environment. Thus, while the rational model stresses the element of independence, the open system model emphasizes the interdependency existing between the elements.

The advancement of the open system perspectives to the study of organizations has raised the issue with regard to inter-firm relations strategy (Milgate, 2001; Sivadasan et al., 2010). Paramount among these strategies is the understanding of the inter-firm relationship. An inter-firm relationship is part of organizational planning and strategies involving multiple firms.

Integrated network refers to the notable structure of the inter-firm relationship. Globalization has made the study of inter-firm relations increasingly important, as the resources needed to undertake the task of organizational management have grown in scale. Hence, this limits the potential of independent action by any single organization (Kauffman, 1993). It is believed that a holistic understanding of the inter-firm relationship would catapult organizations into providing better service as well as cost reduction (Faems, Van Looy and Debackere, 2005; Krauss, Mueller and Luke, 2004; Lawson et al., 2009; Stuart, Hoang and Hybels, 1999).
This situation arises because a network, argued Powell (1990), facilitates the exchange of efficient and reliable information. This is due to the relational capital developed through the firms’ level of embeddedness in the network structure.

The embeddedness concept was initially coined by Polanyi (1957). The author wrote: “the human economy... is embedded and enmeshed in institutions, economic and non-economic” (p. 250). Since Polanyi, studies on embeddedness have developed in various ways. The most prominent work on the topic of embeddedness originates arguably from the economic sociologist, Granovetter (1985). Granovetter (1985) posited that transactions between actors in a network are embedded in a social context. This means that economic transactions in network structure are embedded in interpersonal or social relationships.

According to Granovetter (1985), embeddedness refers to the level of involvement of a firm in the network of inter-relations. A firm’s levels of involvement have an impact upon its actions or behaviour in the network. Granovetter (1985) advanced the concept of embeddedness as an effort by which to explain economic behaviour of an organization.

Embeddedness is based on the contextualization of economic activity in ongoing patterns of social relations and captures the contingent nature of an economic actor’s activities by the virtue of being embedded in a larger social structure (Granovetter, 1985). More specifically, economic decisions and outcomes are affected not only by the actor’s isolated relations with other individuals or firms in the network but also by the structure of the overall network of relations within which the actor resides. Economic behaviors are embedded in the network of relations that provide the context for economic processes (Granovetter, 1985). As every behaviour materializes through some form of outcome, almost all economic processes are presumed to be embedded in the networks of relations.

Thus organizational performance is influenced by the pattern of embeddedness of the organization in the network. Since in the upstream supply network, firm embeddedness relate to the degree of the interaction that a firm may has with other firms in the network which are a direct
reflection of the firm degree of inter connectivity with others in a network. Hence, one may conclude that organization performance in the supply network may also be influenced by the organization embeddedness pattern such as its centrality and connection (Scott, 1998) with other organizations in the supply network (Mueller, 2000). Following the seminal work of Granovetter (1985), the embeddedness concept has become a highly valued research area in the field of organizational studies. The concept has since been adopted in various inter-organizational research domains such as, notably: industrial districts (Ahuja, 2000), cooperative (Gnyawali and Madhavan, 2001), hotel industry (Ingram and Roberts, 2000), banking (Uzzi, 1997; 1997; Uzzi and Lancaster, 2003) and innovation (Oerlemans, Meeus and Boekema, 2001).

Being embedded in a network structure is an indication of interaction among firms in a network structure (Uzzi, 1997). The resulting pattern of firm's embeddedness creates a network of interdependent social exchanges, and subsequently increasing the level of relational capital such as trust, reputation and respect present in the relationships.

Embeddedness and relational capital have their origins in the social network and organizational strategy literature. When a member of an organization is embedded with external networks outside the workplace, it has been documented that opportunity, trust and motivation may increase the level of social exchanges among the group. This concept of social capital or relational capital is well recognized in the group behaviour literature (Burt, 1995, 2004; Burt and Knez, 1996). Group social capital is the configuration of a group member’s social relationships within the social structure of the group itself, as well as with broader social structure of the organizations to which the group belongs and through which the necessary resources for the group can be accessed. Since embeddedness revolve around the issues of relational structure’s characteristics which include the relational quality of inter-organizational interactions and the resulting structure of network ties (Uzzi, 1996), it is principally concerned with how economic activities are influenced by the quality and structural form of material, and information exchange relationships (Uzzi, 1997). Hence, it is argued that, in relation to the social network analysis approach; the configuration of network of
relations can facilitate or impede an organization’s behaviours and performance through the development of social capital (Burt, 1995; Choi and Kim, 2008; Nohria and Gulati, 1996). For example, a firm may decide not to follow through with a contract agreement with a potential partner following a bad review from another. Certain firms of the network may then emerge as trusted exchange partners who may come to assist in time of needs (Ahuja, 2000; Cousins et al., 2006). While this approach may have been widely applied and recognized in the individual and intra-organizational literature (Gnyawali and Madhavan, 2001; Gulati, 1998; Moran, 2005; Simsek, Lubatkin and Floyd 2003; Uzzi, 1997), the central role of embeddedness in larger structure such as the supply network is often overlooked (Mueller, 2000).

Research applying the embeddedness theory lens to supply chain relationship is beginning to appear since the last decade. Recent studies have emphasized the impact of embeddedness in driving improve supply chain performance. For instance, the embeddedness in social interaction between firms in the supply network were found to be an important factor in solving problems and reducing total costs (Stuart, 1997). Choi and Kim (2001) present the initial platform for operations and supply chain management researchers to adopt the embeddedness concept into the supply of supply input in the supply network. Using the Social Network approach, the authors present the embeddedness concept from the perspective of the supply chain. The authors posit the importance of framing organizations in the supply network (i.e. suppliers) as being embedded in a larger supply network than in isolation. Such framing provides organizations in the supply network with better basis in developing policies and long-term strategies. The authors went on to posit that the embeddedness of organizations in the supply network influence its performance, a statement in tandem with previous network research findings that found the configuration of network of relations can facilitate or impede an organization’s behaviors and performance (Granovetter, 1985; Burt, 1992; Nohria, 1992). Krause, Handfield and Tyler (2007) also documented that embeddedness in the supply network of information sharing is an important means for transferring appropriate practice. These findings on embeddedness and relational capital are not particularly new.
Nevertheless, the theoretical elements' underlying firms’ embeddedness and relational capital in the supply network have little theoretical underpinnings based research to underpin them. A more systematic study into the extent to which embeddedness of the different inter-firms relationships network contributes to the creation of relational capital is warranted.

One of the underlying potentials of the network resides in the embeddedness of the organization in the network. More recently the concept has been adopted by the scholars in the operation and supply chain management field to comprehend the supply network (Choi, 2001; Autry and Griffits, 2008).

The findings of the earlier research on network positions and embeddedness indicated that these two network elements provide the organization in the network with resources relevant to the degree of embeddedness. One could argue that organizational embeddedness is an important source of capital such as power and information. These findings, however, centre on research sites that include bio-technology clusters, industrial clusters, media organizations, medical fields and individual networks.

Despite the propositions of scholars on adoptions of the social network research tools to study the impact of network structure on the supply network, little or no research has been conducted to empirically test the relationship between the network structure and the supply network relational capital outcomes.

It’s clear that network scholars have found a strong relationship between organizational embeddedness in network structure and organizational social capital in a decentralized network form of organization (Wasserman and Galaskiewicz, 1994, Ter Wal and Boschma, 2009, Chang, 2003a, McEvily and Zaheer, 1999, Ahuja, 2000, Anderson et al., 1994, Provan et al., 2007, Galaskiewicz and Marsden, 1978, Johnson and Mareva, 2002, Haibin, 2004, Breschi and Lissoni, 2005, Hite et al., 2005). However, the literature is silent about the relationship between organizational embeddedness and organizational social capital in a centrally governed supply
network that is a network governs by a strong focal organization which enforces and monitors the supply and demand of materials by other sub organizations in the network.

Although no doubt organizational social capital matters in network forms of organizations, we argue that the presence of a central actor of or dominant power such as the focal organization in a supply network, may change the pattern of inter connectivity and ties among organizations in the network hence the impact to the organizational social performance. At the minimum, the flow of information may have to go through the central actors before it can be disseminated to other actors in the network. Furthermore, the formal power of the central organization may add new perspectives to the informal, social control mechanism operating in the network.

The increase in the adoption of the embeddedness concept in inter-organizational network research may be driven by the potential rewards harbourd through the network interactions. In the following section, a review of the antecedents of embeddedness of firms in a network is given in order to understand the pulling factors that drive firms to be involved or embedded in a network of inter-firm relations.

A decentralized network structure is a network that was formed voluntarily among firms or organizations in the public area of the business sector. Nevertheless, the literature is rather silent regarding the relations between firm embeddedness and relational capital outcomes in a centrally managed network; that is, networks managed and administered by a focal firm such as the upstream supply network.

2.3.1 ANTECEDENT OF FIRM EMBEDDEDNESS

Gulati, Nohria and Zaheer (2000) argued that organizations’ respective behaviour, and performance can be fully comprehended by analyzing their embeddedness in the network. The business strategy scholars contend that networks give organizations access to information, resources, markets, and technologies (Ahuja, 2000; Cousins et al., 2006). Thus: “(ties) building
may not only be the most important resource for the firm but also the source of a sustainable competitive advantage” (Batt and Purchase, 2004, p. 169). It allows organizations to obtain strategic goals such as: sharing risk and outsourcing value, generating collective benefits (such as higher reputation) to all other organizations in the cluster and regional competitiveness (Krause, Handfield and Tyler, 2007). These advantages are outcomes of the firms’ embeddedness or involvement in the network of inter-firm relations. Consequently, this formed the antecedents of extensive inter-firm cooperation, while putting a check on some of the potentially opportunistic behaviour of other network actors.

In the supply network of interrelated firms, similar results were found. For example, Womack (1991) argued that firms participate in extensive inter-firm collaboration activities in order to integrate, coordinate and obtain resources under the condition of resource scarcity. Others found that organizations affiliate themselves with prominent actors in the networks to obtain power and resources, as well as enhancing their survival (Sivadasan et al., 2010).

Even though organizations build ties with others in the network voluntarily to obtain competitive advantages and resource sharing, ties also emerge through the interjection of forces external to the network. Industry leaders in business sectors and government agencies have been found to have introduced collaboration among other organizations in the network when there is a concern on equal sharing of costs and benefits among organizations in the network (Provan, 1993; Provan and Kenis, 2008). Further, an administrator firm is also often introduced to manage the flow in the supply chain. For example, it is common to find a viable upstream supply network in an automobile supply chain, and a densely-connected downstream network will eventually link computer hardware and fabric’s manufacturers with value-adding retailers (Christopher, 2000; Kapuscinski et al., 2004). Similarly, Human and Provan (2000) found how network administrators help the development of network legitimacy among organizations in the United States wood product industry.
Overall, firms’ embeddedness in network relationships is driven by self-interest and commitments such as the acquisition of more resources and meeting private objectives. The antecedents indicate that firms value a network of inter-relations. Consequently, this indicates that being embedded in a network of inter-relations impacts upon firms individually and the network collectively.

In the following section, a review of the literature studies concerning the impact of firm embeddedness is provided in order to capture the implication of embeddedness.

2.4.2 IMPACT OF FIRM EMBEDDEDNESS

Embeddedness has been extensively discussed and documented in the field of economic sociology (Baum and Dutton, 1996). Sociologists have promptly indicated that the different social structure architectures in exchange relationships shape the flow of resource and subsequently, the embeddedness structure (e.g Coleman, 1988; Freeman, 1979). These distinct architectures in turn generate both constrains and opportunity for the tied organizations and can implicate the organizational performance and behaviour. Base on this viewpoint, we argue that much of the study of buyer supplier relationship in the supply chain characterized an under-socialized account of the buyer supplier organizations behaviour or actions.

Borgatti and Li (2009) reiterated this gap, where in an evaluation of a buyer supplier relationship that forms the supply chain, they posited that researchers should not only focus on the immediate dyadic ties but also the extended ties or networks that the member organizations are embedded in. Choi and Kim (2008) stressed the importance of this perspective in their statement, which says that we can only gauge the true performance of an organization in a network once we “consider how [an organization] is embedded in its own network” (p.5). Furthermore, the authors added that “[organizations] now operate in an era of integrated suppliers and contract manufacturers that pull together parts from second-tier suppliers. Even some of these integrated suppliers, as they become large, are working with smaller integrated suppliers. Further, buying
companies rely more on their suppliers for design activities, and often suppliers are asked to work together to arrive at optimal design solutions. In other words, today we operate in an environment where suppliers have become embedded in their supply networks. If structural embeddedness is not managed well, then the performance of the buying company may ultimately suffer..." (Choi and Kim, 2008 p.6).

The supply network is an amalgamation of relationships or activities between firms (Croxton et al., 2001; Lambert and Cooper, 2000). Structurally, supply chain is virtually formed by the connectivity or links between firms where the integration progressively forms the ultimate structure, which is the supply network itself. According to Choi and Kim (2008), a buyer–supplier relationship represents a dyad, or two nodes and one link, in network terms. Each node can be conceptualized as an actor performing activities for the purpose of generating value (Carter, Ellram and Tate, 2007). The firms need resources from its supplier organization, and the supplier needs contracts and payments from the buyer. On top of that the firms interact to share information regarding market opportunities and new threats (Cousins et al., 2006). As a consequence, these phenomena create a link and form a dyad or a buyer–supplier relationship. Conclusively, a buyer–supplier relationship is not only a dyad. It is also part of a network that has come to bear on individual nodes to the relationship through each other’s extended business relationships. Thus, firms in the supply network are embedded in these different types of buyer-supplier relationships or simply, the supply network ties.

In supply chain management, one strategic way for firms to achieve their objective is through cooperation with other firms in the chain, since chains can raise performance levels above those attainable in normal market operations (Johnston et al., 2004). Through the amalgamation of their resources, firms manage and organize the supply process from the upstream firms to the downstream consumers, in the end forming their network of multiple member firms. The description of the supply chain has been described in many early definitions of the supply chain (see Lamming et al., 2000; Mentzer et al., 2001). The combinatorial emphasis of these definitions is
that: the transfer flow of resources and interaction activities between the firms, consequently, create a network of transacting organizations (Beamon, 1998). This network concept of the supply chain is supported by Lambert and Cooper (2000). Lambert and Cooper (2000) relate supply chain to network through three arguments. First, Lambert and Cooper (2000) argue that the supply chain involves several stages of intra- and inter-organizational vertical coordination. These various coordination spans from the initial source of resources to end users. Second, the supply chain involves multiple independent firms. Thus managing the relationship between member organizations is utmost importance. Third, a supply chain involves bidirectional links. Bidirectional links include formal and informal ties associated within managerial and operational activities.

Within a supply network, the buyer-supplier relationship may take several forms such as contractual ties, or market transactions to informal information sharing ties (Carter, Ellram and Tate, 2007; Galaskiewicz, 2011; Kim et al., 2010; Mueller, Buergelt and Seidel-Lass, 2007). Slack, Chamber and Johnston (1995) identified these ties base on five types of organizing relationships, which include short term trade, semi and long term trade, coordinated-profit sharing, long term alliance, and joint venture. According to the authors, short–term trade refers to a formal single transaction after which the relationship ends. Semi and long-term trade agreements refer to the trade agreements without formal contracts that legally bind the organizations. Van der Vorst and Beulens (2002) view the supply chain as lying between fully vertically integrated systems and those in which the member organizations are totally independent of each other. In our opinion, the buyer supplier relationship in the supply network may take on many forms as discussed above, bounded by one extreme by formal supply network ties and at the other extreme by the informal supply network ties creating a network of interrelated and interdependent firms (Borgatti and Li 2010).

The literature indicated two streams of research that study how the supply network ties influence the management of the supply chain. The first stream of research is in the domain of marketing and supply chain management. This literature stream has studied the embeddedness in
the buyer supplier relationship focusing on the organization as the unit of analysis, relationship quality, duration and type and has indicated that these attributes are success factors in the buyer supplier alliances (Bozarth et al., 2009; Claro, 2004; Mentzer et al., 2001). Even though this stream of research generally centres on the relationship attributes in dyadic ties, this stream of research was successful in determining several essential relational concepts that are generalizable to the overall supply chain. Unfortunately, the determinants or the impetus of the involvement in the network of multiple buyer-supplier organizations have rarely been researched in the literature (Autry and Griffis, 2008).

The second stream of literature addresses the question of the best fit. This line of study attempts to determine the best structure or configuration of the supply network to meet the challenge of market. This stream of literature is primarily concerned with issues such as inclusion or exclusion of buyers or suppliers, mapping the structure of the supply chain, and how clusters of the buyer-supplier relationships should be managed (Cooper, Lambert and Pagh, 1997; Gilsing and Nooteboom, 2005; Powell, Koput and Smith-Doerr, 1996; Shan, Walker and Kogut, 1994). Nevertheless, to our knowledge, there is no known best configuration of buyer supplier organizations operating within the network. This issue is further complicated by the fact that the relative success of network structural configuration is predominantly related to the relational context of the buyer supplier organizations interrelatedness (Autry and Griffis, 2008; Choi and Kim, 2008).

These streams of literature provide a fundamental justification in their explanation of dynamics of buyer supplier network. The attributes of the buyer-supplier organizations are the relevant embeddedness driver. However, the literature falls short of addressing the importance of ascertaining the extent to which the involvement or embeddedness of these buyer-supplier organizations relates to the type of relationships. Furthermore, the focus on the organizations or the partnership as the unit of analysis and the external environment are too atomistic (Cousins et al., 2006). When evaluating potential course of actions, such assumption lacks a certain variable which
equally important: the actions of other organizations or the relationships which the buyer supplier organizations are embedded in (Brookes and Singh, 2008). In addition, the themes ignore the interactive elements of the connectivity, whereby organizations obtain information from this connectivity. It is important to note that, although the buyer supplier relationship is essentially a dyadic tie between a buyer and a supplier, the outcomes and processes associated with the ties can be linked to the social network structure within which the buyer-supplier organizations are embedded in.

Network scholars and organizational study scholars have not only advanced the motivation and drivers of firms’ embeddedness in network relationships, but also the impact of firms’ embeddedness upon the network relationships.

First, in the business sector, scholars have found that embeddedness of firms in dense transactions and exchange relationships with the suppliers, and customers generate improved managerial performance. For instance, inter-organizational collaboration between organizations in the biotechnology industry has been the test bed of many network research studies seeking to highlight how firms’ centrality and strength of ties are key to new patent applications (Chang, 2003; Shan, Walker and Kogut, 1994). Ingram and Roberts (2000) argue that enhanced collaboration and better information exchange can be achieved through network structure. In a study of the hotel industry in Sydney, the authors found that friendship ties with competing hotel managers can assist to eliminate customers’ difficulties in finding suitable accommodation and consequently, increase the revenues of the respective hotels.

Second, it is argued that one important stream of embeddedness research is that a set of relational capital such as influence, reputation and trust has emerged from recurrent trade transactions and the inter-weaving of business transactions with webs of social exchanges in a decentralized network structure (Gulati, 1995). In this business environment, firms depend upon these relational capital items to coordinate and guard their interests against unintended and opportunistic acts from other network members (Stuart, Hoang and Hybels, 1999).
For instance, an opportunist action by one firm during negotiations with other firms might result in the opportunistic firm gaining a bad reputation as news of its unscrupulous acts will be shared with other firms that are directly or indirectly connected to the victimized firms. Consequently, the bad reputation of the opportunistic firm may cost the firm to lose potential accounts, as its promises and intentions are now viewed with less trust and integrity by other firms. In this context, the relational capital mechanism functions as the governance mechanism in embedded relationship exchanges.

Third, embeddedness of firms in the network not only increases economic performance, but also enhances the relational capital which often translates into the economic payoffs (Uzzi, 1997). Pierre Bourdieu (2010) defines relational capitals as the outcomes which have emerged from inter-firm relations. This definition stresses the benefits of network's embeddedness. Through relational capital, firms gain direct access to economic resources or align themselves with firms that provide the resources (Nahapiet and Ghoshal, 1998).

Starovic and Marr (2003) consider relational capital to include customer satisfaction and interactions with other firms by employees, distribution channels, supplier channels and franchising channels respectively. It is the information accumulated by the firm as a result of its interactions with other parties and the potential of future information arising from these exchanges.

Fourth, firms’ interactions are a source of knowledge (Nahapiet and Ghoshal, 1998). A firm’s network partners are, in many cases, an important source of new information and ideas that potentially could contribute to improved economic performance. For example, Gulati, Nohria and Zaheer (2000) argued that an organization’s behaviour, and performance can be fully comprehended by analyzing their embeddedness in the network. The business strategy scholars contend that networks give organizations access to information, resources, markets and technologies (Ahuja, 2000; Cousins et al., 2006). Thus "(ties), building may not only be the most..."
important resource for the firm but also the source of a sustainable competitive advantage” (Batt and Purchase, 2004, p. 169).

Sixth, firm embeddedness in networks facilitates the creation of relational capital (Putnam, 1993). Burt (2001) added that values of relational capital create business opportunities for the related parties. Relational capital such as trust, influence and reputation provides firms with values such as solidarity, especially when interactions are fixated and regulated based on rules and reciprocity (Provan and Milward, 2000).

In addition to that, economic gains such as reduced transaction costs and increased competitive advantages are benefits of improve trust in the respective network of an organization. For example, Powell (2003) argues that the network form of organization relies heavily on reciprocity, collaboration, and reputation in order to reposition products rapidly and responds quickly to changing market conditions and technological developments. The concept of reputation emerges as trust increases among the organizations in the network. Uzzi (1997) shows how firms in the New York apparel industry have embedded ties with each other in addition to arms’ length relationships.

Reputation also plays an important role in the business world. For example, Carmeli and Tishler (2005) analysed the complex set of relationships among perceived organizational reputation and a firm’s quality of products/services. This demonstrates that reputation is related with firm size and customers’ purchases.

Goins and Gruca (2008) present an empirical examination of how a layoff announcement by one firm impacts upon the reputations of other firms. The authors form competing hypotheses as to whether the announcement will affect other firms in the same way that it impacted upon the announcing firm, or whether other firms will instead experience an opposite effect. The authors find support in the theory that firms might gain competitive advantage over a rival who has suffered
layoffs. Hence, we could conclude that the actions of one firm reflect upon its rivals and draw out some of the factors that influence this spill over.

Continuing in the vein of the work of Goins and Gruca (2008), Yu and Lester (2008) applied social network analysis to give a theoretical perspective to elucidate how the reputational spill overs can take place in a network structure. Based on a study that adopted industry as a network, the authors investigated how both proximity and structural equivalence impact upon spill over effects on firms in the network. The authors documented that actors in a network who interact frequently with each other in a network have a tendency to occupy similar network positions and types of network ties between these organizations. These conditions, according to Goins and Gruca (2008), increase the likelihood of the actors to resemble one another and share common perceptions of reputation from stakeholders. Thus, interdependence in the network would depend on the organizational network position.

Purohit and Srivastava (2001) carried out an examination of warranty requirement behaviour among manufacturers and customers and found empirical evidence to suggest how reputation and reference of reputation can increase an organization’s performance in the market. Using the warranty as a predictor of reputation, the authors found support for their suggestion that manufacturers with poor reputation status will have to provide more warranties for their products. However, when these firms are tied to other firms, having a high reputation in the market, their reputation increases as they do not have to provide as much product warranty to their goods as the lesser-connected organizations.

Ebbers and Wijnberg (2010) adopted the panel data social network analysis program SIENA to estimate the effect of actor reputation derived from past performance on alliance formation in the project-based film industry. The authors documented that the strength of reputation and closeness in the network of past alliances increases the likelihood of alliance formation between the network actors. The findings of Ebbers and Wijnberg (2010) suggest that when actors or organizations are
connected or have ties with very significant or reputable actors in the network, their ties become a signal of quality and reliability, which subsequently increases the return of the associated organizations.

Reputation also plays an important role in franchising for outlets of a retail chain. Ou, Abratt and Dion (2006) conducted a survey among 356 grocery store shoppers to study the effects of individual retailer reputation on their store choice patterns. Using the Structural Equation Modeling (SEM) approach, the authors found that retailer reputation affects purchase frequency, travel time and expenditure levels. Podolny (1993) added that visible network ties to a highly reputable firm are a sign of quality. Consequently, bestows status upon an organization.

The author found that reference to prestige through ties to other prominent actors in the network allows for the provision of higher products and service's prices. Reputational capital is posited to contribute to reduced costs, ease of recruitment as well as increased employee loyalty (Carmeli and Tishler, 2005; Fombrun, 2008; Helm and Salminen, 2010; Luoma-aho, 2007).

Furthermore, trust emerges as connectivity increases among the organizations in the network. For example, Uzzi (1997) shows how firms have embedded ties with each other in addition to the arms’ length relationship. Uzzi (1997) refers to the arms’ length relationship as an opportunistic relationship; while embedded ties induce cooperation, and coordination among network organizations. The author further emphasized three features of embedded ties, which include: fine grained information exchange, joint problem-solving and trust (Uzzi,1997). The findings of Powell (2003) and Uzzi (1997) all point to the competitive advantage for organizations in a network form of relationships.

Moreover, a firm’s level of influence is an outcome of affiliations or inter-firm relations. Podolny (1993) found that visible network ties to a highly influential firm are a sign of quality that bestows status upon an organization. The author found that reference to prestige through ties to other prominent actors in the network allows for the provision of higher products and service's
prices. Meanwhile, Benjamin and Podolny (1999) found that firms that hold high interactions with others obtain a higher affiliation status than do organizations conducting lower-level interactions.

In social network terminology, affiliation with other organizations with high network centrality not only provides peripheral organizations with access to capital, these ties also provide other organizations with reputational spill-over benefits. Network centrality refers to an organization's position in the network relative to others (Scott, 1988). As one of the most important properties of network structure, network centrality evaluates an actor's status, prominence and power (Knoke and Kuklinski, 1982). Knoke and Kuklinski (1982) further stated that actors who are the most important or prominent in the network are usually located in the most central positions within the network. Being central means the actors or organizations are connected to almost all other actors in the network. The connections can be in the form of informal ties, such as information-sharing and referrals, as well as formal ties, which include contractual relationships. Exchange of resources occurs between actors who are tied together either formally or informally.

Thus, extensive contacts or associations with the central organizations in the network increase the availability of information and inflate the reputational spill over benefits (Luoma-aho, 2007). Hence, the embeddedness in the exchange network not only begets tangible returns, it also warrants the accumulation of other intangible ones such as the relational capital outcomes.

It is instructive to know that, scholars have argued that as organizational performance information is difficult to obtain, relational capital becomes an important element for the survival of the organizations (Ferris et al., 1998; Kramer, 1999). Relational capital is generated in the network of inter-firm relations. This argument can be promptly adapted to the upstream supply network. Because of the difficulties involved in analyzing the profiles or intentions of firms in the network, relational capital items such as reputation, endorsement, trust and influence are often applied by the stakeholders in order to make resource allocation/partnership decisions (Poppo and Zenger, 2002).
One implication of this dependency on relational capital is that a firm’s high level of involvement may result in increased relational capital outcomes upon it.

However, despite the various impacts of embeddedness found in the literature, many of these inter-organizational network outcomes studies have been focusing on the decentralized network structure. Little to no research has paid attention to firms’ embeddedness in centralized networks with focal firms, such as in the upstream supply network. In the upstream supply network, Choi and Krause (2008) argued that an upstream supply network is likely to be a centralized network structure. What affects firms’ embeddedness in such a centralized network structure has upon network relational capital outcome as per a decentralized network structure is not certain. One important element that may result in diverse relational capital effects is the nature of the network governance between a decentralized network and a centralized network structure.

Governance of network is unique as it often cuts across many rules and regulations. In network governance there is no single shared set of regulations that outline where and how decisions are to be taken and what rules are to be followed. Similarly, there is also no shared constitution that amplifies the fact that particular decisions have been implemented and is forthcoming. The uniqueness of this governance mode also answers for its weaknesses.

Absent in this governance network is not rules, regulations or constitutions per-se but rather, the consensus on what rules, regulations or constitutions to apply. As such, network governance is marked by ambiguity. The term “by ambiguity” signifies that there are no agreed-upon norms or procedures to determine where and how legitimate decisions can be enforced.

In addition, ambiguity also exists when firms are not in alignment when defining a situation or conditions that affect the network. This is because the network actors perceive the environment in different definitions, which imply that the very definitions at stake for particular actors are sometimes unclear to each other. These confusions may lead to incoherent actions between the
network members or participants who may result in unexpected outcomes from the network structure.

Another concern with network governance lies within the structure of the network itself. Since participation in a network is voluntary, voluntary participation alone can spell the ‘destruction’ of the network structure which can then lead to disconnections between the network actors. Since network participation is voluntary, formation or dismantling of the network is subject only to the needs and wants of the interested parties. However, when the network no longer supplies network actors with the tangible or intangible resources they need, the particular network actors are not obligated to announce their departure from the network; nor are they regulated to certain punishments for their abrupt departure.

**Figure 2.5 Complete Network Structure**
Source: Author
The ‘voluntary’ departure of these particular actors may result in what was previously a fully connected network structure becoming a disconnected or disjointed network structure. Figures 2.5 and 2.6 visually illustrate the case in point. In Figure 2.5, the network structure shows a network map with actors in the network connected to each other, except for one isolate, MTUKBALU. However, when three of the centre actors, i.e. APMMH, MTURAWNG, and WILTIM, are removed from the network, it results in a disconnected network structure as seen in Figure 2.6.

![Figure 2.6: Incomplete Network Structure](image-url)

**Figure 2.6 Incomplete Network Structure**
Source: Author
In Figure 2.6, we can see a dramatic change in the pattern of connectivity between the network actors. There are now two groups of isolates existing in the network. This is the sole isolates, i.e., MTUKBALU and a group of isolates, specifically: DMKTAN, MTUKTAN, DMKGANU and DMTBALI. In addition, the network now relies on unknown ‘brokers’ to connect the rest of the network members to other network members. The new brokers are MTUPJAYA, WILUTA and PMBPAHAT respectively.

Thus, clearly, although networks are apt for generation of social capital and consequently, increasing of competitive advantage, its lack of normal constitutions and tendency to be driven by voluntary participation are two main issues with the network structure.

To overcome the weaknesses of the network structure, but at the same time reap the reward of relational capital such as trust, influence and reputation, a centralized coordination mean is often introduced into the network structure. This is the case that this thesis sets out to investigate.

In the lead-up to this section, the researchers have highlighted the fact that the supply chain has become more complex over the years. One source of the complexity resulted from fragmented inter-firm relations. One common solution to the issue of inter-firm relations is through the adoption of an integrated network form of organizations. The impetus behind the adoption of network form of organizations is the generation of relational capital upon the firms embedded in the network structure which is vital for conflict resolution mechanism, as well being a source of competitive advantage. The prevailing belief in the inter-firm network literature is that networks are an effective mode of organization, and they lead to performance outcomes that go beyond what might have been achieved by network member organizations acting on their own (Provan and Milward, 2000). Thus, the network form of organizations holds the potential to solve the problems of coordination and integration in the complex upstream supply network structure. However, as the literature iterated in the earlier sections, networks are not without some issues. To the extent that network relations are decentralized, issues such as voluntary participation and lack of the norm of
constituents may mean that the decentralized nature of the network could create difficulties in the governance of the network.

Issues with a decentralized network structure indicate a need for centralized control and management of activities in the network structure in order to manage the complexity arising from the fragmented yet extensive inter-firm relations. A centralized coordination approach often involves a lead firm or a focal firm or manufacturer (Choi and Krause, 2006) that would manage the transactions of materials and other webs of social exchanges. This is the case that this research intends to investigate.

The basic idea behind a centralized network structure is that an administrative entity will function as the manager or administrator of the network and its activities. Although network members still interact with one another, the existence of the focal actor or firm determined that the network model is centralized. The focal firm plays a key role in coordinating and sustaining the network.

However, because the focal firm is the most powerful firm in the network structure, this may generate a Machiavellian image upon this focal firm. Literature has indicated some trade-offs, such as decreased level of commitments and reduced horizontal connections among firms in the network structure.

Network centralization reduces horizontal connections that are important for the creation of relational capital. As relational capital emerged through informal, horizontal connections between firms in the network, the introduction of a central focal firm may reduce the generation of relational capital or centralize relational capital upon the focal firm alone.

Applying this argument to the centralized upstream supply network structure, the level of relational capital experience by network members may be reduced because their levels of embeddedness are suppressed by the central focal firms in the lean relationships.
Commitments of network actors and horizontal connections between the network actors are important factors towards generating relational capital. Thus, an existence of a centralized firm may mean that network members may experience lower levels of relational capital as the outcome of reduction in commitments from network actors and reduction in horizontal connections.

However, literature has also indicated that the history of successful collaboration between firms can help maintain the level of relational capital between network actors. Thus, the relational capital outcomes that have forged prosperous collaboration activities within or outside of the network’s particular network boundary may be resilient in the eyes of certain network actors. Despite the reduction of embeddedness, some network members will still be perceived as more trustworthy, influential and reputable by other network members.

As indicated and described in section 2.3, the upstream supply network is a centralized network structure within the focal firm, i.e. the main manufacturer managing and administering the transactions between the firms in the supply base or the upstream supply network. To the extent that negative and positive effects influence the centralized network governance, a perplexing issue may also emerge regarding the impact of firm embeddedness in a centralized upstream supply network structure. It is not clear whether firm embeddedness in the centralized upstream supply network, will improve a firm’s level of relational capital; alternatively, will the centralized network governance impede the generation of the relational capital outcomes. This perplexity raised a question regarding the impact of firm embeddedness or involvement in the centralized upstream supply network structure, as follows: Is the embeddedness of firms in the centralized upstream supply network related to their respective relational capital outcomes?

This perplexity emerged as firm embeddedness, or its involvement with other firms in the upstream supply network, emerged solely through inter-firm relations but in the context of a centralized network structure. Although the extant literature studies of supply chain complexity have helped illuminate the strategies, processes and management, this literature may still lack some
of the perspective required to explain the overall nature of supply chain complexity. This includes, more fully, the impact, particularly with regard to the element of inter-firm relationships. Hence, the need to consider the veritable impact of firm embeddedness on relational capital in the context of the centralized upstream supply chain networks (Choi and Kim, 2008) is the key to illuminating the actual nature of supply network complexity and its management strategies (Borgatti and Li, 2009) resulting from extensive and fragmented inter-firm relationships. Even though no doubt relational capital matters in the business environment, such as the upstream supply network, the presence of a powerful focal firm in the centre of the network may alter the pattern of interaction among firms and the resultant consequences.

This need is dire as highlighted in the recent article of Choi and Kim (2008):

[while….literature has enhanced our understanding of relational assets within the dyadic relationship between a buyer and its supplier; it falls short of addressing the importance of extended networks beyond the immediate dyadic relationship… we need to consider how a [firm] is embedded in its own networks if we are to truly gauge its performance. (p.5)

Overall, firms may rely upon relational capital resources such as trust, influence, and reputation as an alternative to the existence of management strategy in order to gain an improved competitive advantage. These relational capital outcomes emerged from horizontal inter-firm relationships within a network structure. Since firms in the upstream supply chain rely upon the same relational capital outcomes to obtain a competitive advantage, one can argue that relational capital outcomes operate in the upstream supply network regardless of the level of embeddedness of the firms. Social capital resources such as trust, influence, and reputation emerge as a result of the embeddedness of the buyer-supplier organizations or involvement in inter-firm relationships within the context of the supply network. Because relational capital outcomes of trust, influence and reputation improve a firm’s competitive advantage (and consequently, its relational capital outcomes), firms may compete intensely in terms of relational capital outcomes due to the potential
rewards that the relational capital outcomes may provide to firms in the centralized upstream supply network.

Because of a network concern relational among the entities of the network, one must comprehend how these relations materialized and are visualized structurally. Proponents of network in the supply-chain research (e.g. Borgatti and Li, 2010; Choi and Kim, 2008; Lazzarini and Chad, 2002) proposed and applied the network approach regularly to study the inter-firm relationship in the context of the supply network. As a result, it is natural to review the literature of the network analysis and its relevance to this study, particularly concerning the development of relational capital outcomes in inter-firm relations. Consequently, a review of the literature of network analysis is given in the following section which will describe how the interactions among entities of the network impact upon overall performance.

2.4 NETWORK ANALYSIS

The network approach or what is commonly termed as Social Network Analysis (SNA), is a tool developed in the field of sociology that has been adopted in the context of organizational studies to study the impact of interaction on the performance of an organization. The origins of network analysis, however, can be traced to three diverse strands. The first were the sociometric analysts (e.g Kurt Lewin and Jacob Moreno) that developed the methods of graph theory to introduce many technical network analysis advancements. Second were the the Harvard researchers (e.g. Harrison White) who explore patterns of social interactions and the development of cliques. This was later further developed by students that he had trained. As his students moved into their respective careers across the world, the arguments of the Harvard and British scholars were united into a complex framework of social network analysis (Knoke and Kuklinski, 1982). Third were the Manchester researchers (notably John Barnes, Clyde Mitchell and Elizabeth Bott) who made marked developments in the alliance of mathematics and social theory. An important aspect in this
strand of researcher is the development of a new ability of the SNA to model a larger network structure that emerged from dyads or actors to triads and consequently the larger network structure.

Social network analysis in its focused form was later adopted by many social science researchers in order to investigate the impact of social interaction in a much more dedicated manner. One of the formative works in the social network analysis literature was the Granovetter (1973) study relating to the strength of weak ties. Mark Granovetter’s (1973) influential paper, “The Strength of Weak Ties,” considered how social networks affect an individual’s ability to find a job. In exploring the social networks of jobseekers, the author characterized the ties the job seeker had to others as being either strong or weak. The strength of the tie was measured by, specifically: the amount of time spent with the contact, the emotional intensity of the relationship, the level of intimacy or the amount of confiding, as well as the reciprocity of these things. The author interviewed a random sample of “job changers” in professional, technical, and managerial fields, and asked those that found new jobs through contacts how often they saw that particular contact during the time the job information was passed on to them. Surprisingly, Granovetter (1973) concluded that people received better job tips from their weak ties than from their strong ties.

Another important research development in SNA came from the work of Freeman (1979). Freeman (1979) investigated the positional impact of an actor in a social network. The author developed several positional measures that contributed to the greater understanding of the impact of structural embeddedness in a network. A centrality measure such as betweenness centrality was among the positional measures developed by Freeman (1979) to examine the relationship between individual position and power within a network. In this seminal work, Freeman (1979) documented that actors in the network occupying a central position between two actors (i.e. betweenness centrality) have access to more important resources as part of the benefits of being in a brokerage position in the network.
While the social network analysis is often applied in research concerning inter-organizational relations, critics of the inter-firm complexity research in the supply chain argued that very limited application of the SNA has been applied by operation and supply chain management literature in an attempt to explain how the structure of interactions among firms in the supply chain enables or disables firms to obtain individual or collective benefits.

For instance, in a typical nature of a supply chain, manufacturers or the focal company usually have more than one supplier for part components, while the supplier in turn has their own suppliers. The researcher should incorporate into their analysis the fact that the buyer-supplier relationship does not only concern one buyer and one supplier (dyad), but also other organizations within the whole network structure.

More recently, Choi and Kim (2008) have also pointed out the need to define the context of the buyer-supplier relationships rather than the interaction process per se. Consequently, it is warranted to argue that the actions of entities in buyer-supplier relationships can only be fully elucidated in terms of the positions of these buyer-supplier organizations in the network relationships.

Choi and Kim (2008) draw on balance theory to stress the need for supply chain managers to adopt a strategy that pictures the firms as being involved or embedded in a larger network structure rather than existing in isolation. The authors argue that such strategy helps create a more accurate response to the market environment.

Despite the increasing recognition of the importance and applicability of network to inter-firm relationships in the supply chain, researchers still address the relational dynamics of inter-firm relationships from a variety of firm-level analyses, rather than from the network perspective (Carter, Ellram and Tate, 2007). This is accomplished by using various theoretical approaches, such as: a resource-based view of the firm (Cao and Zhang, 2011; Holweg and Pil, 2008; Ordanini and Rubera, 2008; Zsidisin, Ellram and Ogden, 2011), transaction cost economics (Cao and Zhang, 2011; Cheung, Myers and Mentzer, 2010) as well as a relational view of the firm (Sanders, Autry
and Gligor, 2011). The level of analysis in much of such existing literature still centres on the isolated dyadic ties between buyer-supplier organizations.

However, scholars of SNA argue that “no firm is an island” (Gibbons, Holden and Powell, 2009). An important development of the network study is the assertion that network actors are embedded in a larger network structure of interconnected actors (Choi and Kim, 2008).

Thus, what this means is that, with the advent of a supply network as the prevalent structure of an inter-firm relationship (Harland et al., 2001; Lamming et al., 2000), it is imperative to understand this in the context of the embeddedness concept within which the inter-firm relationship takes place. This is because, as many scholars have posited, the actions and performance of an organization can be better explained by examining the relationship in which the organization is embedded (Ahuja, 2000; Gulati, 1999; Zaheer and Bell, 2005).

Overall, embeddedness implicates greatly upon firms or organizations in the integrated network form of organizations. Network is superior to hierarchy, as the embeddedness or involvement of the network elements in the network of inter-firm relationships (Powell, 1996) generates relational capital benefits to the firms (Putnam, 1993). Thus, firms’ embeddedness in the network structure contributes positive outcomes to the embedded firms.

2.5 SUMMARY

Scholars such as Mueller (2000), Borgatti and Li (2010), as well as Autry and Griffits (2011), have confirmed the underlying principle of the embeddedness theory. This states that firms in such a supply network structure are also interacting with each other through alternate means of informal inter-firm relations, such as information-sharing and referral relations (Provan and Milward, 2000).

Choi (2008) suggests that learning in order to comprehend and cultivate the type of interaction in the upstream supply network is an alternative to a reductionist strategy in the management of upstream supply chain complexity. For example, Wilding (1998) proposed that to
understand the complex nature of the supply chain, parallel interactions of the network’s interconnected elements of the supply chain must be given due to attention.

In their seminal work, Choi, Dooley and Rungtusanatham (2001) provide a different view of supply chain complexity management. Based on the theory of complex adaptive systems, the authors indicate how a complex supply network should be managed when it is viewed as an adaptive system. Following this, the authors proposed that firms exercised both formal means of coordination (e.g. rules and terms) and informal means of coordination (e.g. social relationships) in order to manage the inherent complexity (Choi et al., 2001, p.363).

Chin et al. (2004), through a survey of 1000 Hong Kong companies, proposed management practices that integrate, particularly: purchasing, inventory control, logistics, forecasting, production and quality management and other webs of social exchanges. The results of a survey conducted by Sahay and Mohan (2003) of 1733 firms in various industries in India suggested an integrated management strategy involving: customer service, inventory management, demands management and information technology among firms in the supply chain. Cooper and Elram (1993) measured a good supply chain and identified SCM activities that include: channel-wide inventory management, cost efficiency, long term time horizons, joint planning, reciprocal information-sharing, interactive information monitoring, supply chain coordination, suitable corporate values, risk sharing, as well as return and reward sharing.

In addition, Koh et al. (2007) surveyed 800 Small and Medium Enterprises (SMEs) in the manufacturing industry and found that cooperation and collaboration with suppliers are a key to effective complexity management in the supply network management. Wong et al. (2005) researched supply chain management practices in the toy industry. Zairi (1998) researched into the foremost TSCMP in the retail sector and identified that integrated practices such as order management, inventory replenishment, distribution and transportation and information-sharing are the optimum way toward providing values to the customers. A survey by Law et al. (2009) of 32 executives in Thailand in the electrical and electronic industries found that the relationship with suppliers, as well as the relationship with customers, is vitally important in managing complexity in the supply chain.

Although the reductionist approach to the management of upstream supply network complexity has previously been adopted by managers, this study argued that the principle of the reductionist approach may disregard other valuable characteristics of partners who are not visible through the accounting measures commonly adopted to evaluate the performance of partners. The alternative to this is the adoption of an integrated network of firms, which rely upon collaboration and cooperation between each other. The literature indicates that management of the complexity resulting from the extensive yet fragmented inter-firm relations require an integrated network of services and process to handle the issue of inter-firm complexity (Womack, 1990). The adoption of network forms of organizations into the management of complexity resulting from inter-firm relationships may be rationalized by the fact that a network form of organizations introduces relational capital outcomes to a firm. Moreover, organizational researchers such as Zaheer et al. (1998) have confirmed that relational capital factors such as trust, reputation and influence contribute improved competitive advantages and consequently, an improvement in the firm’s economic performance.

The hypothesis regarding the effects of network structure and relational capital, as well as the outcomes of studies at the inter-firm network level are rather deterministic (Ahuja, 2000; Zaheer
and Bell, 2005). Previous literature addressed these issues through the argument that a loose, decentralized network is beneficial for the creation of relational capital. This stream of literature did not consider the possibility that the network structure is fragile and non-regulated, which may or may not alter the impact of the potential reward of network connections.
CHAPTER THREE
THEORY AND HYPOTHESES

3.1 INTRODUCTION

In this chapter the researcher discusses the development of the hypotheses created for research question one of this study. The researcher advanced the ideas that are used to develop the hypotheses. Second, the researcher will discuss the network theory of the Social Network Analysis adopted for this study. The researcher will then give a brief summary of the arguments made in this study. Finally, the researcher develops the study hypotheses. The progression of this chapter is described in Figure 3.1.
3.1 Introduction

3.2 Effects of Inter-firm relations

3.2.1 Summary of Theory

3.3 Hypotheses Development

3.4 Research Hypotheses

3.4.1 Embeddedness and Trust

- Hypothesis 1
- Hypothesis 2
- Hypothesis 3
- Hypothesis 4

3.4.2 Embeddedness and Reputation

- Hypothesis 5
- Hypothesis 6
- Hypothesis 7
- Hypothesis 8

3.4.3 Embeddedness and Influence

- Hypothesis 9
- Hypothesis 10

Figure 3.1 Chapter Flow
3.2 **Effects of Inter-Firm Relations**

Relational capital is a concept that is being increasingly adopted in public policy, organizational study and more recently operation and supply chain research (Baron, Field and Schuller, 2000; Dakhli and De Clercq, 2004; Landry, Amara and Lamari, 2002; 2005). It is argued that group involvement in broader social structure construes relational capital and can have a positive impact on the relational capital outcomes of the firms (Portes, 1998). The concept has been applied to elucidate and forecast different phenomena such as industrial districts (Gordon, Kogut and Shan, 1997; Reagans, Ray and McEvily, 2003; Walker, Kogut and Shan, 1997) and across a country (Dakhli and De Clercq, 2004).

The relational capital metaphor is that firms that do in a superior way are in a way are to a greater degree more connected than others. Some firms are connected to others in their environment. Being connected to others increases trust between them and subsequently obligate the linked firms to support their partners. In this condition, firms are dependent on exchange with their joined partners. Occupying a certain position the structure of these exchanges is by itself an invaluable asset to the particular firms. That asset is what is referred as relational capital, in essence, a concept of location impacts in varied market conditions. For instance, Coleman (1988) refers to relational capital as a form of social structure that produces a certain advantage to the occupiers. Putnam (1993) adopted Coleman’s relational social capital metaphor and provides another definition of relational social capital. In his influential work, Putnam (1993) persevered the action facilitated by a social structure as presented by Coleman (1988) and documented relational social capital as the features of social organizations such as norms, trust, and networks that are capable of improving the efficiency of the society through the facilitation of coordinated action. Hence, there is a point of consensus with regard to relational social capital in network structure. Although the perspectives on relational social capital are diverse in origin and supports, these arguments converges on a ground that relational social structure is a form of capital emerged
through interactions and connectivity that can create for certain actors a competitive advantage in pursuing their goals or objectives. In short, better connected firms enjoy more benefits and return.

The impact of being linked other firms in the networks includes information benefits, social solidarity, influence and control. The information benefits of the timeliness and trustworthiness (Nahapiet and Ghoshal, 1998b) of the information provide by other members in the network. Social solidarity arise from mutual trust and commitment among firms in the network (Burt, 1995; 2004). Influence and control are the result of actor’s ability to influence others and the ability to be free of other’s influence (Coleman, 1988). In the management and organizational literature, these benefits are acknowledged as benefits to the organizations. Firms gain information through their network alliances creating higher and improved innovations (Ahuja, 2000; Chang, 2003). Increase trusts between firms in the network facilitate the transfer of complex knowledge (Uzzi, 1997) and reduce the transaction cost (Johnston et al., 2004). Firms with network that is abundance with structural holes can negotiate favourable conditions with suppliers and customers resulting in cost savings and higher returns (Burt, 2004; Cummings and Cross, 2003; Gordon, Kogut and Shan, 1997).

There are three types of flows in a network of interrelated actors who include the information flows, asset flows and status flows (Galaskiewicz and Marsden, 1978). Oh, Chung and Labianca (2004) argue that resources of the actors that actors or ego is connected top also constitute relational capital. For example, Stuart (1999) found that biotech firms with strategic alliance go to IPO faster and earn higher valuations than firms that lack such ties. The overall conclusion of Stuart’s (1999) work is that third parties observe the affiliations of firms to make a judgment of their competitiveness and quality.

The preceding literature discussion shows that information, and resources are exchanges in the network forms of organizations and that, firms can benefits from their relationship networks by obtaining access to information, resources, and increased solidarity. In this thesis, we combine these research streams in order to comprehend how inter-firm and the position of a firm in this
network determine benefits for the firms. Choi and Kim (2001) present the initial platform for operations and supply chain management researchers to adopt the embeddedness concept into the supply of supply input in the supply network. Using the Social Network approach, the authors present the embeddedness concept from the perspective of the supply chain. The authors posit the importance of framing organizations in the supply network (i.e. suppliers) as being embedded in a larger supply network than in isolation. Such framing provides organizations in the supply network with better basis in developing policies and long-term strategies. The authors went on to posit that the embeddedness of organizations in the supply network influence its performance, a statement in tandem with previous network research findings that found the configuration of network of relations can facilitate or impede an organization’s behaviours and performance (Granovetter, 1985; Burt, 1992; Nohria, 1992).

Although, Choi and Kim (2001) article illuminate the essence of embeddedness in the supply network and its impact on the organization in the supply network, it did not describe the type of social network relationship that influences the degree of embeddedness of organization in the supply network and how these resulting embeddedness would impact on the overall performance of the organizations in the supply network. As many Social Network analysts would argue, network is resulting from the various social interactions or inter-organizational relationship that took place between the actors (i.e. organizations) that reside in it.

In social network study, researchers made several important premises regarding the actors, the ties and the network structure. Firstly, with regard to the actors, social network analysts posit that actors are interdependent with each other. The interdependency between the actors resulted from the ties that tie two or more actors together. Secondly, social network researchers posit that ties are conduits that facilitate the transfers and exchanges of resources such as information, money or materials between actors in the network. For instance, in inter-organizational study, Krause (2004) study how network ties in the flow of flow of money between the Tobacco Prevention Organization in the US influence the prestige degree of a particular organization. While Kim et al.
(2011) confirmed ties between organizations in the supply network can be in the form of incoming raw materials or outgoing finished goods. Third, social network researchers also posit that the resulting network structure can act as constraints or opportunity for the members’ actions and decisions in the network. As degree of inter connectivity between actors (i.e. individuals or organizations) are different from one another, and actor can have a very dense (connected to all other's actors) network structure or an actor can as well be an isolate (not connected to any actor in the network). A dense network structure can be a source of competitive advantage to an actor because the dense ties can furnish the actor with information from multiple sources. However, this dense network structure demands high cost to maintain.

Coleman (1980) stated that dense network structure increase actor’s resource attainment. Burt (1985) proved less dense structure (i.e. network with structural holes) increases the actors’ likelihood of finding a job. Ahuja (2000) determined that interaction between researchers in different organizations elevates into an alliance network that subsequently contributes to increase innovation creation in the organizations. Furthermore, Provan and Milward (2000) found that increase in information sharing between health care providers in Arizona, contributed to increase trust, which resulted into increase services provisions. The fundamental impetus of these network studies can be described as trying to determine the type of network structure that can assist of impede the development of a predetermine outcomes. Wellman (1983) echoed a similar believe when he describes the main impetus of network researchers as trying to determine and learn how the resulting network structure facilitated or constrains social behaviour or social exchange.

Being embedded in a supply network structure has been is an indication of interaction among firms in a supply network structure. The resulting pattern of actors’ structural embeddedness creates a network of interdependent social exchanges, and subsequently increasing the level of trust, reputation and respect present in the relationships. Certain actors of the network may then emerge as trusted exchange partners who may come to assist in time of needs (Ahuja, 2000; Cousins et al., 2006). While this approach may have been widely applied and recognized in
the individual and intra-organizational literature (Gnyawali and Madhavan, 2001; Gulati, 1998; Moran, 2005; Simsek, Lubatkin and Floyd, 2003; Uzzi, 1997), the central role of embeddedness in larger structure such as the supply network is often overlooked.

The relational view of the firm suggests that firms systematically share knowledge with each other in return to access to profits from rent that can only be accessed by working jointly. This knowledge exchange, and investment specific asset is argued to occur differently in different from of network structure. The network structure is essentially the firms’ embeddedness in the different supply network. The relationship between structural embeddedness and relational capital are the subject of exploration of this thesis.

When a firm is embedded or socialize with external networks it has been documented that opportunity, trust and motivation may increase the level of social exchanges among the network members. This concept of social capital or relational capital is well recognized in the group behaviour literature (Burt, 1995: 2004; Burt and Knez, 1996). Group social capital is the configuration of a group member’s social relationships within the social structure of the group itself, as well as with broader social structure of the organizations to which the group belongs and through which the necessary resources for the group can be accessed.

When applied within the context of supply network, the relational capital can be interpreted as the configuration and social structure of the network members through which resource can be obtained. Thus, this research proposes that embeddeness produce benefits and goodwill that has been potential to develop into reduced cost, greater flexibility and reduce production time.

As it has been argued, the traditional practices in buyer-supplier relationships management has had a limited focus placed primarily on the individual dyadic relationships. Although buyer-supplier relationship dyads are, in fact, connected to other external ties, most of the buyer-supplier relationship's studies have centred on the dyadic level of analysis. Only recently, the researchers of operation and supply chain management field have begun to acknowledge the fact that buyer-
supplier relationships are embedded in broader network structure. Still, there is a paucity of studies that acknowledged the phenomenon (Choi and Kim, 2008).

Autry and Griffis (2008) article provide conceptual development supporting the valuation of firm-to-firm supply chain connections from the perspective of the focal firm. Based on the social network and economics literatures, the article introduces the concept of supply chain capital, which comprises the value of both the structural and relational embeddedness of the firm's supply network. Choi and Kim (2008) draw on balance theory to stress the importance of framing suppliers as being embedded in larger supply networks rather than in isolation. Such framing helps buying companies create more realistic policies and strategies when managing their relationship with their suppliers. Bernardes (2010) study draws on the social network perspective to explore factors associated with the relational embeddedness of social capital, and investigate the role of supply management on the process. Using empirical data collected from 204 U.S. manufacturing firms, an empirical framework is proposed and tested using structural equation modeling. The results of this study confirm that the relational embeddedness aspect of social capital should be treated as a critical antecedent to performance. It also highlights the potential role of the supply management function in developing social capital in network interactions. These findings support this thesis position that network of buyer-supplier organizations has effects on the dimension of relationship management, i.e. trust, influence, reputation, and collaboration. This will ultimately influence the operational and financial performance of the organizations.

Despite the increase recognition of the importance and applicability of network embeddedness perspective to buyer-supplier relationships, researchers still address the relational dynamics of buyer-supplier relationships from variety of firm-level analysis, rather than the network perspective (Carter, Ellram and Tate, 2007), using various theoretical approaches such as resource-based view of the firm (Cao and Zhang, 2011; Holweg and Pil, 2008; Ordanini and Rubera, 2008; Zsidisin, Ellram and Ogden, 2011), transaction cost economics (Cao and Zhang, 2011; Cheung, Myers and Mentzer, 2010) and relational view of the firm (Sanders, Autry and
Gligor, 2011). The level of analysis in much of such existing literature still centres on the isolated dyadic ties between buyer-supplier organizations. However, no firm is an island (Gibbons, Holden and Powell, 2009), rather they are embedded in larger network structure of interconnected firms (Choi and Kim, 2008). Furthermore, with the advent of supply network as the prevalent structure of buyer-supplier relationship rather than the chain metaphor (Harland et al., 2001; Lamming et al., 2000), it is imperative in the context of this study to take the perspective of buyer-supplier relationship to the embeddedness context within which the buyer-supplier interaction took place. As many scholars have posited, the actions and performance of an organization can be more explained by examining the relationship in which the organization is embedded in (Ahuja, 2000; Gulati, 1999; Zaheer and Bell, 2005). Thus, this thesis adopts the perspective of network embeddedness in its effort to deepen the understanding of the impacts of the relational dynamics on the performance of the organizations.

In this study, the researcher argues that contract ties, information-sharing ties, referral made ties and referral received ties constitute networks among firms in the centralized upstream supply network structure. The researcher further explains the important characteristics of these and clarifies how and why these ties or inter-firm relations constitute the networks.

First, inter-firm relations such as: contract ties, information-sharing ties, referral made ties, and referral received ties are conduits of information (Srividasan, 1999). Ahuja (2000) stated that inter-firm relations could also function as the communication channels between firms and their partners. For instance, it was found by McEvily and Zaheer (1999) that relevant advice obtained by managers from their colleagues in other firms is instrumental in developing the capabilities and innovation of the respective firms.

In this study, the researcher also argues that contract ties, information-sharing ties, referral made ties and referral received ties constitute networks among firms in the centralized upstream supply network structure. Wasserman and Faust (1994) stated that a network was made up of a finite set of actors and relations. The authors added that the relations between the actors defined the
actors of the network. In the following networks, namely: contract tie, information-sharing tie, referral made tie and referral received tie; actors are the firms. Similarly, the relations are, specifically: contract, information-sharing, referral made, and referral received, all of which exist in the upstream supply chain. Knoke (1999) proposed classifying network ties through increasing formality of the ties.

Poppo and Zenger (2002) found that governance of inter-firm relationships involves formal and informal coordination. Under formal coordination or inter-firm relations, Cousins et al. (2001) argue that long-term resource dependencies between firms or organizations are forged to ensure future commitments and cooperation. Examples of this formal coordination include inter-firm relations such as contract ties and joint planning programs (Poppo and Zenger, 2002). An important characteristic of the formal inter-firm relation is the existence of a hierarchical or a top-down approach to the governance of the inter-firm network. Through the hierarchical or top-down approach governance benefits such as administration, and control are realized (Powell, 1990). On the other hand, Cousins et al. (2001) argue that informal coordination relates to inter-firm relations of communication that emerge from informal social relationships. Thus, inter-firm relationships under the informal coordination are largely voluntary and horizontal in nature.

Scholars have also focused around the controls that the network embeddedness may confer upon the prospective actors. One of the seminal works that convincingly documented this relationship was of Burt and Knez (1996). The author's finding indicated that an actor that is embedded between two actors in the network structure can derive control advantage from its strategic structural position. Structurally, this occurs in the network when various actors wanted to be in a relationship with a focal actor. This is common in a supply chain structure where numerous actors wanted to be in a contractual relationship with the focal actor for the supply of familiar materials. Related, an actor could be structurally positioned between two different actors for with conflicting demands. In either case, the actor may utilize the potential of its structural position and confers benefits from that.
Based on this argument, clearly a firm’s level of embeddedness in a network would involve a continuum of inter-firm relations from formal to informal coordination. This may include network ties such as: contract ties, information-sharing ties, referral made ties, and referral received ties. The embeddedness theory also predicts that trading transactions are an embedded web of social exchanges. Poppo and Zenger (2002) have identified commercial transactions to include formal contractual relationships; while the web of social exchanges includes informal inter-firm relations such as information-sharing. These indicate both formal and informal inter-firm relations of the centralized upstream supply network.

Similar to the embeddedness of firms in interlocking directorates (Mizruchi, 1996) and managerial ties (Ingram and Roberts, 2000), the embeddedness of firms in the contractual ties' network, information-sharing tie network, referral made tie network, and referral received tie network is a cross-level phenomenon (House et al., 1995). In order to comprehend the effects of these networks on the firm’s level variables, the mechanism demonstrating how these networks affect the firms must be specified.

In this study, the researcher argues that there are three mechanisms in which the contract ties, information-sharing ties, referral made ties and referral received ties affects firms. First, the researcher argues that these ties or inter-firm relations bond the firms to trust, reputation and influence. Second, these ties function as information conduits between the firms. Lastly, the interpersonal trust, influence and reputation may transfer into inter-firm trust, influence and reputation.

First, relational capitals in the network are created within the network of firms (Ingram et al., 2000). In a research study conducted among hotel managers in Sydney, the authors found that highly successful managers are involved in a large number of collaborative activities with other managers. As these managers are more connected to others in the network, they obtain relevant information through developed trust and reputations. Consequently, the numbers of customers of
the hotels with these highly-involved managers are more than the less-connected managers. Relational capital such as trust and reputation were created in these collaborative relations between the managers. Similarly, highly-involved managers play an important role in the creation of these relational capitals. As the upstream supply chain is filled with high uncertainty (Wilding, 1998), in order to stay ahead of the competition, firms need to be connected to these networks of relational capital creation. One way to be connected to these networks of relational capital creation is through the external relations that supply chain managers of the firms have with other supply chain managers. The involvement increases the quality and quantity of relational capital that the firms can obtain, as well as the relational capital created by the firms.

Second, resources such as information are exchanged through interpersonal relations, and this translates into benefits for the firms. Through their involvement with other managers of additional firms in the supply chain, managers not only gain technical information in their field but also market trends, as well as potential threats from new competition (Beamon, 1999). Tushman (1977) stated that informal communications could function as an environmental scanner. Knoke (1999) added that the amount of time spent in conducting collaborative activities among managers make the amount of resources such as information and knowledge among the firms more valuable than through industry meetings and discussions. Firms can tap into the network of their managers when they require particular resources such as information and knowledge. Thus, externally and internally highly-involved supply chain managers may disseminate the resources obtained from their involvement when required.

Third, frequent involvement between supply chain managers of different firms in the centralized upstream supply chain may create relational capital between these supply chain managers. These relational capital outcomes may subsequently transfer into inter-firm relational capital outcomes. Zaheer et al. (1998) indicated that interpersonal relational capital and inter-firm relational capital are different. The author added that interpersonal relational capital between managers of two firms leads to the inter-firm relational capital firm between the two firms. Inter-
firm relational capital will increase the competitive advantage of the firms. Increasing involvement between the supply chain managers will increase the relational capital outcome of the firms. Relational capital exists in a network of inter-firm relations (Putnam, 2000). Being related to other firms in the centralized upstream supply network is beneficial. However, this, we argue, is subject to a firm’s holistic understanding of its embeddedness in the network structure. The inter-firm relations in the centralized upstream supply network structure not only emerged from the formal administrative exchange, but were also initiated through other informal webs of social exchanges. Among the firms that are embedded in the centralized upstream supply, some will gain more benefits compared to others as a result of the respective firm’s embeddedness or its involvement, which is based on its network structural positions.

In addition to that, embeddedness, the researcher argues, carries relevant capacity, which explains the benefits accrued by the involved firms. In this case, through the embeddedness principle, the further that firms engage in exchanges of resources through inter-firm networks with others in the centralized upstream supply chain, the more resources the firm can gain, assimilate and exploit from the networks. Thus, embeddedness may benefit firms in several ways. First, embeddedness will allow firms in the centralized upstream supply network to understand the transactions' landscape. Second, embeddedness benefits firms as it allows them to seek better partners in the complex network structure. Third, embeddedness helps firms to acknowledge and understand their own capacities, as well as the capacities of other firms that are also embedded in the centralized upstream supply network. Fourth, firms can equally important combine these capacities to work towards the benefit of the respective firms. Fifth, embeddedness assists firms to improve their ability to work with other firms in the centralized upstream supply network. Thus, based on the position taken by Granovetter (1985), Cousins et al. (2001) and Poppo and Zenger (2002) respectively, this study posits that the essences of firm embeddedness in centralized upstream supply network structures are based on the firm network structural position within the
particular network ties i.e.: contract ties, information-sharing ties, referral made ties and referral received ties.

In summary, Granovetter (1985) posited that firms in a network do not act as atoms outside of the social context, and transactions between actors are embedded in a social context. Because embeddedness refers to the degree to which a network actor is involved in a social system and how, in turn, this level of involvement impacts the actor’s behaviour. In other words, the concept of embeddedness captures the contingent nature of an economic actors’ activity by virtue of being embedded in a larger social structure. More specifically, decisions and outcomes in a network are not only influenced by an actor’s isolated links with other actors but also the structure of the overall network of relations within which the actor is located in (Choi and Kim, 2008).

Since, embeddedness concepts centres on the idea of the organizational position (Gulati, 1998). The position that an organization holds in the network structure is by itself the source of capitals and resources. Consequently, being embedded in the position is strategically competitive. Embeddedness's concepts focus on the characteristics of relational structures, which includes the quality of the inter-organizational exchange and the structure of the network ties (Simsek, Lubatkin and Floyd, 2003). Uzzi (1997) stated that the principal concern of embeddedness theory is contingent with how economic interactions and activities in the network are influenced by the quality and the structure of exchange relationships. Thus, the basic thrust of embeddedness is the configuration of a network of relationships that can impede or facilitate an organization’s behaviour, action and outcomes (Nahapiet and Ghoshal, 1998; Nohria and Gulati, 1996). As a consequence, the focus of research shifted from the dyadic and triadic forms of ties towards the whole system or network structure. In social network analysis, the position of the actors in the structure is contingent upon the relational pattern that the actors have in the network structure. With regard to this, Gulati (1998) stated that actors that occupy the identical position in the network need not be tied to each other. Instead, the actors are more likely to be tied to the same group of other actors or similar groups of other actors. Social network analysts have developed a whole array of
network measures to capture the structural positions that an actor may occupy in the network structure (see Knoke and Kuklinski, 1982; Marsden, 1990).

Even though the early work of social network research focuses on the embeddedness of individuals in the network structure and how the embeddedness influenced the behaviour, the similar arguments have been extended upon the inter organizational study as well. An organization can be connected to another organization to another actor through a wide array of economical and social relationships. Economic relationships may include contractual ties, material flow and supplier relationships. Social relationships may include sharing of information, relationships among individuals and many more.

Relatedly, supplynetwork relationship is distinctive in that entering one constitutes a strategic action, and the cumulative connectivity or ties can also progress into a social network which confers upon the embedded actors or organization network benefits.

Based on the review of literature, this study posits that embeddedness concerns the fact that economic action and outcomes are impacted by firm's relations and by the structure of the overall network of relations (Granovetter, 1985). What this means is that economic commercial transaction carried out by firms are embedded in the social relationships among them. These relationships and the structure resulting from these relationships are beneficial to the firms. In order to acquire the rewards of these network's, greater understanding of governing and managing these patterns of embeddedness is needed. Specifically, the firm’s network centrality, clique overlapped and its multiplexity of ties will impact upon its relational capital outcomes such as trust, reputation and influence. The issues of centrality, clique overlapped and multiplexity increase the exchanges or interactions among firms that are embedded in the network, and consequently, the firms’ relational capital outcomes also. These arguments have formed the model of hypothesized relationship for this study.
3.2.1 THEORY SUMMARY

As our review of the literature on organizational embeddedness in network structure posits, we know to a great degree the relationship between organizational embeddedness and organizational social capital in decentralized networks, a network that is naturally occurring or one where organizations come together in large part out of their own will. We also know that the relationship between organizational embeddedness and organizational social capital are chiefly consistent across organizational networks in business and non-profit domains. However, the relationship between organizational embeddedness and organizational social capital in a supply network, such as the supply network in decentralized networks, is less clear. Researchers have investigated the influence of centralized networks on trust, reputation, and influence in such networks.

Shrum and Wuthnow (1988) investigated the multi-sector, centrally coordinated network. The dependence on external sources of support rather than contacts with government programs by researchers show that contact performance; only contact with government Wuthnow (1988) conjure the question: embeddedness of organization in a network such as the supply network? The influence of centralized network has been studied in the literature. For example, voluntarily form its own sub-network when
circumstances which they are incapable of political activity, and fund raising. The author form of organization to deal with issues such as industry, the network tends to reduce the number network structure. In addition, when the sub-associated organizations' survival, the sub-activities of affiliates. As an illustration, in most not only provides resources to its related Toyota and Honda also controls, monitors, and al. 2007).

Accordingly, Tsai (2001) in his study, posits organizational coordination. The author refers linking together different parts of an structure (centralization, formalization, important finding from this study is that, in the prevents the unit administrators or managers relevant task environment. Consequently, take in inter-unit exchanges, those that consist a Hence, the impact of centralization in a network, concern among inter-organizational scholars.

Perrone, Zaheer and McEvily's (2003) work the impact of centralization on social exchange role autonomy and trust on a sample of 119 buyer – supplier relationship, a supplier the manager is acknowledged to be free from too
They found that with minimal constraints when the ability to demonstrate their degree of request of the supplier representatives high, it becomes more difficult for the and obligations demanded by the supplier.

Radin and Romzek (1996) stated that under certain relationship condition, mainly low professional norms and politics. They added hierarchical authority would produce less.

Milward (2004), among others, stated that in a efficiency. In addition, network centralization connections among network members.

In this section, the researcher explains that firms’ involvement or embeddedness in the networks of, respectively: contract ties, information-sharing ties, referral made ties, and referral received ties are acquired through the connections of the inter-firm relations. Firms, consequently, benefit from these networks by accessing relational capital and creating relational capital with other firms. The involvement or embeddedness of firms in these networks increases the levels of relational capital. Relational capital is created in the integrated inter-firm network. Being embedded to this network is rewarding for the embedded firms (Putnam, 1992). This embeddedness, initiated by the different inter-firm relations such as contract ties, information-sharing ties, and referral received ties, and referral made ties rewarded the firms with outcomes of relational capital such as trust, influence and reputation.

In the following section, the researcher presents the research hypotheses developed for this study.
3.3 HYPOTHESES DEVELOPMENT

In this study, the researcher argues that, among the firms that are embedded in the centralized upstream supply network; some will obtain more relational capital compared to other firms as a result of this embeddedness. Thus, the level of relational capital trust, relational capital influence and relational capital reputation will depend upon the embeddedness or involvement of the firms in both formal and informal inter-firm relations. The network structural positions are, namely: firm’s multiplexity, degree centrality, betweenness centrality and clique overlap. In Figure 3.2, the researcher posited that firm embeddedness based on this network structural position implies a firm level of relational capital outcomes in the upstream supply network structure. In the following section, the researcher provides the definitions of the concepts and arguments for the hypothesized relationships between firm network embeddedness and its relational capital outcomes.
Firm Embeddedness Based on Network Structural Position

Degree Centrality

Betweenness Centrality

Clique Overlap

Multiplexity

Relational Capital Outcomes

Trust

Reputation

Influence

H1

H2

H3

H4

H5

H6

H7

H8

H9

H10
3.3.1 Firm Embeddedness: Multiplexity

In Figure 3.2, the firm embeddedness box contains four networks structural positions of firms which this research argues indicates the level of embeddedness or involvement of the firms in the centralized upstream supply network structure. Each of these concepts is discussed below.

Multiplex/uniplex nature of the relationship between the member organizations plays a key role in the formation of social capital in network relationships. As mentioned earlier, multiplexity is the number of relations within a given link (Wasserman and Galaskiewicz, 1994). In the business sector, Uzzi (1997) found that embedding economic exchange in a multiplex relationship made up of economic investments, friendship, and altruistic attachments promote trust, fine-grained information transfer, and joint problem-solving arrangements between partner organizations. The author added that organizational embeddedness in social relationships (e.g., supplier, friend, community member) promotes goodwill between partner organizations. While Uzzi finding shows that multiplexity indicates the presence of trust, Perrone, Zaheer and McEvily (2003) argue that trust creates multiplexity in a relationship over time. As parties in a relationship gain confidence in each other over the course of their interaction, they may transfer the trustworthiness that is observed in one type of ties to another type of ties over time.

In network relationship, it is the embeddedness of organization's collaborative activities (joint grant application, joint program, professional meetings, and common clients) in personal and professional relationships among the leaders and agency staff that create trust between member organizations. For example, Snazely and Tracy (2000) found that field staffs who work with clients establish trust-based informal relationships with other member organizations in their joint efforts to overcome bureaucratic obstacles to obtain the resources needed in a poorly organized system and to gain access to needed service for their clients in a poorly-integrated system.
Usually in a network of alliance or collaboration, to guarantee appropriate partners’ behaviour in the process of trust building, organizations sign memoranda of understanding to establish obligations and set up inter-organizational routines through which organization members consult with each other and draw upon each other’s resources. Related, Ford, Wells and Bailey (2004) suggest that in a contractual relationship, member organizations could improve cooperation within the networks by requiring contractual agreements among participants. The authors argue that the establishment of a contractually specified corporate structure will improve transparency of member motivations to all those affected and help reduce uncertainty in the cooperative relationship. These findings were also observed in Provan, Isett and Milward (2004).

In sum, firms’ embeddedness in informal personal and professional relationships as well as in formal administrative relationships gives new meaning to the concept of multiplexity. This concept was originally developed in business organizations’ embeddedness in informal personal relationships in place of contractual relationships. Despite the differences in the content of ties, multiplex relationships between two organizations in business and non-profit sector share a mutualistic orientation that promotes trust and achievement of organizational goals.

Thus, in this study, multiplexity refers to conditions where there is greater than one type of relationship connectivity (Wasserman and Faust, 1994) between two firms in a centralized upstream supply network structure. Firms can have at most one formal or informal relation with another or greater than one type of relation to acquire what is known as multiplexity. For example, a firm in the upstream supply network structure may be connected to another through only a contractual relation (uniplexity), or through an additional type of relations such as information-sharing or referral relations (multiplexity).
3.3.2 **Firm Embeddedness: Centrality**

Centrality relates to the coreness of a firm position in a network of inter-firm relationships (Freeman, 1979). By coreness is meant central location of the firms in the network. Network analysts relate centrality with control and power as function of certain relational characteristics (Hanneman and Riddle, 2005). Centrality can be measured as characteristics of the overall network in which it is called centralization. Centrality can also be measured at the actor level property. Centralization index ranges from 0 to 1, provides a measure of variation around a central tendency, similarly to the standard deviation (Knoke and Kuklinski, 1982; Knoke and Yang, 2008). Three measures of centralization are commonly applied in the social network research are the degree centrality, closeness centrality and betweenness centrality.

In this study, the researcher adopted two types of network centrality measures by which to illustrate firms’ centrality in the centralized upstream supply network structure, i.e. degree centrality and betweenness centrality index. Degree centrality measures the number of other firms in the centralized upstream supply network to which a firm is tied. The betweenness centrality concept measures the degree to which a firm in the centralized upstream supply network is located between the path connecting two or more firms (Freeman, 1979; Wasserman and Faust, 1994; Scott, 1998).

3.3.3 **Firm Embeddedness: Clique**

Clique overlap relate to the extent to which an actor who belonged to a clique is also in interaction or communication with other actors from other cliques.

There are two competing arguments with regard to the fundamental structure of a network. One argument posits that the elemental structure of a network is a dyad (Coleman, 1988). Another school of thought argues that a dyad, when viewed on its own, does not make a network. This school of thought argues that the basic form of a network is a triad. A triad is a group of three actors.
who are connected to each other through direct and indirect connectivity (Gnyawali and Madhavan, 2001).

Kilduff and Tsai (2003) argued that triads are formed by network actors in order to ensure balance of power as a form of risk mitigation strategy in inter-firm relationships. A triad is essentially a clique made up of three network actors (Choi, 2008).

In a network structure, a clique also interacts with other cliques through its overlapping clique member. For example, let us examine two cliques: one consisting of actors A, B, and C, and the other of D, C, and E. The two cliques are connected by one clique member who overlaps the two clique structures, i.e., actor C. The actor who occupies this clique overlap position can be argued to have a significant impact on the firm level of relational capital outcomes (Kilduff and Tsai, 2003)

3.3.4 RELATIONAL CAPITAL OUTCOMES

As mentioned earlier, social capital is a concept that is being increasingly adopted in public policy, organizational study and more recently operation and supply chain research (Dakhli and De Clercq, 2004; Lamming et al., 2000; Landry, Amara and Lamari, 2002; 2005). It is argued that individual and group involvement in broader social structure construes social capital and can have a positive impact on the overall performance (Simatupang, Wright and Sridharan, 2002). The concept has been applied to elucidate and forecast different phenomena such as human capital (Coleman, 1988), job promotion (Burt, 1995), performance of organizations (Nahapiet and Ghoshal, 1998b), industrial districts (Gordon, Kogut and Shan, 1997; Reagans and McEvily, 2003; Walker, Kogut and Shan, 1997) and across a country (Dakhli and De Clercq, 2004).

There have are numerous literature that review the concept of social capital (Coleman, 1988; Cousins et al., 2006; Dakhli and De Clercq, 2004; Lamming et al., 2000; Landry, Amara and Lamari, 2002; Lawson, Tyler and Cousins, 2008; Nahapiet and Ghoshal, 1998a; Simatupang,
Social capital is defined in the literature as the “aggregate of the social potential which are linked to possessions of a durable network of more or less institutionalized relationships of mutual acquaintance and recognitions - or in other words, to membership in a group” (Liker and Wu, 2006, p. 51).

Benefits of being linked other actors in the networks include information benefits, social solidarity, influence and control. The information benefits of the timeliness and trustworthiness (Nahapiet and Ghoshal, 1998b) of the information provide by other members in the network. Solidarity benefits arise from mutual trust and commitment among actors in the network (Burt 1995, 2004). Influence and control are the result of actor’s ability to influence others and the ability to be free of other’s influence (Coleman, 1988). In the management and organizational literature, these benefits are acknowledged as benefits to the organizations. Managers gain innovation and competition information through interlocking directorates (Mizruchi, 1994; Ruef, 2002). Organizations gain information through their network alliances creating higher and improved innovations (Ahuja, 2000; Chang, 2003). Increase trusts between organizations in a network facilitate the transfer of complex knowledge (Uzzi, 1997) and reduce the transaction cost (Johnston et al., 2004).

Oh, Chung and Labianca (2004) argue that resources of the actors that actors or ego is connected to also constitute social capital. For example, Stuart (1999) found that biotech firms with strategic alliance go to IPO faster and earn higher valuations than firms that lack such ties. The overall conclusion of Stuart’s (1999) work is that third parties observe the affiliations of firms to make a judgment of their competitiveness and quality.

If economic action is embedded in networks of relations (Granovetter, 1985), then a logical first step is to specify the dimensions of embedded relationships and the mechanisms by which they influence economic action. This undertaking builds on the work of others who have launched the important enterprise of reintroducing social structure into the analysis of economic phenomena. In
trying to demonstrate the unique organizational and market processes that follow from an understanding of social structure and economic performance, this research analysed the properties of embedded relations and how they create competitive advantages for firms and networks of firms in the forms of relational social capital.

The relational capital outcomes' box indicates three items of relational capital, which consist of: the firm level of influence, its reputation and, lastly, firms’ trust. In network relationships, these relational capital factors may also function as a form of managerial mechanism on top of the conventional management strategies (Stuart, Hoang and Hybels, 1999; Uzzi, 1996;).

Trustworthiness refers to the quality of a firm and the level to which a firm can be relied upon to honour its words and obligations in the network. Reputation is the recognized quality of products and services provided by a particular firm in the network structure. Influence refers to the degree to which a firm’s opinions or actions are considered by other network firms when these firms are about to make important decisions.

Although previous studies have confirmed that these relational capital outcomes materialized in network relationships, these findings were centred in the context of a decentralised network structure. However, the impact of firms’ embeddedness based on the network structural position degree centrality, multiplexity and clique overlap in a centralized network structure remain unknown.

The remainder of this chapter discusses the development of the research hypotheses for these relationships and consequently, provides answers to research question one of this study.

3.4 RESEARCH HYPOTHESES

In the following section, the researcher developed the research hypotheses following a review of the literature.
3.4.1 Firms Embeddedness in Centralized Upstream Supply Network and Trust

Extensive interactions generate trust among firms. For example, Uzzi (1997) found that, in order to obtain information regarding a potential partner before collaboration activities can be carried out; firms resort to trusted firms for information. The trust between the firms, argued (Uzzi (1997) is the result of multiple exchanges in the past. In the same vein, Gulati (1995) highlighted that years of inter-firm relationships generate trust among them. In addition to that, Gulati and Gargiulo (1999) found that negative gossip by third parties about another party’s uncooperative behaviour significantly reduces the likelihood of direct relations; whereas positive gossip strengthens the likelihood of direct relations among firms in the network. What this literature shows is that, in a network relationship, a firm will sometimes refer to its partner’s previous experience and information with potential partners before agreeing to short-term or long-term business commitments. Extensive interactions are a catalyst for trust in networks of inter-firm relations.

Similarly, Eccles (1981) found that extensive interactions among a network of homebuilder firms also create trust among network members. The authors found that exchanges of information among the contractors regarding materials prices create stronger inter-firm relationships and thereby facilitate the creation of trust.

Trust also materializes in the long run through the contract relations among firms. For example, Brown and Troutt (2004) found that trust emerged through extensive contracts and social relations between government organizations and non-profit organizations.

McEvily, Perrone and Zaheer (2003) found that an important structural condition in a network of inter-firm relationship is trust. A firm that loses the trust of its network members may see that some of its ties are removed and the firm itself is pushed into the periphery from the core network position. Consequently, this will create a new firm that will take the central figure and become the core firm in the inter-firm network.
Thus, the literature indicates that firms in a network having an extensive relationship with other firms in the network may be perceived as trustworthy by others. Since extensive relationships in network analysis can be pictured based on the level of firms’ coreness in the network structure, this thesis hypothesizes that:

**Hypothesis 1:** Firms’ embeddedness following their degree centrality position in the centralized upstream supply network through different inter firm relations impact the level of trust that the firms may acquire from other network members.

And,

**Hypothesis 2:** Firms’ embeddedness following their betweenness centrality position in the centralized upstream supply network across formal and informal inter-firm relations impact the level of trust that the firm may acquire from other network members.

Close network structure improves collective actions (Coleman, 1988). Firms’ embeddedness in the larger network structure, such as triads of cliques, can be just as important as dyads. This is because the existence of the checks and balances between three actors places more constraint on the firms’ behaviour and functions and provides greater protection against opportunist actions (Coleman, 1988). The chief reasons for these constraints relate to the capability of triads or cliques to reduce the power of individual actors and provide checks on opportunist behaviours (Krackhardt, 1999). In the more connected and guarded clique structure, it is posited that trust will develop much easier among dyads. Similarly, Coleman (1988) argues that a clique promotes the development of normative actions which can help maintain the trustworthiness that one actor may sense in another.

Inter-firm interaction may be greater within cliques or triads because of the presence of checks and balances. What these extensive interactions may create is the homogenous form of triads and cliques. Because of the homogeneity, the cliques sometimes run counter to other cliques.
in the network structure when differences are detected (Coleman, 1988). For example, it is likely that cliques of firms in the upstream supply network may work against each other initially, rather than with each other, when new cliques with conflicting values within the broader network context are formed (Choi, 2008).

Under this condition, a clique member who is connected to another clique (i.e. clique overlap member) may function as the ‘bridge’ to the otherwise disconnected or heterogeneous cliques. These overlapping clique members or firms may well be the dampener to soothe any future possibility of inter-clique issues and open the way for potential inter-clique collaborations. Thus, these firms may unintentionally perform the role of mediator or negotiator among other cliques of the network. In such a case, this research posits that the firms that occupy the clique overlap position may experience an increase in their stock of relational capital, such as an increased level of trust.

**Hypothesis 3:** *Firms’s embeddedness following their clique overlap position in the centralized upstream supply network through different inter-firm relations impact the level of trust that the firm may acquire from other network members.*

Uzzi (1997) stated that the existence of several relationships among firms promotes goodwill. Since numerous relationships relate to multiplexity of ties in a network relationship, it can be argued that similar effects may be observed between multiplexity and trust.

Similarly, Perrone, Zaheer and McEvily (2003) added that enduring multiple relationships among firms is an important catalyst for trust. As parties in the inter-firm relations believe in each other throughout the the relationships, the trust developed in one type of inter-firm relations may be transferred on to another type of inter-firm relation. For example, Snazely and Tracy (2000) found that personal (informal) and professional (formal) relationships between field staff established trust-based informal relationships with the field staff of other organizations when dealing with clients’
requirements and needs. These trust-based joint efforts are developed in order to overcome bureaucratic obstacles to obtaining the resources needed in a poorly-organized system when serving important clients.

Trust also emerged slowly from formal relations at the same time as informal relations emerged through the process of contractual relations. Normally at the start of an inter-firm alliance, formal memoranda of understanding are signed among partners to ensure their commitment to the alliance. The memoranda ordinarily function as guidelines for firms by which to communicate and perform their roles according to the accepted level of the network members. The establishment of the memoranda will improve transparency of motivations and facilitate the creation of new informal relations (Ford et al., 2004). These informal relations and the signed memoranda reduce and remove any threats of relationship complexity or uncertainty in inter-firm relationships and consequently, improve trust among the firms.

In summary, a firm’s embeddedness in multiple inter-firm relations or multiplexity of ties may have an impact on its level of trust. Thus, the nature of multiplexity of the inter-firm relationship between firms in a network could reward embedded firms with an improved level of trustworthiness perceived from other firms. Applying this argument to the centralized upstream supply network, this study hypothesizes that:

**Hypothesis 4:** Firms’ embeddedness following their multiplexity position in the centralized upstream supply network through different inter-firm relations impact the level of trust that the firm may acquire from other network members.

### 3.4.2 Firms' Network Embeddedness and Reputation

In a complex and uncertain business environment, firms often turn to their partners for input (Gulati and Gargiulo, 1999). These partners are an additional source of tangible and intangible resources for firms. For example, firms may turn to their partners to seek reputation information or
evaluation of past performance of potential partners before agreeing on collaboration projects (Gulati and Gargiulo, 1999). Thus, the reputation of a firm’s past performance in the network tends to be socially developed (Galaskiewicz and Marsden, 1978).

In an upstream supply network, obtaining information regarding the past performance of others is even more glaring as the firms in a supply chain are often widely dispersed (Choi, 2008). The physical dispersion of firms makes direct connectivity between network firms difficult to be achieved. This subsequently contributes to the difficulties in obtaining information regarding past performance. Thus, firms may rely upon other connections in the network to obtain indirect reports regarding other firms. Under these conditions, a firm may rely on both direct and indirect relations for evaluating other reputations, as well as improving its own.

A strategy that a firm can apply in order to increase its direct and indirect relations with others in the network structure is to occupy a focal position in the network structure (Freeman, 1979). Firms that occupy the central position in the network structure will have comprehensive direct and indirect ties connecting them to other firms in the network structure. Consequently, these far reaching linkages may lead to increased visibility of the central firm in the network, which may bring positive reputational evaluation from other firms. Other member organizations will then adjust their evaluations accordingly to mirror the high evaluation of others (Borgatti and Li, 2010). In addition to that, the indirect linkages by which central firms in the network may function as the reputational conduit will carry the focal firm’s good reputation values to the other periphery members of the network. Following this argument of the literature studies, the researcher posits that:

**Hypothesis 5:** Firm’s embeddedness following their degree centrality position in the centralized upstream supply network through different inter-firm relations impact the level of reputation that the firm may acquire from other network members.

And,
**Hypothesis 6**: Firm’s embeddedness following their betweenness centrality position in the centralized upstream supply network through different inter-firm relations impact the level of reputation that the firm may acquire from other network members.

A firm that bridges the gaps among cliques of firms has multiple accesses to information and resources. In his seminal work of structural hole theory, Burt (1995) found that firms which become a bridge among otherwise disconnected dyads of firms stand to gain benefits from their advantageous network structural position. Consequently, the bridging actors will then see that resources and information will have to pass through them before they can reach firms in other cliques.

In this study, the researcher argues that similar effects can also be realized by the bridging firms in cliques or the clique overlapped firms. Furthermore, these bridging firms are seemingly to manipulate their brokerage positions for reputational mileage. Extending the structural hole argument of Burt (1995) to the centralized upstream supply network, this thesis posits that firms belonging to multiple cliques may presumably acquire an enhanced reputation in the upstream supply network.

**Hypothesis 7**: Firm’s embeddedness following their clique overlap position in the centralized upstream supply network through different inter-firm relations impact the level of reputation that the firm may acquire from other network members.

Reputation travels the network. Thus, the number of direct and indirect ties that an organization has in a network with its partners can be critical for its reputation level (Wasserman and Faust, 1994; Scott, 1998).

These findings were also observed in Provan, Isett and Milward (2004). In their findings, the authors found that a formal contractual relationship does not change over time. They discovered that over time, informal ties emerged through the formal contractual relations. Informal ties such as information-sharing emerged as a result of the extensive contractual relations and strengthening of
connections among firms. Increased tie strength results are a sign of increased trust among firms. The increased tie strength between network members is a sign of trust existence in the network. The news of the trustworthiness of particular firm travels across the network, as the firm is connected to other firms though multiple relations. This, consequently, improves the reputation of the respective firms. Hence, the contract tie, together with the information-sharing ties, can become conduit instruments by which to reinforce a firm’s reputation among the embedded firms.

Extending this logic to the centralized upstream supply network setting, this study predicts the following:

**Hypothesis 8:** Firm’s embeddedness following their multiplexity position in the centralized upstream supply network through different inter-firm relations impact the level of reputation that the firm may acquire from other network members.

### 3.4.3 Firms Network Embeddedness and Influence

Influence is the indirect measure of firm power (Freeman, 1979). For example, Oliver and Montgomery (1996), using data from in person interviews with the directors of 20 organizations in Oregon, found that the organization with the greatest influence within the system is the one that has the best ability to allocate funds.

Power can be derived in an inter-firm relationship from the resources that a firm may hold in its inventory. Resource control can alleviate a firm’s influence over others. Emerson (1962) found that a firm may have influence upon other firms when these firms rely upon it for the resources that they need for operations. It follows that the more other firms rely upon one firm for resources, the more powerful or influential the resourceful firm will be perceived in the network (Hager, Galaskiewicz and Larson, 2004).

Resource dependency theory argues that firm centrality in inter-firm relationships can be the result of frequency of interactions or exchanges that take place among firms in the network.
Furthermore, firm centrality also functions as a gate-keeper of resources which increases the influence of the firm in the network structure.

Aligned with previous works (Farmer and Rodkin, 1996; Freeman, 1979; Galaskiewicz, Bielefeld and Myron, 2006; Ibarra, 1993; Mehra, Kilduff and Brass, 2001; Nahapiet and Ghoshal, 1998), the researchers posited that influential or powerful firms tend to be located at the centre of a network. Consequently, the researcher posited that, in the context of the centralized upstream supply network structure:

**Hypothesis 9:** Firm’s embeddedness following their degree centrality position in the centralized upstream supply network through different inter-firm relations impact the level of influence that the firm may acquire from other network members.

And,

**Hypothesis 10:** Firm’s embeddedness following their betweenness centrality position in the centralized upstream supply network through different inter-firm relations impact the level of influence that the firm may acquire from other network members.

### 3.5 Summary

In this chapter, the researcher discusses development of the literature that sets the theory and the study hypotheses.

From the literature review, the researcher found that an element of inter-firm relationships, i.e. the embeddedness of the firms in the supply network, may actually present another perspective of the complexity resulting from the extensive connectivity in the supply network. It may not all be bad. As economic sociologists argue that economical actions are embedded in network relationships (Granovetter, 1985), the underlying impact of supply network complexity resulting from the inter-firm relationships’ warrants an investigation from a new perspective. Furthermore,
since supply networks usually involve a focal network that has ‘invisible hands’ in terms of managing the flow of activities in the supply network, the way these focal firms influence the impact of firms’ embeddedness in the supply network demands a deeper look into the issues.

In the next chapter, the researcher presents the research methodology adopted for this study.
CHAPTER FOUR
RESEARCH METHODOLOGY

4.1 INTRODUCTION

The focus of this research is situated on the relations between firms’ embeddedness in a centralized upstream supply network structure. According to Wasserman and Faust (1994) and Lusher (2000), standard statistical methods and analysis are not adept at measuring relations. This is since normal statistical analysis disavows the existence of relationships between firms in a network through its assumption of independence of observation. However, the network approach, more specifically the Social Network Analysis (SNA), focuses on the relations between firms, as well as the pattern of the relations and the implication of the relationships. Consequently, in this study, the researcher adopts the SNA research methodology for data collections, analysis and presentation of the analysis findings.

The overall flow of this chapter is arranged in the following manner. Firstly, the researcher discusses the premises and concepts of the social network analysis. Second, the researcher describes the research site and sample, and then explains the data collection strategy. Following this is a detailed description of data preparation for analysis. Figure 4.1 overviews the flow of this chapter in a graphical manner.
4.1 Introduction

4.2 Social Network Analysis

4.3 Research Site

4.4 Determining Study Sample

4.5 Boundary Specification

4.6 Study Design

4.7 Survey

4.7.1 Administration of Instrument

4.7.2 Data Preparation

4.8 Definitions and Operationalization of Study Variables

4.8.1 Network Structural Measure of Embeddedness

4.8.2 Organizational Structural Measure of Embeddedness

4.8.3 Relational Capital Variables

4.9 Analysis Plan

4.9.1 Exponential Random Graph Model (ERGM)

4.9.2 Exploratory Network Analysis

**Figure 4.1 Chapter Flow**
4.2 RESEARCH STRATEGY: SOCIAL NETWORK ANALYSIS (SNA)

This research follows the exploratory and statistical social network analysis approach found in literature studies in order to determine how the impact of firms’ embeddedness in the centralized upstream supply network impacts upon the firms’ relational capital outcomes. In this section, the researcher briefly discusses and justifies the adoption of the SNA methodology.

Structuring of network of relations has an important implication for actors of the various networks (Knoke and Yang, 1998). Given a collection of actors, a social network analysis can be used to study the structural variables measured on actors in the respective network. These structures involve the pattern of ties between the actors. A network analyst would seek to model these ties to depict the structure of a group. One could then investigate the impact of these structures on the functioning of the network or the influence of these structures on actors embedded within these network structures (Hanneman and Riddle, 2005).

Investigation of the implication of these structures upon the embedded firms requires a method that can analyze not only the characteristics of the actors, but also the relations between the firms that form the structures. Wasserman and Faust (1994) documented that the unit of analysis in network study is not just the actor, but consists of an entity made up from the collection of the actors and the linkages among them. An actor of the network, stressed Knoke and Kuklinski (1982) can be an individual, a team or even organisations. Consequently, the unit of analysis of this study comprises the relationships between the firms and the attributes of firms of the APMMHQ-1 upstream supply network.

In addition, Wasserman and Faust (1994) as well as Lusher (2000) argued that the typical statistical method and analysis are not adept at measuring relations. One important fact behind this argument is that standard statistical analyses disavow the existence of relationships between firms in a network through the assumption of independence of observation. However, the network approach, more specifically the Social Network Analysis (SNA), focuses on the relations between
firms and the pattern of the relations and the implication of the relationships (Wasserman and Faust, 1994).

The relevance of proper management and understanding of the supply network from the SNA perspective has been discussed and proposed in literature (e.g. Ahuja, 2000; Corteville and Sun, 2009; Krauss, Mueller and Luke, 2004). Choi, Dooley and Rungtusanatham (2001) propose that supply network is rather a complex adaptive system consisting of both hard ties (e.g. materials) and soft ties (e.g. knowledge flow) among the organisations in a supply network. Choi and Hong (2002) map the complete supply network for the centre consoles assembly of an automobile manufacturer with three different assemblers. The authors provide several propositions regarding the operation of supply network structures, relating to the structural characteristics of formalization, centralization and complexity. Carter, Ellram and Tate (2007) stated that social network theory was a useful tool with which to study the influence in the supply chain. Kim et al. (2010) present a conceptual definition of supply network elements based on the SNA methodology.

Borgatti and Li (2009) stated that the social network analysis concepts were particularly suitable to study how the patterns of inter-organizational relationship in a supply network translate to competitive advantage. This can be achieved through management of the hard ties and soft ties in the supply network. Furthermore, according to Borgatti and Li (2009), adoption of the social network analysis to the study of the supply network will allow a better understanding of the operations of the supply networks, both at the individual level and the network level. This determines the importance of the organisations, given their position in the network and how the network structure affects individual organisations and the network performance as a whole. Consequently, this study adopted the social network analysis method strategy for data collection, analysis and reporting of results, as this is the most appropriate means for arriving at valid results and testing the hypotheses set forth in this study (Marouf, 2011). The following section will discuss the research site of this study.
4.3 THE RESEARCH SITE

The shipbuilding industry in Malaysia comprises firms that are involved in designing, building and construction of various types of ships, such as: ocean going, passenger, offshore and fishing vessels.

The shipbuilding industry has existed in Malaysia since the early 1900s. One of the preliminary shipyards was built in Kuching, Sarawak. Since then, more shipyards have emerged in the country. Shipyards in Peninsular Malaysia can be found in Lumut, Perak, Port Klang, Selangor, Kemaman, Terengganu and Pasir Gudang, Johor. Currently, there are about 70 registered shipyards in Malaysia.

The shipbuilding industry in Malaysia is largely divided into two foremost clusters comprising two principal regions, i.e.: the Eastern Cluster and the Peninsular Malaysian Cluster. The Eastern Cluster produces large vessels such as tugs, barges and river ferries. Shipyards in this cluster were considered as cost effective, viable and dynamic due to their close proximity to the main market, namely, the oil and gas sector.

In the Peninsular Malaysian cluster, the shipbuilders specialize in steel and aluminium vessel buildings for government, as well as the oil and gas sector. Figure 4.1 displays some of the various shipyards currently operating in Malaysia in the Eastern Cluster and the Peninsular Malaysian Cluster respectively.
Among the shipyards included in Figure 4.2 are leading shipyards such as: Malaysia Marine and Heavy Engineering Sdn Bhd (ships, vessels, FPSO – Floating, Production, Storing and Offloading and FSO – Floating, Storing and Offloading); Boustead Heavy Industries Corp. Bhd. (shipbuilding, ship repair and fabrication); Labuan Shipyard and Engineering Sdn Bhd (shipbuilding, ship repair, naval craft maintenance and oil and gas fabrication); Muhibbah Marine Engineering Sdn Bhd (shipbuilding and ship repair); Coastal Contracts Berhad (builders of barges, AHT – Anchor Handling Tugs); Kencana Petroleum (fabrication for oil and gas); Brooke Dockyard and Engineering Works Corporation (repair and building of ships and oil and gas offshore modules); Ramunia Fabricators Sdn. Bhd. (repairs and support for offshore operation); NGV Tech Sdn Bhd (shipbuilding and repair); Nam Cheong Dockyard Sdn Bhd (offshore support vessels) and Hong Leong Lurssen Shipyard Sdn Bhd (ship-building and repair). In terms of product, these shipbuilders handle Malaysia’s normally developed simple, low-cost fibre glass boats primarily for the fishing and tourism industries. Medium-sized vessel building projects include offshore support vessels
(OSV), tugs, barges, patrol crafts and the like. The construction of huge vessels, on the other hand, has seen better days and is fast ceasing in business. This is mainly due to the Malaysian Marine and Heavy Engineering (MMHE) strategy of focusing only on repair and conversion, consequently leaving Boustead as the last standing large vessel builder.

Although the industry is not widely known, vessels developed by the shipyard are sold worldwide, especially to Middle Eastern oil and gas companies. The shipbuilding industry has also been acknowledged as a critical industry due to its spill-over effects. For example, the Organization for Economic Co-operation and Development (OECD) has acknowledged the industry as having strategic importance in terms of job creation, industry capacity and technological capability.

The shipbuilding industry offers great potential to the economy of Malaysia and has significant room for improvement. For instance, in 2010, the Malaysia shipbuilding industry was ranked 22nd in the world in terms of production and value, while only accounting for less than two per cent of the world vessel production.

According to the President and Chairman of the Association of Marine Industries of Malaysia (AMIM) Tan Sri Ahmad Ramli Mohd Nor, Malaysia is aiming to capture two per cent of the worldwide shipbuilding industry by 2020 from one per cent in 2010. Ahmad stated that the strategy for attaining Malaysia’s vision to be an all encompassing player in the shipbuilding industry is to improve two important items, specifically: skilled personnel and the supply chain.

For the purposes of this study, a centralized upstream supply network of a small maritime industry seemed to be an ideal setting. A supply network in the maritime industry is a material-intensive enterprise. Much of the activity is highly dynamic and is widely dispersed throughout the network. The flow of materials and information is transferred through interactions among different firms. Because firms in a supply network operate in an environment having a high degree of complexity (Bozarth et al., 2009) and uncertainty (Wilding, 1998), these firms seek an edge through connections or interactions with members of the network. Lambert and Cooper (2000) stated that
the key to these issues is the on-going relationship with other partners. They stressed the importance of investigating the relationships that suppliers and customers have. Johnston et al., (2004) suggested that on-going relationships among members of the supply network increase efficiency and effectiveness of the supply network.

The focal research site of this study is located in the Peninsular Malaysian cluster. The network, labeled here as APMMHQ-1, is part of the centralized upstream supply network. APMMHQ-1 is a company in the Malaysian shipbuilding industry involved in ship repairs, maritime, engineering and related service provider matters. To date, the company has awarded contracts to local vendors and suppliers totaling RM 31 million for the development of small vessels in the region. Recently, the company invested RM 100 million to create new facilities in different locations across Malaysia to develop and service small vessels in the country. Efforts are being undertaken to determine partners for the operations. APMMHQ-1 has also crafted a vendor development program to work with the small and medium enterprises, attracting some firms to supply SBSR products and services.

APMMHQ-1’s centralized upstream supply network was considered to be one of the best supply systems in the region through its Integrated Logistic Support (ILS) programs. Top level management was approached for possible participation in the study. After several communications about the goal of this study and the potentials' benefits for the APMMHQ-1 supply network, positive commitments were received from the top management to participate in and grant participation for this study.

In network studies, all the actors who are located within the naturally-occurring boundaries are included for analysis. Consequently, network studies do not use samples as in the conventional sense; rather, it seeks to include all the actors in some population or populations (Hanneman and Riddle, 2005).

As such, the research population for this study consists of all the supplier firms in the
centralized upstream supply network of APMMHQ-1. More specifically, this study investigates the firms operating in the upstream supply network of APMMHQ-1 relating to the supply of parts and materials for the production of Rigid Hull Inflatable Boat (RHIB) to the APMMHQ-1. In APMMHQ-1 production, the RHIB is a small, fast craft that received the highest demand from the market. Thereby, the upstream supply network for the RHIB product is one of the most active networks of firms in the APMMHQ-1 vast supply network variety.

In the following section, the researcher discusses the strategies applied in determining the network members in the APMMHQ-1 upstream supply network for the product RHIB.

4.4 DETERMINING STUDY SAMPLE

The first step of social network analysis is to determine the population of the study to be surveyed. There are two sampling units in this study, namely: the firms that occupy the APMMHQ-1 upstream supply network for the product RHIB and the ties or relationship between them. The sampling frames for the firms and for the connections between them are nested. In network studies, the method used to sample relations is part of the survey instrument.

As mentioned, in network studies, determining the boundaries of a network is of utmost importance in a network study (Hanneman and Riddle, 2005). To identify and define the target population within the APMMHQ-1 upstream supply network for RHIB for this study, the author combines the realist and the nominalist approaches. Nominalist and realist approaches are parts of the boundary specification strategy of this study and are discussed next.

4.4.1 BOUNDARY SPECIFICATION

One of the difficulties in conducting social network research is that of determining the boundary for the network study (Wasserman and Faust, 1994). An accurate boundary specification technique will allow the network researcher to identify the target population, as well as permitting an effective description of the population under study. An incorrect boundary specification strategy
may produce erroneous network measurements. The difficulties associated with setting up the proper boundary specifications in network study demand careful treatment of any particular strategy chosen by the researcher (Knoke and Kuklinski, 1982).

Laumann, Marsden and Prensky (1989) discussed the problem of specifying network boundaries in network research and studied the pattern of boundary specification techniques adopted by network researchers. In their review of various boundary specification techniques adopted and implemented by network researchers circa 1989, the authors concluded that the issues arise as network researchers have generally restricted their research to using either the realist or nominalist strategy alone. These two strategies will be discussed in the following sections.

**Boundary Specification Technique: Realist Strategy**

In the realist boundary specification strategy, the researcher presumes the boundary to be the limit that is experienced by all or most of the actors in the network (Knoke and Kuklinski, 1982). Such boundaries include kinship, friendship or directorships. Laumann, Marsden and Prensky (1989) described this as the vantage points of the actors in the network. Saunders (2007) relates the realist approach to define network boundaries based on actors’ own interpretations of whether or not their organization is a part of the network in question. Thus, under the realist boundary specification technique, the inclusion and exclusion of actors inside and outside the boundary depends on whether the other actors view themselves to be part of or connected to the network members or not. A specific technique under the realist approach is the name generator or “snowball” method (Scott, 2000). Under this technique of boundary specification, the researcher extracts names of other actors from a sample of actors and then asks these sample actors to name those actors of the particular relationships to which they are tied (Wasserman and Faust, 1994).

One application of this technique was the work of Choi and Hong, (2002). The authors applied this principle to identify the suppliers who exist in the upstream supply network of Honda in the United States for the Acura model’s centre console assembly. In their research, the authors
asked the upstream suppliers of Honda's supply network to list and name the suppliers for the materials and parts for the centre console assembly of the Acura model. They excluded any organisations that were not related to the supply of the particular parts and materials.

**Boundary Specification Technique: Nominalist Strategy**

The nominalist boundary specification strategy is based on the researchers’ own perceptions and constructs with regard to their theoretical interests. This involves seeking out those actors who are of interest, as well as finding out the extent of links between the actors in the network (Knoke and Kuklinski, 1982). In the nominalist approach, the researchers draw the boundary by developing a conceptual framework to serve the researchers’ analytical purpose. In practice, under the nominalist strategy, the network analyst will determine the characteristics defining the membership of the network. Using these characteristics, the researchers will select the related actors and then proceed to study the interaction between the identified network actors. For example, legal or other formal membership requirements can represent a clear boundary construct for network research.

**Limitations of Nominalist and Realist Strategy**

Both the nominalist and the realist approaches each has their limitations (Diani 2002). Diani (2002) stated that the nominalist approach may sometimes cause the researcher to focus too much on certain traits or attributes of groups of actors while disregarding the concrete relationship between them, which is the essence of network research. Another concern with the nominalist approach, argued Diani (2002), is that the researchers’ own theoretical interest could restrict or constrain the network (Knoke and Kuklinski, 1982).

The realist approach also has its limitations. Saunders (2007) argued that the realist strategy may remove from the network actors who do not define their identity in the same vein as do the rest of the network actors. Second, there is also a lack of guidance with regard to the appropriate place at which to stop the process of a snowballing procedure (Saunders, 2007).
Overcoming the limitations of realist and nominalist approaches requires a combinatorial strategy which is discussed as follows.

4.5 STUDY DESIGN

Combining the Approaches

Overcoming the above limitations has led researchers to propose and adopt a boundary specification strategy that combines both the nominalist and the realist strategies. Diani (2002) argued that, in order to overcome the shortcomings of everyone strategy, a boundary specification strategy that combines both strategies should be adopted. For example, in accordance with Diani’s (2002) proposition, Krauss, Mueller and Luke (2004) applied both boundary specification strategies in their study of a five-state tobacco control network. The authors initially used the nominalist strategy and then supplemented the network with a realist strategy. Through the adoption of the nominalist technique, Krauss, Mueller and Luke (2004) developed a network roster of all organisations that are involved in the five-state tobacco control program using criteria such as: 1) geographic location; 2) level of program capacity (e.g., funding level, age of the program); 3) presence of tobacco farming and 4) type of lead agency (state health departments or independent organization).

By consulting the Centre for Tobacco Policy Research, the authors identified and listed the organisations identified via a roster of tobacco control network organisations. In addition to the network roster, Krauss, Mueller and Luke (2004) asked the tobacco control manager from each organisation to compile a list of partners whom either contributed substantially to the programs or had a unique role that was not listed in the roster. The combination of both the nominalist and the realist boundary specification strategies generated a list of 70 organisations identified as being part of the tobacco control network. A similar strategy has been adopted in other research studies, such as those by Corteville and Sun (2009), Lusher et al. (2010), and Lusher (2011).
Following this, to identify the population of this study (i.e. the firms in the centralized upstream supply network of APMMHQ-1 for product RHIB), this researcher followed the guidelines of Diani (2002) and Krause, Mueller and Luke (2004). The authors proposed that network researchers could begin setting up the research boundary with a nominalist approach and follow this up with a realist approach.

Thus, the researcher began by compiling a database of firms that are perceived to be part of the centralized upstream supply network for the product RHIB. This was achieved through consulting the Director of Logistics and three executives of APMMHQ-1 Logistics Department in Putrajaya, Malaysia, as well as the APMMHQ-1 archival records. In relation to the inclusion or exclusion of actors in the upstream supply network, the firms had to provide actual materials or services with regard to the supply of spares and parts within the centralized upstream supply network of APMMHQ-1 for the production of RHIB. Consistent with the realist criterion, firms were selected because of their involvement with the provision and supply of materials to all relevant areas of the APMMHQ-1 for the production of RHIB, not simply because they were already linked to other firms for the spares and parts.

Once a list of related firms had been compiled, the list was shown to three senior logistics officers in the APMMHQ-1 Logistics Department. Their validation of the list was sought before embarking on the next step. Once validated, the researcher made a phone call to the firms. The objectives of the phone calls were to determine the key informants or respondents and to determine the suitability of the informant to answer the survey instrument. The introductory call was also made to determine the correct address of the firms so that the survey instrument could be sent correctly. Once this information was gathered, the researcher mailed cover letter and the research instrument to the identified firm. The researcher followed this up with a phone call to set up appropriate phone communication dates to explain to the key respondent the objectives of the research and to clarify any unintended issues. The information obtained during these phone calls, and the returned survey forms assisted the researcher to determine the firms that did not participate.
in the APMMHQ-1 upstream supply network for the production of RHIB. Based on this finding, the populations of the study were reduced. Each of the remaining firms would only be included based on the boundary specification criteria set established for the mixed nominalist and realist strategy that was adopted.

Firms that did not return the survey are still included as part of the network members, but are known as isolates of the network (Wasserman and Galaskiewicz, 1994). It should be noted that in bounded network studies, even members who decline to participate are included in the resulting network data and analysis as isolates, as their relationships are still assessed through the survey responses of their colleagues (Borgatti and Molina, 2003). In the following section, the researcher describes in detail the instrument used for this study network data collection.

4.6 SURVEY

This research follows the exploratory and quantitative social network analysis approach found in the literature in order to determine how firms’ relational capital outcomes are affected by their embeddedness in the supply network structure.

In a Social Network Analysis (SNA) study, the relationships or ties between the actors in the network are the primary data collected while the actor attributes or characteristics serve as the secondary data. This is the unit of analysis of the study. Social network analysis adopted both statistical and graphical methods to elucidate the relational and attribute data of the network members.

An actor of the social network is represented in the network diagram by a node or a point. Two or more nodes in the network diagram are connected by a line which represents the ties that exist between the connected nodes. In social network method, relational data can be visualized and explored through the development of the Moreno’s (1934) innovative sociomatrix and sociogram. A sociogram (Figure 4.2) provides a graphical display of network members as a set of points
(representing the nodes or actors) and a set of lines (representing the relational ties). These ties are uniquely known as *arc* if the ties are directed, *edges* if the ties are undirected (Knoke and Kuklinski, 1982, Wasserman and Faust, 1994, Scott, 1988). A sociomatrices (Figure 4.3) is relationship tie matrices that recorded the existence of the tie between the network actors. Binary codes of “1” represent the existence of a tie, while “0” represent the absence of a tie between two nodes. The figures below are examples of a sociogram and its corresponding sociomatrix representing the directed network of relationship between four individuals.

Figure 4.3 Sociogram of friendship network between Bob, Carol, Ted and Alice (Source: Hanneman and Riddle, 2005)
Wasserman and Faust (1994) stressed that the unit of analysis in network study is not just the actor, but an entity made up from the collection of the actors and the linkages among them. An actor of the network, stressed Knopke and Kuklinski (1982) can be an individual, a team or even organizations.

Leading network researchers such as Galaskiewicz and Marsden (1978), Knopke and Kuklinski (1982), Burt (2004), and Borgatti and Li (2009) asserted the ability of surveys to obtain network data on inter-firm relations such as: information transfer, resource transfer and joint activities. A survey is suitable for this type of study because it allows the researcher to investigate the participants’ subjective perceptions of interactions (Diani, 2002).

The survey questionnaire consisted of closed-ended questions and open-ended questions. It begins by asking general questions and is followed by more specific and probing questions. In general, the questionnaire was framed following the standard of Choi and Hong (2002), Provan and Milward (1995), Stone (2001), Corteville and Sun (2009) and Cross and Parker (2004) respectively.
For the development of the network survey instrument, the researcher traveled to the APMMHQ-1 in Putrajaya, Malaysia and met with the Director and Assistant Director responsible of the production of RHIB in APMMHQ-1. At this in-depth meeting, the researcher explained procedures and sought further assistance. He then presented, discussed and refined a list of firms in the APMMHQ-1 upstream supply network dedicated to the provision of materials and parts for the production of RHIB for the APMMHQ-1. The initial list was developed based on archival review and vendor programs attended by the researcher. From the list of firms that the researcher had generated and refined through this meeting, the researcher then developed and finalized the survey instrument.

In addition, the survey instrument also asked each of the key informants to name up to five other organisations that may have been involved in each of the ties for the provision of materials in the APMMHQ-1 upstream supply network for the product RHIB but were not recorded on the list. This basically represents the snowball question of the data collection technique.

The original English language questionnaire was translated into the Malay language by a professional and certified translator in order to facilitate a survey of organisations in the supply network of the APMMHQ-1. To guarantee clarity, accuracy and consistency of the information, as well as ensuring that the participants’ comprehension would not be affected by the translation, the researcher followed the translation process as recommended by Triandis (1992). First, the instrument was developed in the English language. The English questionnaire was then sent to an expert in both languages, namely, Malay and English. The expert subsequently translated the English questionnaire into the Malay language. For the third step, the Malay questionnaire was sent to another expert in both English and Malay to translate the questionnaire into the English language. In the fourth step, the researcher and the translators compared both English copies (the original and translated copies) to check that there were no discrepancies in the questions in both translations.
More specifically the following steps were taken. For the network questionnaire, the researcher asked qualified interpreters to translate the complete original network questionnaire (Qi) into the native language of the target respondents, i.e. the Malay language (Qii). Following that, the researcher seeks other professional interpreters to translate the Malay questionnaires (Qii) back to the English language (Qiii). Lastly, the researcher asked eight native English speakers (four men and four women) to compare the back-translated English questionnaire (Qii) to the original English (Qi) version. These eight evaluators were asked to indicate whether the meaning of each sentence (item) had remained similar on a 5-point scale ranging from 1 (the meaning of the sentence has not remained similar) to 5 (the meaning of the sentence has remained similar). Overall, the network questionnaire items have an acceptable rating of 4.12.

The final questionnaire was comprised of 13 main questions, including the demographic section arranged in a 14-page booklet. It is prefaced with an introductory preamble at the top of page one asking for the participation of the respondents and signed by the author. In order to make the network questionnaire as easy as possible, it is broken up into sections. In addition, some necessary questions, such as the network ties questions, are preceded by instructions on how to answer. The survey instrument is then divided into several sections consisting of three types of questions.

The first type of question seeks general demographic information from the respondents with regard to the firms that they are serving. This set of questions also provides the descriptive statistics of the responding firms. Information acquired through this type of question consists of material regarding the firms’ address, total number of employees or staff, as well as the number of years in operation.

The second category of questions investigates the network ties between the firms in the APMMHQ-1 centralized upstream supply network. In this section, the survey shows a table with the names of all the firms listed in the first column of the table. Based on this, the respondents were
asked to indicate by a check on the table the list of firms that they have been in communication with for each type of relationship listed in the last sixth months. These four types of ties are important in order to understand both formal and informal relationships between organisations (Choi and Hong, 2002; Corteville and Sun, 2009; Provan and Milward, 1995). The four types of ties investigated were, specifically: contracts, information-sharing, referral made and received ties. The contractual tie questions show how formally linked one firm is with another in the upstream supply network. The survey instrument asked the key informants to indicate on the roster the list of firms with which they have formal service contracts relating to the supply of materials for the product RHIB. The firms can be in tier two supplying materials to the tier one supplier who in turn supplies the focal firm (i.e. APMMHQ-1) with the materials necessary for the production of RHIB (Provan and Milward, 1995).

The information-sharing ties illustrate the norm of collaboration and cooperation between the organization/unit that is asserted in formal links or ties. Network data on information-sharing ties reveal collaboration in a network. Information-sharing was assessed in the network survey by asking key informants to indicate on the rosters which of the firms listed below might have an exchange of information to accomplish their work (Cross and Parker, 2004).

The key informants were asked to indicate by a check on the rosters the list of firms to which they made referrals. Similar actions were asked from respondents for referral received ties. Key informants from each firm were asked to select firms from which they received referrals. Referral made, and referral received ties followed procedures detailed in the work of Corteville and Sun (2009).

In this, network ties section, an additional column was added so that the survey respondent could indicate the quality of the working relationship that the responding firm has with other firms in the APMMHQ-1 centralized upstream supply network. Respondents were asked to indicate the quality on a 4-point Likert-type scale, ranging from 1= poor relationship to 4 = excellent
relationship. This column denoted a firm opinion of the network links or ties (by the mean score), as well as the firms’ opinion of their links or ties with specific organisations/units.

Another important source of network ties data was gathered indirectly during the surveys. For example, key informants were likely to mention existing information, contracts, or referral relationships that they had formed outside of the known boundary. The researcher also invited the respondents to name other firms that may have participated in the APMMHQ-1 upstream supply network for the production of RHIB, but are not listed as being among the 37 firms. The researcher, however, did not receive any additional names to be included into the network data.

4.6.1 ADMINISTRATION OF THE INSTRUMENT

Administration of the instrument rigidly follows the Tailored Design Method (TDM) (Dillman, 2007). The instrument was mailed together with a covering letter (Appendix B2), as well as the endorsement letter from the Director-General of Logistics of APMMHQ-1 and a pre-paid envelope, as well as a pre-paid return envelope. For the mailing design, this research considered the issues of cost, speed and accuracy (Bryman and Teevan, 2004). Because the entire population is included in the sample, accuracy was not an issue.

This study applied a mixed-mode data collection strategy. More specifically, this study combined two modes of data collection: mail and telephone. Because of the advantages of mail surveillance, particularly cost and ready access to mailing addresses, this mode is used as the primary form of data collection. Up to two self-administered surveys were mailed to the study population. Key informants who did not respond to the mailings were followed up by telephone and encouraged to complete a telephone survey.

There are two main reasons behind this initial phone call. First, the phone call is to confirm the receipt of the survey instruments by the targeted respondents. A replacement package was re-sent if the respondent did not receive the survey package. Second, if the survey instrument had
been passed on to other more qualified personnel or individuals inside the organization, the changes would be noted, and the new key informant details would be entered into the database. Future communications would only be made with this new respondent.

The combination of multiple contacts and mixed data collection modes has proven effective in increasing response rates in many studies (Dillman, 2007).

During the initial phone conversation, the respondents were asked to give the estimated time that they would need to complete the survey. The respondent was asked to return the survey once it was completed. Follow-up letters and reminders were sent to the identified respondents until the survey was returned (Appendix B4, Appendix B5, and Appendix B6). Follow-up calls were also made.

If the respondents required a fresh survey package, the package would be re-sent immediately to the respondent. When there was no response from the key informants, or they were not able to be reached over the phone, a fresh follow-up survey package would be sent out. The new follow-up package consisted of the entire original package and a new letter of encouragement to participate in the survey, as well as a pre-paid return envelope. The survey instrument would be re-sent to the same respondents two months after the first survey response was returned. The re-sent package consisted of akin items as in the initial test. Similar rigorous procedures were taken to ensure an efficient and prudent response. Seven to ten days after the final mailing, telephone calls were initiated with any non-respondents. Multiple telephone calls were made in an attempt to reach the key informants and persuade them to complete a telephone interview. In certain cases, due to a respondent’s busy schedule, the phone survey had to be conducted on an alternative date. During the phone communication, the researcher would guide the respondents through the questionnaire and provide assistance when needed.
Minimizing the Potential for Informant Bias with Self-Report Methods

Informant bias in network research occurs when there is a discrepancy between the self-reported behaviour and the actual behaviour (Knoke and Kuklinski, 1982; Wasserman and Faust, 1994). This phenomenon can result from several sources. One source of informant bias is the inability of the actors to handle the large amounts of data required to report on their behaviour in the network (Knoke and Kuklinski, 1982). Another driver for informant bias may result from the respondents’ tendency to correct their perceptions in order to keep a balanced network with other actors in the network. Research on informant bias in network studies has presented advice regarding how to safeguard against informant bias. One possible solution is through seeking to contact highly informed informants in the organization (Freeman et al., 1987). “Highly knowledgeable informants produce unbiased data about long term repeated patterns” (Knoke and Yang, 2007 p. 35) and guard against informant bias, as well as increasing the research validity. Their knowledge and experience of the system will provide concrete reflection of the actual phenomena in the field. Contacts in each firm were the supply chain manager or its equivalent.

In addition, self-reports of connections or relationships have been criticized for being inherently unreliable and invalid. Sensitive survey questions are intrinsically vulnerable to error for two central reasons, namely: 1) participant may view the questions as an invasion of privacy and 2) fear of disclosing information due to legal repercussions. In consequence, the threat to validity includes: high non-response rates, lower item-specific response rates and greater measurement error. Once more, the approach utilized by the researcher and staff mitigated this potential bias.

To reduce informant reporting bias, techniques that improve recall, such as providing a specific six-month reporting period, were utilized. The researcher used direct questions to reduce the incidence of ambiguous responses. Finally, phone communications allowed the researcher to provide clear definitions and also to clarify and probe unclear or vague responses.
**Survey Response Rate**

Of the 37 firms approached, the researcher received returned surveys from 36 respondents. The response rate was 97.3 per cent. Extensive follow-up procedures contributed to the high percentage of response. Although several network researchers such as Marsden (1990) encouraged the collection of network data from the whole network population, Borgatti and Molina (2003) stated that such percentage of response is impossible in an empirical research. The authors added that a percentage of response of higher than 90 per cent is sufficient with the non-respondents to be included in the study as the isolates.

**Data Coding**

The data collected through the survey instruments were coded in two different techniques. As with similar research such as Mayo and Pastor (2005), Gilsing and Nooteboom (2005) and Moran (2005), coding systems such as dichotomous, Likert and continuous scales were applied to code attitudinal and descriptive data, and the data was then placed in a spreadsheet. Secondly, the researcher applied a 37x37 socio-matrix technique to record type of connection in the APMMHQ-1 supply network (Wasserman and Faust, 1994).

The descriptive, attitudinal and network data were maintained using two different software packages. Network data was maintained and analysed using socio network software packages, i.e. UCINET (Borgatti Everett and Freeman, 2002), NetDraw, Mage and Pajek (Nooy, Mrvar and Batagelj, 2005). Concurrently, the descriptive data was maintained using the Excel spreadsheet software.

Even though the researcher only received 36 returned surveys, the researcher kept records of the firms that had not returned the survey instruments since other responding firms reported having ties with them.
4.7 DEFINITIONS AND OPERATIONALIZATION

This study has two main classifications of network data variables. First are the independent variables, i.e. the firms’ embeddedness variable. The second is the relational capital performance variables which form the outcome variables of this study.

In this section, the researcher first discusses the definition of six measures of network structure measures of embeddedness. These include: reciprocity, k-core, centralization, density, geodesic distance and clustering coefficient. These structural measures illustrate the overall pattern of network embeddedness of the firms in the network of different types of linkages of relationship, namely: contracts, referrals, and information-sharing. The researcher then presents the definition of firm measures of network embeddedness, which include: clique overlapped, degree centrality, multiplexity and betweeness centrality.

4.7.1 NETWORK STRUCTURAL MEASURE OF EMBEDDEDNESS

Network Structural Measures: Network reciprocity

The network reciprocity index measures the rate of reciprocation of relationships. Whether that who was the centre of communication also receive communications from the organization concern is determined by the nature of the reciprocal nature of the ties (Sommerfeld et al., 2007).

Network Structural Measures: Network K-Core

Network k-core index measures the strength of connectedness of firms in the network. A k-core is a subset of all the nodes in a network such that each node is linked to at least \( k \) nodes in the same subset. A k-core is a highly-interlinked collection of nodes within a larger network. Comparisons of k-cores of a network having different levels of \( k \) also provide some insight into the strength of the connectedness of the actors in the network (Mueller, Buergelt and Seidel-Lass, 2007).
Network Structural Measures: Network Centralization

The network centralization index refers to the extent to which the relations or connectivity between the actors or firms in the network centre around an actor or a few actors or firms (Freeman, 1979). According to Freeman (1979), network centralization is, specifically: the ratio of the difference between the centrality index of the most central actor in the network and other actor centrality index in the network, as well as the highest total differences of actor centrality index score possible in the network.

$$CENTRALIZATION = \frac{\sum_{i=1}^{g} [Ca(n^*) - Ca(n_i)]}{\max \sum_{i=1}^{g} [Ca(n^*) - Ca(n_i)]}$$

Where Ca (ni) is an actor centrality index. Ca (n*) is the largest centrality index of all the g actors (Freeman, 1979). A centralization index value of one indicates greater network centralization, and zero indicates no central actor in the network structure.

Network Structural Measures: Network Density

Network density is the degree or strength of interrelatedness among actors in a network. Network density is calculated by dividing the number of actual ties between the network actors by the total of possible ties in the network (Wasserman and Faust, 1994)

$$DENSITY = \frac{2L}{g(g-1)}$$

Where L is the total number of connections represented by the lines in the network. The total number of actors is represented by g. A network index of density is often recorded in a percentage format. Thus, the nearer the density index is to 1; the closer is the strength and connectivity between the network actors. A network with a density index of zero indicates a completely disconnected network structure. A high density score indicates that the networks are much interconnected.
**Network Structural Measures: Network Geodesic distance**

The cohesiveness of the different networks of contractual ties, information-sharing ties and referral ties respectively is first examined by calculating the distance between firms of the networks and the number of ties between the firms. The geodesic distance is the shortest path between the firms and measures the extent of connection in the network (Knoke and Kuklinski, 1982). Understanding the geodesic distance firms in the network allows the researcher to determine the level of connectivity among firms in the supply ties. Consequently, it gives general descriptions of embeddedness levels of firms in each of the network ties.

**Network Structural Measures: Clustering Coefficient Index score**

The clustering coefficient is the extent to which any two organisations in the network are connected to the same organisations and hence are also directly connected to each other. In other words, the clustering coefficient score indicates the degree to which inter-clique interactions may exist in the particular buyer supplier network. A higher cluster coefficient score may indicate more collaborative activities between different sets of cliques. Hence interactions in this network are expected to be higher.

In the following sections, the researcher discusses the organizational measures of the network embeddedness in relation to this study.

**4.7.2 ORGANIZATIONAL MEASURES OF THE NETWORK EMBEDDEDNESS**

**Organisational Measures of the Network Embeddedness: Degree centrality**

Degree centrality measures the number of other actors in the network to which the focal organization or ego is tied. The index is defined as,

\[
DEGREE CENTRALITY = C(ni)
\]
For $C(ni)$, $C$ refers to the degree of the node $i$. The total number of actors in the network is identified by $n$. However, because degree centrality of an actor is not inclusive of the actor itself, the total number of actors in the network is always minus the actor where $n = n-1$ (Wasserman and Faust, 1994).

**Organizational Measures of the Network Embeddedness: Betweenness Centrality**

Betweenness centrality index refers to the extent to which an actor is located in a bridging position between actors of a network. For example, let us suppose actor B is located in a betweenness centrality position between actor A and C in a triad network (Freeman, 1979). Because of the bridging position of the actor, betweenness centrality is also an indication of an actor’s brokerage power in the network. Betweenness centrality index is defined as,

$$BETWEENNESS CENTRALITY = \frac{\sum_{j>k} g_{jk}(ni) / G_{jk}}{(g-1)(g-2)/2}$$

Where $g_{jk}$ and $g_{jk}(ni)$ are the minimum ties needed for linking actor, $i$ and actor $j$ in the network of $g$ nodes. Index score of zero shows that an actor is not occupying any bridging position in the network of $g$ actors, while an index score of one indicates that the actor is in a bridging position among all the network actors (Wasserman and Faust, 1994). Ibarra (1993) stated that, actors that occupy this brokerage position often possessed the advantage as the broker for the flow of information among the network actors. Hence, taking away a node betweenness centrality index may result in the network becoming disconnected through the indirect connections.
Organizational Measures of the Network Embeddedness: Multiplexity

This network concept refers to the extent to which two or more network actors are connected to each other through more than one type of relation (Knoke and Kuklinski, 1982; Scott, 1988). For example, actors A and B may be connected to each other through a contract tie. The two actors may also be connected to each other through an information-sharing tie.

It is assumed that the more types of relations that actor A has with actor B, the stronger the relations between the two actors would become. In this study, the researcher assesses the multiplexity of ties between the network actors in four types of network relations, namely: the contract tie, information-sharing tie, referral made tie and referral received tie. It is argued that when the firm has all these connections or a multiplexity of ties with other firms in the network, relations between the firms will become stronger.

Organisational Measures of the Network Embeddedness: Clique and Clique Overlap

In network analysis, a clique refers to a group of three or more actors in a larger network structure which are connected to each other through direct or indirect ties (Wasserman and Faust, 1994).

Clique overlap is the degree to which an actor in clique structure is also in interaction or communication with other actors from other cliques of the network (Knoke and Kuklinski, 1982). In this study, an actor clique overlapped is measured by the number of times that an actor of a clique appears in other cliques of actors. Wasserman and Faust (1994) stated that network often consisted of clique overlaps. Clique overlap can add additional value to the study of the clique itself. Adopting the proposition of Wasserman and Faust (1994), this study investigates the clique overlap position of firms rather than the cliques only.
4.7.3 RELATIONAL CAPITAL VARIABLES

The following sections describe the outcome variables (relational capital performance) for this study.

Trust

Trust is the extent to which a firm can be depended upon to honour its obligations. In the context of this research, trust is considered when a firm believes that another individual will take actions that are mutually beneficial and not solely to one’s own advantage (Burt, 2001). Thus, it implies the quality of relationship among actors or firms in a network structure.

For this research, the actor’s ratings of relationship quality with other firms are rated from one to four. With one indicating a poor relationship and four indicate an excellent relationship. These are identified by respondent firms in the questionnaire matrix. Overall, trust is the ratio of the sum of a firm relationship quality score to the number of firms that give the quality rating of the particular firm (Provan and Milward, 2000).

Influence

In this study, influence refers to the extent to which a particular firm in the APMMHQ-1 centralized upstream supply network is taken into consideration when other firms are making important decisions (Brass, 1984; Marsden and Friedkin, 1993). In the survey instrument, the researcher used a name generator question to elucidate the influence network. Respondents were asked to name up to five other firms whose opinions would be considered when the respondents are about to make some decisions related to the supply of spares and parts in the APMMHQ-1 upstream supply network for the product RHIB (Stone, 2001). A firm level of influence is the number of times that a firm’s name appears in the snowball questions that reported the firm as being influential in the network structure. The answers were also used to develop the influence network structure of the APMMHQ-1 supply system.
Reputation

Reputation refers to the perception of good performance that a firm may have upon other firms in the network (Kilduff and Krackhardt, 1994). In the survey instrument, the researcher asks the respondent to name up to five other firms in the APMMHQ-1 centralized upstream supply network that they admired. This was primarily in relation to the performance of an excellent job in terms of providing the materials and services to the APMMHQ-1 upstream supply network for RHIB. Reputation score is the number of times that the firm is named by others in the APMMHQ-1 centralized upstream supply network for completing a good job.

4.8 ANALYTIC METHOD

The analysis was divided according to the type of analysis technique applied. First, the researcher performed an exploratory social network analysis (visual analysis) of a firm’s organisational network by exploring the network maps and the network structural measures. The researcher then tested the research hypotheses using innovative statistical network modeling known as Exponential Random Graph Modeling (ERGM). The next section discusses each of these analysis techniques in detail.

4.8.1 EXPLORATORY NETWORK ANALYSIS

Robins et al. (2001) suggested that, in social network analysis, the network structure needs to be searched for and not assumed from previous related literature. Consequently, different network analysis routines were applied to explore patterns of connectivity between the firm’s organizations that are embedded in the APMMHQ-1 supply network and to examine the structural characteristics of these entities. These analyses were performed using the software package UCINET (Borgatti, Everett and Freeman, 2002).

The first step in exploratory network analysis is to determine whether the data displays any interesting patterning at all (Freeman, 2004). This can be done by combining the visualization
techniques with mathematical algorithms to search for an optimum arrangement of actors and links. The objective is to find the optimal layout to position the nodes on a graph in a way that accurately represents the structural patterning of the network by depicting the pairs that are socially closest in the graphic image.

For this purpose, this study adopted a spring-embedding visualization method in the UCINET program whereby a network layout is computed using a force-directed algorithm. More specifically, the algorithm places nodes based on node repulsion and equal edge length bias. When so configured, the placement of nodes in the sociogram is based on forcing the nodes apart and tending to select placements that lead to equal edge lengths (i.e., equal length lines between nodes). This particular layout has the advantage of detecting network centrality patterning (Polites and Watson, 2008). For these routines, this thesis applied the network imaging software within the UCINET (Borgatti, Everett and Freeman, 2002) i.e. the NetDraw, which is equipped with sophisticated visualization techniques. Visual representation of supply networks can provide useful direction for researchers, and act as a starting point to develop subsequent quantitative analyses (Choi and Hong, 2002).

4.8.2 Statistical network modeling: Exponential Random Graph Modeling

This section discusses the quantitative data analysis adopted for this study. More specifically, this section discusses the statistical network modeling tool known as the Exponential Random Graph Modeling (ERGM).

Scholars of social networks have consistently confirmed that the fundamental theoretical insight of the social network analysis rests on the importance of the ties between actors (Carrington, Scott and Wasserman, 2005; Lusher, 2011; Lusher and Ackland, 2010; Lusher et al., 2012; Nahapiet and Ghoshal, 1998). In social networks, the embedded nodes or actors are interdependent, thus making them a related unit of analysis (Lusher et al., 2012; Snijders et al., 2006). Consequently, it is not appropriate to assess a network member’s relations in a quantitative manner
through the standard series of traditional statistical analysis (Shumate and Palazzolo, 2010). The chief reason for this argument is that the regular series of traditional statistical techniques consider each node or actors of a network to be unrelated or independent (Igarashi, Robins and Pattison, 2006; Robins, Lewis and Wang, 2012). Many leading network scholars have claimed that traditional statistical analysis disregards the possibility of relations between the individual nodes or actors through the assumption of independence of observation (Bamber, Jiang and Wang, 2010; Lusher et al., 2012; Robins, Pattison and Wang, 2009; Shumate and Palazzolo, 2010), when, in fact, in social network, node and actor are an interdependent, related unit of analysis (Knoke and Kuklinski, 1982). It is for this interdependency and relatedness argument that a special class of statistical models is preferred when investigating social relations phenomena, in particular, the Exponential Random Graph Model (ERGM) (Shumate and Palazzolo, 2010).

Exponential random graph models, also called (p*) models (Frank and Strauss, 1986; Pattison and Wasserman, 1999; Robins, Pattison and Wasserman, 1999; Wasserman and Pattison, 1996), are a class of stochastic models, which use network local structures to model the formation of network ties for a network with a fixed number of nodes. Exponential Random Graph Models (ERGMs) are the most promising method of modeling observed social networks (Snijders et al., 2005). ERGM is a relatively new methodology whose use is not yet widely understood in the broader academic community. Exponential Random Graph Model (ERGM) has been developed over the last 20 years as a method of directly modeling the underlying forces which create social networks (Pattison, Kalish and Lusher, 2005). The ERGM analysis technique has evolved through the years since its original proposition by Frank and Strauss (1986). It was later developed by a series of additional analysis parameters and techniques, including the work of Wasserman and Pattison (1996), Snijders et al. (2006) and Robins et al. (2009) on multiple platforms such as Statnet of Handcock et al. (2003) and most recently, PNet of Wang et al. (2006a).

In ERGM, a social network is simulated to determine other possible ways that the network with a given number and size of social relations can be configured. The simulated outcomes
provide insights into the patterns of social structures, which are interpreted as representing the underlying social process (Wang, Robins and Pattison, 2006a; Wasserman and Robins, 2005). ERGM informs the researcher as to which social processes are important for the presence of social network ties in a particular context. In using ERGM, a researcher seeks to make inferences about what is happening within a particular context (Robins et al., 2007). Hence, the results of ERGM social network analysis involving one context are not generalized to others (Snijders et al., 2006).

In the past decade, statisticians have proposed various methods for random graph model estimation (Nooy, Mrvar and Batagelj, 2005; Robins et al., 2007; Shumate and Palazzolo, 2010; Snijders et al., 2006; Wasserman and Robins, 2005). Currently, the most preferred option involves the usage of the Markov Chain Monte Carlo Maximum Likelihood Estimation (MCMCMLE) (Robins et al., 2007b). This preferential is largely because the MCMCMLE produces more reliable standard errors than pseudo likelihood estimations (Wasserman and Robins, 2005). This process is described in detail in RObins et al. (2007). The routine consists of running a computer simulation that produces distribution of random graphs from a starting set of parameter values (determined by the researcher) and subsequently estimating and refining the parameters by repeating these simulations until the model is converged (Powell, 1996; Robins et al., 2007). Basically, the program starts with a set of parameter values, simulates a set of graphs, measures the likelihood that it matched the ascertained graph, improve the parameter values, simulates an improved set of graphs, measures how closely these new graphs match the observed graph. This process is repeated until an adequate set of parameter values is found.

The parameter values estimated by the MCMCMLE procedure need to be tested for their adequacy as a model for the observed network. The process for testing the adequacy of parameter values involves: first, simulation of the model through the generation of simulated graphs based on the parameter values; and second, the comparing of simulated graphs with the observed graph through the calculation of goodness of fit statistics. A simple goodness of fit statistic is the t-ratio. Small t-ratios indicate a good model fit. For statistics that are modeled in a given ERGM, the
absolute value of the t-ratios should be less than 0.1 to prove that the model has converged. For other network statistics, t-ratios that are smaller than 2.0 are considered as indicating a good fit.

**Network effects of ERGM**

Network effects in ERGM refer to the associations between social network ties and the actor attributes of the particular network (Robins et al., 2007). An example of network effects includes the tendency of dyadic ties to be mutual, i.e., Actor A likes Actor B and Actor B likes Actor A in return.

However, there are also other effects that incorporate nodes or actors’ attributes that may help to explain the formation of ties between the network members. For instance, a highly popular node or actor of the network may be attributed to either the actor’s level of education or age. In the ERG model, a number of effects can be included in the model by the researcher just as adding variables into a regression analysis can determine the explanatory power of particular variable/s. As the ERGM model is statistical, it is possible to determine if certain network effects occur at greater or less than chance levels. The complexities of social relations suggest that there are many interdependent network effects that are occurring at the same time within the network. ERGM provides the means to explore these network effects together, manage the different attributes and explore the network complexity as a whole (Lusher, 2011). This research applied these capabilities of the ERGM analysis to answer Research Question Two of this study. The network effects are divided into the pure structural effects and the pure attribute-based network effects or, at the same time, known as the pure actor effects (Shumate and Palazzolo, 2010). Each of the effects is discussed in the following sections.

**Pure structural effects**

Figure 4.2 presents the listing of purely structural network parameters.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Interpretation</th>
<th>Description</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density Arc</td>
<td>Baseline tendency for a tie to occur</td>
<td>One firm nominating another firm</td>
<td></td>
</tr>
<tr>
<td>Reciprocity</td>
<td>Tendency for reciprocation</td>
<td>Mutual ties between two firms</td>
<td></td>
</tr>
<tr>
<td>Degree Based Popularity A-in-S</td>
<td>Tendency of Spread of in-degree distribution, Centrality, core-periphery as a result of actor popularity</td>
<td>Indicative of presences of highly nominated firms within the network</td>
<td></td>
</tr>
<tr>
<td>Activity Based A-out-S</td>
<td>Tendency of Spread of out-degree distribution.</td>
<td>Indicative of the activity of firms to engage many others</td>
<td></td>
</tr>
<tr>
<td>Closure/Clustering AT-T</td>
<td>Tendency of Closure of two paths</td>
<td>Triadic clustering (i.e. a friend of a friend is a friend)</td>
<td></td>
</tr>
<tr>
<td>Closure/Clustering AT-U</td>
<td>Tendency of Activity-based structural homophily</td>
<td>Triadic clustering (i.e. a friend of a friend is a friend)</td>
<td></td>
</tr>
<tr>
<td>Closure/Clustering AT-D</td>
<td>Tendency of Popularity-based structural homophily</td>
<td>Triadic clustering (i.e. a friend of a friend is a friend)</td>
<td></td>
</tr>
<tr>
<td>Closure/Clustering AT-C</td>
<td>Tendency of Generalized exchange</td>
<td>Triadic clustering (i.e. a friend of a friend is a friend)</td>
<td></td>
</tr>
<tr>
<td>Multiple connectivity</td>
<td>Tendency of Multiple localized connectivity</td>
<td>Two firms connecting through other partners</td>
<td></td>
</tr>
<tr>
<td>Multiple two paths (A2P-T)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared activity</td>
<td>Tendency of Activity-based structural equivalence</td>
<td>Two firms connecting through other partners</td>
<td></td>
</tr>
<tr>
<td>(A2P-U)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared popularity</td>
<td>Tendency of Popularity-based structural equivalence</td>
<td>Two firms connecting through other partners</td>
<td></td>
</tr>
<tr>
<td>(A2P-D)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4.2 Pure Structural Effects Parameters**

Source: Robins et al. (2012)
The parameters measure (and control) endogenous, or self-organizing, structuring within the networks of this study, relate to the study hypotheses and consequently, help to answer the research question of this thesis.

The pure structural effects are the self-organizing characteristics of a social network that do not rely on either the characteristics or the attributes of individual nodes or actors (Lusher et al., 2012; Robins, Elliott and Pattison, 2001; Wang, Robins and Pattison, 2006a, 2006b). For instance, the fact that people shake hands with others regardless of the attributes of the other individuals is a form of pure structural effects, which indicate mutuality or reciprocity of ties. In principle, the pure structural effects explain the conditions whereby the presence of one or more ties leads to the formation of other social ties. The first column of Figure 4.2 lists the names of pure structural effect’s parameters (as well as the codes) relevant to this study. These parameters are selected based on the theoretical objectives of this thesis. The first parameter is the Arc parameter. Arc is the baseline parameter in any network. It represents the tie that connects (minimum) two nodes into a dyad. Using the Arc parameter estimates, the researcher can determine the density or cohesiveness of the network under consideration (Wang, Robins and Pattison, 2006b). The second groups of pure structural effects parameters are the degree-based parameters. For the ERG models, this study includes two degree-based pure structural parameters, which represent degree centrality. The parameters are the popularity-based and the activity degree centrality parameters, coded as A-in-S and A-out-S respectively. The third groups of pure structural parameter estimates are the closure type of parameters. These parameters are included to investigate the presence of clusters or cliques in the networks under study. Four parameters are included and are coded as AT-T, AT-U, AT-C and the AT-D. The next batch of pure structural parameters is the parameters which represent multiple connectivity or multiplicity of ties in the networks. Based on the study objectives, the following pure structural parameters are selected, i.e., Multiple localized connectivity (A2P-T), Activity-based structural equivalence (A2P-U), and Popularity-based structural equivalence (A2P-D). The second column of Figure 4.2 indicates the interpretation of
parameters. The second column of Figure 4.2 explains how the propensity of the structural parameters effects take effect given the network size and number. For instance, an ERG model with positive and significant \textit{reciprocity} estimates (details of determining the parameter significant are given in the following sections) indicates the high propensity for mutual ties to occur in the network given the network size and number of nodes. The third column of Figure 4.2 describes the pure structural effects parameters in graphical formats. In column three, firms are represented by the blue nodes, while the lines between two nodes represent the ties that connect them. The lines also have arrows indicating the direction of the tie, either inward or outward respectively.

The final column discusses the meaning of the parameters from the supply chain perspective. From the perspective of supply relationships, the \textit{arc} parameter refers to the tendency of firms to forge ties with other firms in the network given the size and number of nodes in the network. \textit{Reciprocity} relates to the presence of mutual ties between the firms in the trust network of the APMMHQ-1 supply system. The popularity parameter (\textit{A-in-S}) suggests that popular firms tend to receive more ties from shared alters and to communicate together. Activity spread (\textit{A-out-S}) relates to the activity of organizations in engaging other firms in the network. Closure or clustering (\textit{AT-T}, \textit{AT-T}, \textit{AT-C}, \textit{AT-D}) are parameters, which examine the transitivity effects between firms; while multiple connectivity parameters (\textit{A2P-T}, \textit{A2P-U}, \textit{A2P-D}) analyze the propensity of ties to form as part of formations involving multiple ties between other firms. Significance and positive outcomes of these parameters indicate the propensity of certain structural tie formations that the firm’s organizations are likely to be embedded in. For example, an ERG model with significant and positive \textit{A-in-S} indicates the network is under consideration. There is a high propensity that the tie structural formation may be forged based on the \textit{A-in-S} formation, which is indicative of an in-degree based popularity structural form. In other words, in the network under consideration, there is a high propensity that a core actor may exist in the network, which is an indication of network
centrality or in-degree centrality. In the next section, this thesis discusses the second type of network effects, namely, the Pure Attribute Based Network Effects or the pure actor relation effects.

**Pure Attribute Based network effects**

This section discusses the second network effects investigated in this study. Effects that include the characteristics of the nodes or actors, as related to social tie formation, are known as the Pure Attribute Based Network Effects or the actor-relation effects (Robins et al., 2007; Wang, Robins and Pattison, 2006a, 2006b). Inclusion of these effects is twofold.

First, it allows the researcher to determine the impact certain node attributes would have on the propensity of a tie structural formation to take a form within the network. For example, using the ERGM analysis, a researcher can determine whether a node attributes such as organisational size or age can influence the propensity for tie formation to take place in the network.

Second, using the Pure Attribute Based Network Effects also allows the researcher to determine the individual likelihood of particular firms being selected in the tie formation within the network when these firms possessed the attribute in question. For example, firms’ attributes equally important help the researcher to determine whether specific attributes of the nodes would give the nodes leverage in terms of partner selection or not. Figure 4.3 presents the relevant attribute network-based effects of this study.

First, the *Sum of Continuous Attribute Effects* shows the tendency for a tie to occur between network members who are high in the particular continuous attributes. A significant and positive *Sum of Continuous Attribute Effect* indicates the tendency between actors that are both high in the particular type of continuous attribute (e.g., embeddedness) or have a level of between high and low continuous attributes to forge ties with each other. A significant and negative *Sum of Continuous Attribute Effects* indicates the unlikelihood of the tie to form between two network members with the attribute under consideration.

On the other hand, the *Difference in Continuous Attribute Effects* indicates that network
members with differences in the particular continuous attributes are likely to forge ties together (Robins et al., 2012). More specifically, these attribute-based network effects are included in the ERG model to investigate and determine whether the related embeddedness attribute would influence the firms organisational tie formation in the networks under consideration. A positive parameter indicates a high probability that the configuration will be present in the network. A negative parameter indicates that it is less likely that the configuration will be in the network.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Interpretation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of Continuous Attribute</td>
<td>Denotes that nodes or firms that are high in attributes are likely to forge ties with other nodes or buyer supplier firms with high or low attributes when the parameter is significant and positive.</td>
<td>+</td>
</tr>
<tr>
<td>Difference of Continuous</td>
<td>Denotes that nodes or firms that have differences in their attributes are likely to forge ties together when the parameter is significant and positive.</td>
<td>-</td>
</tr>
<tr>
<td>Attribute</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4.3 Pure Attribute Effects Parameters**
Source: Robins et al.(2012)

4.9 VALIDITY AND RELIABILITY

This section discusses the validity and reliability approaches applied in this research.

4.9.1 EXTERNAL VALIDITY

Ideally, generalizations of the results of this research should be made over the supply chain system in Malaysia. Unfortunately, as with other social network studies, the respondents of the study were not chosen randomly. In fact, they consist of the specific population of the APMMHQ-1 supply system that supplies the APMMHQ-1 with spares and materials for the maintenance and
development of ships and boats. Therefore, as in similar social network studies, the findings of this research have limited external validity and are open to argument that they could represent an atypical class.

4.9.2 CONSTRUCT VALIDITY

Most of the important variables defined in this study measured constructs of unobservable attributes cognitively created to theorize or explain a firm’s behavior. That is, they were not directly measured, and proxies were used instead.

4.9.3 RELIABILITY OF NETWORK DATA

The development of the network structure relies on many assumptions. First, the rosters of the related firms were provided, given the strong assumptions that the observed firms were the equilibrium results of a long-term process of various interactions. Second, the collection of social network data is a free-recall technique. Therefore, the researcher trusts the key informants to remember network members and their ties; hence the researcher is subject to the respondent’s cognitive bias.

4.10 SUMMARY

This chapter presents the mixed-methodology design, which includes exploratory network analysis and statistical network modelling. These methods were used to collect network data and analyses the data on aspects of both network and firm embeddedness relating to the firms residing in the APMMHQ-1 upstream supply chain for the product RHIB.

In the following chapters, the researcher will present the results of network data analysis to answer the research questions developed for this study. It is important to note that the researcher will first present the results of the exploratory network analysis to answer research question two, before deliberating on the results of the statistical network modelling in order to answer research question one and its sub-research questions. The assessment of network maps and network
structural measures represent the exploratory component of this research. The quantitative part used ERGM analysis to establish the effects of organisational measures of network embeddedness in greater detail.

The general outlook of the embeddedness of firms in the APMMHQ-1 upstream supply network structure will be provided by answering research question two in the first instance. The results of the exploratory network analysis will assist the researcher in terms of providing a more accurate assessment of individual firm embeddedness in the APMMHQ-1 upstream supply network structure needed to answer research question one.

The results of each methodological approach are reported separately in the following two chapters. The next chapter presents the results of the exploratory network analysis. The findings of the ERGM analysis are then presented in the following chapter.
CHAPTER FIVE
EXPLORATORY NETWORK ANALYSIS

5.1 INTRODUCTION

This chapter presents an exploratory social network analysis of the network data. More specifically, the researcher utilizes visual analysis and network structural measures of embeddedness to illustrate the overall pattern embeddedness of firms in the different types of network linkages or firm relationships (Scott, 1988; Wasserman and Faust, 1994).

The flow of this chapter will begin with a description of the exploratory network analysis and what it entails. The researcher will subsequently discuss the management of the network data to perform the exploratory network analysis. This will be followed by the results of visual analysis of the sociograms of, specifically: contract tie, information-sharing tie, referral made tie, and referral received tie. The researcher then presents the structural measure results of the exploratory analysis. Finally, the researcher summarizes the findings and concludes the results with regard to RQ2. The overall process flow of this chapter is described in Figure 5.1.
5.1 Introduction

5.2 Exploratory Network Analysis

5.3 Management of Network Data

5.4 Results of Exploratory Network Analysis

5.5 Visual Analysis of Network Embeddedness

5.5.1 Visual Analysis Network Maps of Contract Tie

5.5.2 Visual Analysis Network Maps of Information-Sharing Tie

5.5.3 Visual Analysis Network Maps of Referral Made Tie

5.5.4 Visual Analysis Network Maps of Referral Received Tie

5.6 Analysis of Structural Measures of Network Embeddedness

5.6.1 Structural Measures of Network Embeddedness: Reciprocity

5.6.2 Structural Measures of Network Embeddedness: K-core

5.6.3 Structural Measures of Network Embeddedness: Density

5.6.4 Structural Measures of Network Embeddedness: Centralization

5.6.5 Structural Measures of Network Embeddedness: Geo-Desic

5.6.6 Structural Measures of Network Embeddedness: Clustering Coefficient

5.7 Summary Research Question 2

**Figure 5.1 Chapter Flow**
5.1 EXPLORATORY NETWORK ANALYSIS: JUSTIFICATION FOR THE VISUAL ANALYSIS OF SOCIAL NETWORK

The process of visual analysis has been applied in many social network studies in an attempt to provide an overall structure outlook of the network in question (e.g. Krauss et al., 2004; Kindermann, 2007; Creswick and Westbrook, 2010). Visual analysis is useful for displaying relevant network data information. It provides a pictorial form of data as an early part of network analysis (Tufte and Weise Moeller, 1997). Tufte and Weise Moeller (1997) analysed the visual analysis performed by Dr. John Snow, concerning the London cholera epidemic of 1854. The authors concluded that Dr. Snow mapped and identified the source of the cholera by mapping the area (in terms of interactions of patients) where deaths have been recorded. The map of the interactions placed most of the cholera victims around a central point near a well pump on Broad Street in central London. The interaction map served as proof that victims all used the water from the well and tested that it was the water that caused the epidemic.

Tufte and Weise Moeller (1997) highlight Dr. Snow’s method of placing the data in an appropriate context for assessing cause and effect, thereby enabling him to make quantitative comparisons and to consider alternative explanations.

Arguably, Tufte and Weise Moeller (1997) demonstrated the explanatory power of social network visual analysis. The explanatory power of the social network visual analysis undoubtedly has been proven and accepted in literature (Scott, 1998; Hanneman and Riddle, 2005). Using network maps or sociograms, social network analysis can explore the location of individual actors in the network. The location of these actors in the network (referring to: centrality (Freeman, 1979), clique (Coleman, 1988) and structural holes (Burt, 1994), in turn, have been found to provide firms with intangible resources as mentioned in a study (e.g. Ahuja, 2000). Hence, the researcher applied the visual analysis of the network maps as part of the exploratory network analysis to answer research question two of this study. More importantly, the result of the exploratory network
analysis will set the background for the analysis of an individual firm’s pattern of embeddedness. It is anticipated that this will help answer research question one of this study.

In the next section, the researcher describes the steps involved in the management of the network data to perform the social network visual analysis.

5.2 MANAGEMENT OF NETWORK DATA

This section describes the step by step process involved in generating the network maps for this study. The data from the network maps were later utilized to calculate the network structural measures which were then used to further analyses the structure of the network maps; consequently, answering the research question.

5.2.1 Development of Network Sociograms

In this study, network sociograms were developed using the NetDraw and the Mage software packages. Although NetDraw and Mage were used to create the final output (i.e. the network sociograms), two other software packages were used in the early stages of the visual analysis, i.e. Excel and UCINET® (Borgatti, Everett and Freeman, 2002). Microsoft Excel was used to enter the binary data from the network survey and UCINET® converted the Excel worksheets into a readable format for the NetDraw program before converting it into sociograms. In the following section, the researcher briefly describes the entering and uploading processes performed via the three different applications (Excel, UCINET® and NetDraw).

Development of the relevant sociograms or network maps requires two types of network data to be collected from the network survey. The network data are the node data (or the firm attributes data) and the tie data. In the following sections, the researcher describes how these network data were processed and entered into the relevant program to perform the exploratory network analysis.
**Entering the Node data (Firm attributes)**

First, for each of the network ties (i.e. contractual ties, information-sharing ties, referral made ties, referral received ties) the researcher created two Excel worksheets (NODE-DATA and TIE-DATA worksheets). For example, for the contract tie networks, a CONTRACT TIE NODE-DATA worksheet and a CONTRACT, TIE-DATA worksheets are created. The NODE-DATA worksheet was used to enter the node data or the firm attribute such as organization size, age, and so on. The first column header of the Excel worksheet contained the ID or the label for the research sample, namely, the 37 firms in the APMMHQ-1 upstream supply network for RHIB equipment and materials. In the subsequent columns of this worksheet, we record relevant information about the firms, such as the size, age of, address or location of the organizations, and the sectoral affiliation respectively. An example of the node data worksheet is attached in Appendix A1.

**Entering the tie data**

The tie data worksheet is used to enter the tie data which are the binary data representing the existence (or non-existence) of ties between the firms. To do this, the researcher headed the first two columns in the tie worksheet as FROM and TO. In the first cell of the FROM column, the researcher copied the first organization ID in the node data worksheet and pasted it into the first cell. The researcher then copied the full list of the IDs from the NODE-DATA worksheet and pasted the list into the TO column of the tie worksheet. A third column was added, named the TIE STRENGTH column. The researcher entered zero (0) in the initial reflexive tie and ‘0’ or ‘1’; where “1” indicates the existence of relations between two firms and “0” indicates no relation between two firms from the tie data from the network questionnaire for the subsequent cells. Next, in the TIE-DATA worksheet, the researcher used the fill down function in Excel to fill in the IDs for every row of the FROM column. This step made each row of the FROM column a fully defined item from the tie data. All steps mentioned were performed to generate the matrix for each of the four ties in the network questionnaire (appendix nine). In the following section, the researcher
describes the uploading of the network tie data and the firms’ attribute data into the UCINET to perform the exploratory network analysis.

**Loading Data to UCINET®**

Once the node data and tie data was recorded in Excel, the next step involved uploading the worksheets into the SNA software, i.e. the UCINET®. In the UCINET® software, the following steps were performed. The researcher used ‘Data’→’Import via spread sheet’→’DL type formats’ command to upload the Excel worksheets into the UCINET® program. When a dialogue box opened, the researcher used the ‘File’→’Open Excel file’ command to direct the software to the Excel program that contained the ties and node data. The researcher located the Excel worksheet and selected the NODE DATA or the TIE DATA worksheet of each tie. When the NODE DATA worksheet was selected, the researcher selected the Full Matrix format and checked the column header in the UCINET® dialogue box. The researcher then used ‘File’→’Save UCINET® dataset’ command and named the new file after the type of node attribute uploaded. Similar steps were performed in order to upload the TIE DATA worksheets into the UCINET® program. However, instead of the ‘Full Matrix’ format, the ‘Edgelist (1 mode)’ format was selected in the corresponding dialogue box. To cross check the uploaded NODE DATA and TIE DATA worksheets, the researcher used ‘Data’→ ‘Display’ to see how UCINET® has stored the data.

**Creating Network Sociograms using NetDraw**

Once the NODE DATA and TIE DATA worksheets were stored in the DL format of the UCINET® program, the researcher then loaded the NetDraw program to create the sociogram for each of the ties in the study. In NetDraw, the researcher used ‘File’→ ‘Open’ → ‘Ucinet Dataset’ → ‘Network’ to open the CONTRACTUAL TIE DATA for contractual tie network. In the subsequent dialogue box, the researcher browsed the UCINET file contract tie data and clicked the file. This step is performed to create the network structure of the sociogram. To upload the NODE DATA, the following steps require selecting the contract tie NODE DATA of the UCINET® files.
Once the contract TIE DATA and contract tie NODE DATA files were uploaded in NetDraw program, the program generated the network sociogram based on the entered binary data sets. The above processes were repeated for all other network ties. The outcomes are discussed next.

5.3 RESULTS OF EXPLORATORY NETWORK ANALYSIS

The structural formations of these firms will set up the platform for detailed discussion to answer research question two of this study. The researcher combined descriptive data with the exploratory network analysis to provide an explanation for the results.

5.4 VISUAL ANALYSIS OF THE MAP OF APMMHQ-1 UPSTREAM SUPPLY NETWORK FOR PRODUCT RHIB

In this chapter, the metaphorical structure of the APMMHQ-1 upstream supply network for the product RHIB was first developed. Following Choi and Krausse (2006), the upstream supply network structure for the RHIB was developed based on the archival review and discussion that the researcher conducted with key informants from AMPPHQ-1. These consisted of, namely: two tiers one firms and one tier two firms concerning the flow of materials from the upstream firms to the focal firm, i.e. APMMHQ-1 for the product RHIB. Based on the data collected, the following figure depicts the upstream supply network structure of APMMHQ-1 for the supply of materials for the product RHIB. In Figure 5.2, the firms are coloured based on their positions in the upstream supply network structure. APMMHQ-1 is the focal firm in this centralized upstream supply network structure and its colour in red. Firms in tier one has a blue colour and consist of seven firms. Tier two firms are represented in green and consist of 16 firms. Finally, firms in tier three are purple in colour and consist of twelve firms.

The structure in Figure 5.2 indicates a hierarchical structure of the APMMHQ-1 upstream supply network for the supply of materials and services for the product RHIB. Flow of materials for the production of the RHIB consists mainly of three tiers of suppliers having a total of 37 firms.
The largest number of suppliers or firms in the upstream supply network structure resides in tier two of the upstream supply chain consisting of 17 firms. The logic behind this is that the firms in tier two are the firms that manufacture the raw materials from tier three firms into work in process (WIP) components or parts for the tier one supplier and, ultimately, the focal firm or manufacturer. This hierarchical structure is normally the result of the flow of resources in the APMMHQ-1 upstream supply chain network.

In the following section, the researcher presents the network map of four network ties, i.e.: contract tie, information-sharing tie, referral made tie and referral received tie.
The Upstream Supply Network of AMPPHQ-1 for the Supply of Rigid Hull Inflatable Boat (RHIB)

**Figure 5.2** Upstream Supply Network Structure of APMMHQ-1 for the Product RHIB
5.4.1 Visual analysis of the contractual tie network

This section presents the network maps and visual analysis of the contractual tie network generated using the NetDraw and Mage package. Figures 5.3 and 5.4 are the sociogram for the contractual tie network. In Figure 5.3, the researcher shows the sociogram of the contract network showing only the nodes without the ties connecting the nodes. Figure 5.4 shows the structure of the contract network with the nodes and ties that link the nodes in the network.

Similarly, the colours of the nodes which represent the firms in the network map were coded in the same manner as in Figure 5.2, namely: red represents the focal firm in the upstream supply network; blue nodes are the firms in the first tier of the upstream supply network; purple nodes represent the firms in the second tier of the upstream supply network, and the green nodes represent the firms in the third tier of the APMMHQ-1 upstream supply network for the product RHIB.

Visually, in Figures 5.3 and 5.4, we see a dense central area made up of ties mainly concentrating among the APMMHQ-1, as well as other first-tier firms. The other firms are located in the outer region of the network. Firms such as WILUTA-4, WIKLSAB-31, together with APMMHQ1, appear to be centrally embedded in the network. This is an indication that in an administrative or hierarchical relationship, such as contractual relationships, the focal firms and the first-tier firms appear to be central in the network. This is because the focal firm is visible in the network structure as the firm with the most resources in terms of contracts compared with other firms in the network structure. The tier one firm are also centralized in this network map as they are similarly closely associated with the focal firm for the supply of materials for the product RHIB. This may ultimately present them with other contract relations with the focal firm. There is low connectivity between firms in the periphery structure of the contract tie network map.

The need for contract relations from the APMMHQ-1 may have made the APMMHQ1 a source of contractual information by other firms. However, firms in the network map also have
other contract relationships with additional firms in the network structure. These relations may involve the supply of other materials or services for the contracted firms to functions in the upstream supply network.

In the contractual tie network map, firms are largely situated based on their operational locations, i.e. tiers indicated by the grouping of similarly colour-coded organizations. The location of a firm in the upstream supply network tier is an unwritten indicator of the size of the firms. Accordingly, this means that, in the contract ties network map, firms are closely tied to other firms that are similar in size and capability.

Overall, the network maps of the contract tie indicate that firms’ connectivity are rather high, but having the focus of relations centering upon the focal and tier one firms. In addition, firms of a similar position in the upstream supply network tiers are found to be closely connected to each other through an alternative form of contract's relations.

In the following section, the researcher presents and discusses the network map for the information-sharing tie.
Figure 5.3 – Network of firms based on contractual tie. Sociogram without ties
Focal Firm, Tier 1 firms, Tier 2 firms, Tier 3 firms

Figure 5.4 – Network of firms based on contractual tie. Sociogram with ties.
5.4.2 Visual Analysis of the Information Sharing Tie Network

Figures 5.5 and 5.6 describe the pattern of inter-firm relations between firms in information-sharing exchanges for the firms in the APMMHQ-1 upstream supply network structure for the product RHIB. To evaluate the pattern of connectivity of the information-sharing tie, a comparison must be made with the contract tie network structure. Visually, clearly when compared to the contract tie network structure, the information-sharing tie network structure showed a stronger level of connectivity between the firms in the APMMHQ-1 upstream supply network structure for the product RHIB. What can be the justification for these differences?

It is important to restate that, following the embeddedness theory prediction that commercial transactions are embedded in a web of social exchanges; this study posited that commercial transactions which include the contract ties that function as the administrative arm of the focal firms represent a formal means of coordination enforced upon firms in the network structure. Contractual terms and rules regulate interactions and transactions between the firms in the APMMHQ-1 upstream supply network structure. The rigid but necessary nature of the contractual relations may contribute to the occurrence of lesser ties or relations between firms in the contract tie. However, information-sharing ties represent what embeddedness theory predicts, namely, as being a form of social exchanges. Cousins et al., (2001) have stated that social exchanges such as information-sharing activities formed the informal types of relation coordination that exist between firms in the supply network. The informal nature of the information-sharing relations between the firms means more opportunities for interactions between firms in the upstream supply network structure.

Compared to the contract tie network, the information-sharing network clearly has more ties connecting the firms. In Figure 5.6, we also see several dense regions in the network structure, indicating that information-sharing occurs extensively with multiple firms of the various tiers in the network. The dense central section of information-sharing tie networks is now populated by a mix of first tier and second tier firms, as well as the focal firm at the central node. Figure 5.6 shows
that firms such as APMMHQ1, WILUTA4, WILSAB31, and DMPKLANG-14 are centrally embedded in the social network. Furthermore, the sociogram indicated that, in the information-sharing network, firms are communicating among themselves despite the different tiers. This can be seen from the sociogram where buyer organizations such as PMTMANIS29, DMTBALI23, WILTIM20, and WILUTA4 are quite embedded in the network structure along with other firms from other tiers. Such conditions have happened as per the nature of information-sharing ties, which are rather less formal than contractual ties; for example, encouraging organizations to look outside their comfort zone for information.
Figure 5.5 – Network of firms based on information-sharing ties. Sociogram without ties
**Figure 5.6**– Network of firms based on information-sharing ties. Sociogram with ties

- **Focal Firm**, **Tier 1 firms**, **Tier 2 firms**, **Tier 3 firms**
5.4.3 Visual analysis of the referral made tie network.

Figures 5.7 and 5.8 display the sociogram for a referral made tie network. Again, for the visual analysis, the researcher made a optical comparison of the pattern of connectivity between firms in the referral made tie, information-sharing tie and contract tie respectively. In this study, referral activities are considered relationships that sit in the middle of the formal and informal continuum (as some referral activities are part of contractual requirements, as well as informal communications activities).

The visual analysis of the sociogram indicated the following. Compared to the information-sharing tie network and the contract tie network structure, the network map or sociogram of the referral made tie indicate that the patterns of relations between firms are lesser compared with the information-sharing tie, however, considerably more than the contract tie. The dense central section of referral made tie network is occupied by the APMMHQ-1. Figure 5.8 also indicates from the network plot that, in the referral made tie network WILSAB31, WILUTA4, WILSA25, and WILTIM20 are centrally embedded in the outer ring of the network central location.

The sociogram also indicated that, in the referral made network, firms are embedded into a number of clusters. We could see this from the grouping of several forms into sub-groups in the referral made network as indicated in Figures 5.7 and 5.8. For example, the network maps show a cluster of MTUJBARU-13, DMPKLN-14, PMBPAHAT-18, PMMRSNG-17, DMKGANU-22, and DMPKLN-15. This heavy clustering of firms in the AMPPHQ-1 upstream supply network structure could be related to the nature of referral activities that mostly centre or focus upon other network members who are physically closer than the “far fetched” connections.
Focal Firm, Tier 1 firms, Tier 2 firms, Tier 3 firms

**Figure 5.7 - Network of firms based on referral made tie. Sociogram without ties**
Focal Firm, Tier 1 firms, Tier 2 firms, Tier 3 firms

**Figure 5.8 - Network of Firms Based on Referral Made Tie. Sociogram with Ties**
5.4.4 Visual analysis of the referral received tie network.

Figures 5.9 and 5.10 display the sociogram for referral received tie network. Visual analysis of the sociogram indicated that this network structure is less dense compared to the information and contractual ties, as well as the referral made tie network structure. We could identify from the sociogram that the density of the network has shifted to the different clusters. There are two main clusters in the referral received network structure as indicated in Figure 5.9. For example, in the central clusters, firms from the first, second and third tiers are clustered into the central clusters. However, in other clusters, we see only clusters from the second and third tiers grouped together. The referrals received network indicated that communications are largely directed within the different clusters.
Focal Firm, Tier 1 firms, Tier 2 firms, Tier 3 firms

**Figure 5.9 - Network of firms based on referral received tie. Sociogram without ties**
Focal Firm, Tier 1 firms, Tier 2 firms, Tier 3 firms

Figure 5.10 - Network of firms based on referral received tie. Sociogram with ties
5.4.5 Summary of visual analysis

In this study, in order to guide the analysis of the network maps, the researcher argues in favor of Cousins et al. (2006). The authors argue that inter-firm relations in the supply chain can be classified into formal and informal types of relations depending on the type of coordination involved in overseeing these inter-firm relations. Relations that are based on terms and written guidelines as the coordination mechanism are classified as being a formal form of inter-firm relations. On the other hand, relations that are formed voluntarily and are not bounded by the rigidity of rules in its coordination mechanisms are classified as the informal form of relations. Thus, the contract ties can be identified as being the formal form of relations as they are based on the contractual terms and requirements; while the information-sharing tie is a form of informal relations due to its being voluntary and not bound by any written conditions. Referral activities may sometimes involve performing referral duties as required in a contract, such as sending staff for training. They may also include voluntary referral activities, such as sending or seeking price information. Consequently, referral activities are considered as being in the middle of the formal and informal continuum of inter-firm relations in the centralized upstream supply network.

First, the visual analysis performed showed that, in the more formal relationships, the core nodes or central firms with high numbers of tie connections are largely the focal firms and the first-tier firms. On the other hand, the optical analysis of the sociogram for the informal information sharing ties shows that the network structure differed. The differences again centred on the type of firms that received the most ties or connectivity. In the informal information-sharing tie network structure, there is a mix of firms from distinctive tiers that are central in the network. The researcher argues that this distinct network structural formation relates to the type of resources offered by the different kind connectivity. This is rightly so, as the distinctive type of ties may offer the connected organizations with distinct social capital (Cousins et al., 2006; Gordon, Kogut and Shan, 1997) of competitive advantage (Porter, 1985; 1998). Our finding is similar to Oh et al. (2004). They documented that the configuration of group members' social relationships is related
to the construct of the group social capital that is inherent in the structure or pattern of relations between actors (Burt, 1995; 1995; Coleman, 1988; Nahapiet and Ghoshal, 1998). This pattern of connection creates a network of interdependent social exchanges. Consequently, organizations with the right connections occupy a position in the network of social exchanges that allows them to bring their resources to bear on problems in a more timely and effective manner (Burt, 2004).

Secondly, the network maps show that firms are more connected in the informal network structure than they are in the formal network of relations. This is indicated by the pattern of connectivity between firms in the upstream supply network structure. As we see in Figures 5.4 and 5.6, there are more lines connecting the firms in Figure 5.6 (i.e. the information-sharing tie network) than in Figure 5.4 (i.e. the contract tie network). Such pattern of connectivity is an indication that firms are more connected in the informal network structure than in the formal network structure.

Comprehensively, although the visual analysis of the four network ties provided some general description of patterns of embeddedness among firms, the analysis merely describes the macro outlook of each network structure. To obtain a much deeper understanding of how each of the firms are embedded in the different network structure, the researcher analysed the overall network structural pattern of embeddedness through a network structural measures index which indicates the network embeddedness or involvement of firms. The structural measures such as reciprocity, density, and k-core provide the researcher with a holistic statistical perspective of network embeddedness and help to illuminate the embeddedness patterns of firms with more accuracy and in a more informative fashion (Wasserman and Faust, 1994; Scott, 2000).

In the following section, the researcher presents the results of exploratory network analysis using network structural measures of embeddedness.
5.5 EXPLORATORY NETWORK ANALYSIS: NETWORK STRUCTURAL MEASURES

In this section, the calculated network structural measures will be presented in detail regarding the embeddedness of firms in the APMMHQ-1 upstream supply network for the product RHIB.

5.5.1 ANALYSIS OF NETWORK STRUCTURAL MEASURES OF EMBEDDEDNESS: RECIPROCITY

Reciprocity is the measure of the rate of reciprocation of relationships (Wasserman and Faust, 1994; Scott, 2000). Whether that who was the centre of communication also receive communications from the organization concerned is determined by the extent of the reciprocal nature of the ties (Sommerfeld et al., 2007).

The reciprocity index score for the contractual tie's network is 0.3532. Percentage wise, of all the pairs of actors in the contractual tie's network that have any connections, 35.32% of these pairs have reciprocated connections. This means that 35.32% of those firms in the contractual tie network which communicate with others regarding the contractual aspects of the supply of spares and equipment for the APMMHQ-1 are sought out by those same organizations. This is rather low, indicating that there is a hierarchical rather than a horizontal structure in the contractual tie's network.

Second, the reciprocity index score for the information-sharing ties network is 0.4684. This indicates that, of all the pairs of actors in the information-sharing tie's network that have any connections; 46.84% of these pairs have reciprocated connections. This means that 46.84% of those firms in the information-sharing tie network which share information regarding the supply of spares and equipment for the APMMHQ-1 are sought out by those same organizations.

Third, the reciprocity index score for the referral received made network is 0.3234. In general, 32.34% of these pairs have reciprocated connections with each other. The reciprocity
index score for the referral received ties network is 0.4471. This means that 44.71% of those firms in the referral received tie network are sought out by those same organizations. The index score is quite high, indicating that organizations which have considerably been fewer formal ties reciprocate information between each other more frequently, particularly with regard to the embedded organizations.

More reciprocation means more mutual interactions and more activities, which make firms more connected and consequently, more embedded in the network. Between formal and informal ties, this study found that, with regard to formal ties, lesser reciprocation of ties was found compared with a situation of informal ties.

In Figure 5.11, we see that the level of reciprocity increases from formal to informal ties. This may be due to the fact that formal tie communications are regulated by terms and rules.

![Reciprocity Index](image)

**Figure 5.11 Reciprocity Index Score**
This may reduce levels of interaction, which, consequently, result in low levels of network embeddedness. On the other hand, the reciprocity index indicates that firms are more embedded in an informal network.

5.5.2 Analysis of Network Structural Measures of Embeddedness: K-Core

In this section, the researcher discusses k-core analysis results. A \( k \)-core is a subset of all the nodes in a network such that each node is linked to at least some other \( k \) nodes in the same subset. A \( k \)-core is a highly-interlinked collection of nodes within a larger network. Comparisons of \( k \)-cores of a network for different levels of \( k \) also provide some insight into the strength and connectedness of firms in the centralized upstream supply network (Mueller, Buergelt and Seidel-Lass, 2007). The visual analysis indicate that the lower the \( k \)-cores in the network structure, the stronger the connectedness of the firms (i.e. the involvement or embeddedness of firms) in the centralized upstream supply network structure.

Analysis of K-core value of contractual tie’s network

Figure 5.12 shows the \( k \)-core groups under the contractual tie network. A large number of the firms in the network fall into the \( k \)-core of nine followed by \( k \)-core eight, seven and six. In Figure 5.12, the subgroup, which includes: APMMHQ-1, MTUPJAYA-2, MTURAWNG-3, WILUTA-4, DMLKAWI-5, DMPPINANG-6, DMLUMUT-7, PMKKEDAH-8, PMKKURAU-9, PMKPERLIS-10, MTUPINANG-11, WILSEL-12, DMJBARU-13, DMPKLN-14, DMLGKI-15, PMMRNS-17, PMBPAHAT-18, MTUJB-19, MTUKTN-24, WILSAR-25, WILSAB-31, DMLBUN-32, DMKBAL-33, DMSAKAN-34, and PMLDATU-36 are the 9-core group. The subgroup which includes: DMDILI-16, WILTIM-20, DMKCHNG-26, DMBTULU-27, DMMIRI-28, PMTMANIS-29, and MTUKCHG-30 is the 8-core group. The sub-group comprising: DMKNTAN-21, DMKGANU-22, DMTBALI-23, and DMTAWAU-35 are the 7-core group. Lastly, subgroup MTUKBALU-37 is the 6-core group.
Overall, the contract tie network structure indicates that there are four \textit{k-cores} in the contract tie. This means that in a contract tie, there are four sub-groups of highly-interlinked firms in the network structure.

In the following section, the researcher discusses the pattern of embeddedness of sub-groups in the information-sharing tie network.

\textbf{FIGURE 5.12 – K-CORE DIAGRAM FOR CONTRACTUAL TIE’S NETWORK}
**Analysis of K-core of information sharing ties**

Figure 5.13 displays the data sets that indicate the k-core value for an information-sharing tie network. From the figure, we can see that there are only 2 $k$-core in the network, specifically: 9 $k$-core and 10 $k$-core. The majority of the organizations fall under the 10 $k$-core groups. In Figure 5.13, there are two different sub-groups in the network structure. The first subgroup includes: (DMKNTAN-21, DMKGANU-22, MTUKTAN-24, DMKCHNG-26, DMBTULU-27, DMMIRI-28, PMTMANIS-29, MTUKCHG-30, DMLBUAN-32, DMKBALU-33, DMSDAKAN-34, DMTAWAU-35, PMLDATU-36, and MTUKBALU-37) which form the 9 $k$-core. The second subgroup comprises: (APMMHQ-1, MTUPJAYA-2, MTURAWNG-3, WILUTA-4, DMLKAWI-5, DMPPINANG-6, DMLUMUT-7, PMKKEDA-8, PMKKURA-9, PMKPERLIS-10, MTUPINANG-11, WILSEL-12, DMJBARU-13, DMPKLNG-14, DMLGGI-15, DSMIL-16, PMMRNG-17, PMBPAHAT-18, MTUJB-19, WILTIM-20, DMTBALI-23, WILSAR-25, and WILSAB-31), which is the 10 $k$-core.

These results indicate that, in the information-sharing tie network structure, there exist at most two sub-groups of highly inter-linked firms. What this means is that firms in the information-sharing network are more involved with each other, as represented by only two sub-groups of firms in the in Figure 5.13.

The following section discusses the $k$-core for the referral made tie network structure.
Figure 5.13 – K-core diagram for information-sharing tie’s network
Analysis of K-core value of referral made tie network.

In Figure 5.14, there are four $k$-core groups indicating the groups in the referral made network. Within the referral made network, the subgroups are, namely: 5 $k$-core, 6 $k$-core, 7 $k$-core and 8 $k$-core. The majority of the network subgroups fall under the 8 $k$-core and 6 $k$-core. This result indicates that, in the referral made tie network structure, the level of involvement or connectivity among firms in the referral made tie network are lower compared with those in the information-sharing tie network.

The results confirm the coordination and continuum of relations, which place the referral activities in the middle between contract ties and information-sharing ties.
Figure 5.14 – K-core diagram for referral made network.

Analysis of K-core for referral received tie network

Figure 5.15 presents the analysis result for k-core value of referral received tie network. Based on the figure, we can identify that there are only three k-cores in the network.
Figure 5.15 displays the $k$-core network structure for the referral received tie network. The network structure indicates that the main $k$-core for the network is: 5 $k$-core, followed by 7 $k$-core and lastly 6 $k$-core. Structurally, the majority of the organizations are embedded in the less dense subgroups compared to the contractual and information-sharing ties network. Thus, compared with the contract tie network, information-sharing tie network, and the referral made tie network; the referral received tie network $k$-core results indicate that it is the second most connected network structure. This means that firms are more embedded in the referral received tie network and occupy
second place right after the information-sharing tie network that has a $k$-core of two. To provide the holistic picture of the k-core pattern of the firms across all four ties, the following graphs (Figure 5.15) summarized the findings in a visual manner.

![K-Core Subgroups Graph](image)

**FIGURE 5.16 K-CORE SUBGROUP INDEX**

The $k$-core analysis finding indicates the pattern of connectivity in the four different types of ties. In Figure 5.16, the $k$-core value relates to informal ties, i.e. the information-sharing tie is less than in the formal ties. In the contractual ties, we found that the network is divided into four subgroups, which indicate lower connectivity and consequently, less embeddedness. In the informal sharing tie network, the firms are more connected as the network contains only two subgroups of $k$-cores. Structurally, based on the $k$-core analysis, we posit that the pattern of embeddedness of firms in the network does rely upon the type of ties being considered. Information-sharing ties, which are a less formal group of relationships, created a high level of network embeddedness wherein fewer subgroups exist. However, in more formal ties, the subgroups are more visible, thus decreasing the overall network connectivity.
Thus, the overall pattern of embeddedness of firms based on the k-core value indicates that firms are more embedded in the contract ties with informal coordination mechanism compared to the network ties having formal coordination mechanism.

5.5.3 Analysis of Network Centralization

Figure 5.17 documents the centralization score of the four supply ties.

**Figure 5.17 Centralization Index**

The centralization index of contractual ties is 0.3142; the referral made tie is 0.3174, and the referral received tie is 0.3821. The centralization score for information-sharing is 0.4724. This score suggests that formal ties or firm relationships, such as contract ties, are less centralized than a lesser continuum of the buyer relationships.

The information-sharing network centers on the focal organizations. This could be due to the fact that, in a supply network, the focal firms dictate the flow of resources within the network. Because of that, other firms seek information directly or indirectly from the focal firms in the form
of orders and supply on a constant basis. These make the focal organizations the centre of information sources and provide them with a powerful positional advantage.

The distribution of the network centralization (Figure 5.17) shows that firms are more centralized in the information-sharing ties. The referral ties have the middle score while the contract ties have the lowest score. This pattern suggests the following: firms are more involved in network relations that are based on informal coordination mechanisms than in a formal one.

In the following section, the researcher presents the results of network structural measures of embeddedness density.

5.5.4 Analysis of Network Density

Figure 5.18 shows the density score for the contractual tie network.

**Figure 5.18 Network Density Index**
The density of the whole network of contractual ties is recorded as being 0.1660. This means that 17% of all possible ties between the firms are present in the contractual tie's network. The density network of information-sharing ties is recorded as 0.297. This indicates that 30% of all possible ties between the firms are present in the information-sharing tie's network. The density of referral received ties network is recorded at 0.200. This means that 20% of all possible ties between the firms in the network are present. It is an indication that firms are less embedded in the referral network structure. The network for referrals received has a density score of 0.185. This indicates that 18.5% of all possible ties between the firms in the network are present. Holistically, this is an indication that firms are embedded to a lesser degree in the referral received tie network.

Overall, the results of the network structural measures of embeddedness density show that firms are more connected in informal relationships than in formal relations.

This conclusion is consistent with findings from studies in other fields of inter-firm relations (Cousins et al., 2006; Oh and Labianca, 2004). It is argued that fewer formal interactions took place rather frequently among organizations, and the information gathered from the informal ties is more fluent than formal ties. Hence, organizations more often than not involve themselves with informal ties or activities with multiple types of organizations rather than in formal administrative activities based on contracts or transmittal of money.

In the following section, the researcher discusses the results of exploratory network analysis of network structural measure geo-desic distance.

5.5.5 Analysis of Network Geodesic Distance

The cohesiveness of the different networks is also examined by calculating the distance between firms of the networks and the number of ties between them. The geodesic distance refers to the shortest path between the firms and measures the extent of connection in the network (Knoke and Kuklinski, 1982). Understanding the geodesic distance between firms in the network allows the
researcher to determine the level of connectivity among firms. Consequently, it also gives general descriptions of the embeddedness level of firms in each of the network ties. Figure 5.19 displays the geodesic distance score in a graphical manner.

**FIGURE 5.19 GEO-DESIC DISTANCE INDEX**

The average geodesic distance between the firms in the contractual tie network is 2.0. This indicates that, on average, each organization is only two steps on the path away from other organizations in the network. This means that the contractual tie is an important tie to each of the firms in the APMMHQ-1 upstream supply network, as the majority of the firms tend to stay close to each other in the network with an average of two geodesic distance values between two embedded firms. The closeness between firms in the formal contractual tie may be due to the value of the ties to the overall management of the contracts that exist between the connected firms.

The average geodesic distance between firms in the information-sharing tie network is 1.8. The network structure indicates that in the information-sharing tie, firms are closely connected to each other. Firms are closely connected to each other in information-sharing ties due to the informal nature of the information-sharing tie. The average geodesic distance between the firms in
the referral made tie network is 1.92. In theory, the 1.92 geodesic distance score means that firms in the network would have to go through approximately 1.92 ties of actors in the network in order to gain access to certain resources. The geo-desic distance in a referral received tie is 1.85.

The analysis of the geo-desic distance indicates the overall literal distance between firms in the network structure through the length average length of ties between firms in the network. The longer the length of ties indicates the larger the distance between two firms to connect with each other in the network structure. As such, when comparing a geo-desic distance of 2 in the contract tie and a geo-desic distance of 1.8 in the information-sharing tie, it can be concluded that firms are closer or more connected to each other in the information-sharing tie than in the contract tie. This is because it took a lesser path to the next firm in the information-sharing than in the contract tie.

Figure 5.18 indicates that, in the more formal ties such as the contract tie; firms are more closer to each other than in the informal network structure. Clearly, the geodesic distance statistics indicate that firms are more closely embedded in the informal tie's network than in the formal tie network.

5.5.6 ANALYSIS OF CLUSTERING COEFFICIENT INDEX SCORE

The clustering coefficient is the extent to which any two organizations in the network are connected to the same organizations, as well as being also directly connected to each other (Hanneman and Riddle, 2005). In other words, the clustering coefficient score indicates the degree to which inter-clique interactions may exist in a particular network. A higher cluster coefficient score may indicate more activities between different sets of cliques. Hence, interactions in this network are expected to be higher. Consequently, attention is given to the level of embeddeness.

As indicated in Figure 5.20, in the formal relation, the clustering coefficient index is recorded as a score of 0.461.
The informal, information-sharing relationship recorded a clustering coefficient score of 0.572, and a score of 0.487 for the referral made tie respectively.

What the score indicates is that more collaborative activities or inter-clique interactions occur in the informal network compared to a formal network.

Thus, this is another indication that firms are more embedded in a firm’s informal relationship network than in the formal one.

5.6 **Summary of Exploratory Network Analysis for Research Question One**

The goal of the exploratory network analysis was to determine the pattern of embeddedness of firms in the upstream supply network structure in relation to the type of network ties being considered.
Using six indexes of social network analysis, the researcher mapped the overall pattern of involvement of a firm in four network ties on line graphs. To guide the analysis of the network maps, the researcher argued in favor of Cousins et al., (2006) and placed the four network ties on the continuum of formal to informal class of inter-firm relations.

The distribution of the network structural measures of embeddedness show an interesting pattern. Using the exploratory network analysis, the researcher established that the embeddedness of firms in the centralized upstream supply network is related to the formal versus informal classification of network ties. Overall, relationship networks with high formality are less centralized, less dense and less connected in the network. The network plots and network structural measures indicate that, in the formally-integrated relationship, firms are less involved or embedded in the network structure. On the other hand, in a network based on informally-integrated relationships, the network shows a high pattern of interactions as indicated by the high score of network structural measures of embeddedness. Combining the results of the network maps and the statistical results of network structural measures of embeddedness, the network plots and network structural measures indicate that, in the informally integrated relationship, firms are more involved or embedded in the network structure. More specifically, two sets of findings emerged from the data analysis. These are described as follows.

First, the network structural measures indicated that firms that are embedded in informal ties (such as information-sharing ties) are more actively connected to each other than formal contractual ties. This could mean that informal relationships carry more weight than formal relationships. Our finding is consistent with Choi and Kim’s (2008) work examining the relationships between a supplier’s embeddedness in the supply network and the supplier’s performance. Choi and Kim (2008) posited that firms are more embedded within their extended network through their informal social networks. Because of that, managers must pay higher attention to the pattern of embeddedness of these firms. By doing so, managers may do a better job of selecting partners for
long-term relationships and may also find value in maintaining relationships with poorly performing firms who may potentially act as a conduit to other companies with technological and innovative resources.

The second set of findings elaborates on the tendency of the different types of firms to participate in distinctive relationships. Based on the description of the network plots, we posit the following: that in a formal supply relationship such as contractual ties, the most involved or embedded firms in the network are mostly the focal and first-tier firms. Hence, we could argue that the extent of the embeddedness of a firm in the upstream supply network would appear to be contingent on the type of relationship network (formal versus informal). Thus, the finding from the exploratory network analysis shows that a firm’s embeddedness in the network relates to the type of ties being considered. Firms are less embedded in the core structure of the formal tie network, such as contract ties, compared to informal network ties. These findings have a strong impact on the management of the resources devoted to inter-firm relationship development, which will be elaborated further in the discussion chapter.

Overall, the results of the exploratory network analysis show that firms are more embedded in networks of informal relations than in a network of formal relations. The results of the exploratory network analysis are used in the following chapter to determine the impact of firms’ individual embeddedness levels in the upstream supply network structure on its level of relational capital outcomes.

In the next chapter, the researcher analyses the network data using ERGM analysis to answer research question one of this study.
CHAPTER SIX
EXPONENTIAL RANDOM GRAPH MODEL

6.1 INTRODUCTION

In this chapter, the researcher presents the results of the quantitative network data analysis and consequently answers research question one of this study.

Valid interpretation of the exploratory network analysis requires deeper understanding of the network environments. Exploratory network analysis alone does not provide a holistic picture of the network formation and reasons behind it (Cross, Borgatti and Parker, 2002). Network analysts have obtained more in-depth knowledge of the environments by combining the visual data with quantitative statistical analysis (Marsden, 1990; Scott, 1988). More recently, stochastic network modeling procedures have been applied by network analysts in an attempt to capture the probabilistic variants of structural formations of ties and contributory attributes to the formations (Robins, Lewis and Wang, 2012; Robins, Pattison and Wang, 2009; Wang, Robins and Pattison, 2006b). Consequently, the researcher will also adopt a statistical network analysis technique to holistically capture the true nature of the network environment of this study. More specifically, in this chapter, the researcher combines the visual analysis of the networks with the Exponential Random Graph Model (ERGM) so as to investigate the relationships between firms’ measure of network embeddedness and the impact on relational capital influence, relational capital trust and relational capital reputation that these firms may experience within the network structure. These will help answer the hypotheses developed for this study and consequently answer the first research question of this thesis.

The structure of this chapter is as follows. In the first section, the researcher detailed the process of ERGM analysis conducted for this study. The researcher will then present the result of ERGM analysis involving the firm measure of network embeddedness in, specifically: contract tie,
information-sharing tie, referral made tie and referral received tie on social capital trust. The second section will discuss the result of the ERGM analysis involving the network embeddedness measures on reputation. The third section will discuss the result of the ERGM analysis involving the network embeddedness measures on influence. The final section will discuss the results of each testing of the hypotheses and determine what it means with regard to the research question under consideration. Figure 6.1 shows the overall flow of this chapter.
6.1 Introduction

6.2 ERGM Analysis

6.3 Embeddedness and Trust
- 6.3.1 H1: Degree Centrality and Trust Network
- 6.3.2 H2: Betweenness Centrality and Trust
- 6.3.3 H3: Clique Overlap and Trust Network
- 6.3.4 H4: Multiplexity and Trust Network

6.4 Embeddedness and Reputation
- 6.4.1 H5: Degree Centrality and Reputation Network
- 6.4.2 H6: Betweenness Centrality and Reputation Network
- 6.4.3 H7: Clique Overlap and Reputation Network
- 6.4.4 H8: Multiplicity and Reputation Network

6.5 Embeddedness and Influence
- 6.5.1 H9: Degree Centrality and Influence Network
- 6.5.2 H10: Betweenness Centrality and Influence Network

6.6 Summary Research Question One

**Figure 6.1: Chapter Flow**
6.2 Exponential Random Graph Modeling (ERGM)

To investigate and analyse the complex social network data, this study applies a particular class of a statistical model for social networks, i.e. ERGM. The following description of the ERGM and its model specification are adapted from Lusher (2010), Lusher (2011) and Robin et al. (2006).

ERGM is a method that models the processes which create the networks (Handcock et al., 2004). ERGM basically functions as a ‘pattern’ recognition device, determining the relationship between network actors’ relations and the attribute of the actors.

There are two types of ‘pattern’ of relations in any ERGM analysis. The first is pure structural parameters, and the other is the actor attribute parameter (these are described in detail in Figures 4.2 and 4.3 of the researcher methodology chapter).

A pure structural parameter effect is a pattern of relation that exists in a particular network, regardless of what network it is. An example can be the tendency for mutual ties (i.e. reciprocity). There are, however, other network parameters that incorporate network actors’ attributes or qualities; for instance, if actors with certain attributes received more network ties. These configurations are known as actor-attribute effects. The actor-attribute effects are the parameters that help explain, as an illustration, why a firm in the upstream supply network would be perceived as being more trustworthy than other firms residing in the network structure.

Thus, any attribute or measure of interest to the researcher can be converted to the actor-attribute effects (e.g., age, location, attitudes, demographics, or in this case, the embeddedness attribute) and incorporated into the ERG model for analyzing the effects in a particular network of relations. Hence, a number of configurations can be added in a model, in much the same way that a researcher might add variables into a regression analysis to understand the important effects in the data. Similar to regression, ERGM parameters are estimated for the real-world social network data collected by the researcher.
A major methodological assertion of the ERGM framework is the interdependency of the actors in the network (not independent assumptions), implemented through provisional dependence assumptions (Lusher, 2010). For example, using the provisional dependence assumption, one could argue that one may have a slim chance of meeting Prime Minister Julia Gillard\(^2\), though the probability might increase if one happened to know her partner. Nevertheless, using the independence assumption of standard statistics means that knowing Prime Minister Julia Gillard’s partner has no impact on your chances of meeting the Prime Minister herself and that these events are totally independent of each other. This study argues that conditional independence is more sensible for the social context which is, by definition, about social relationships between the network members (Lusher, 2011).

As mentioned in Chapter four, section 4.8.2, the researcher considers two types of actor–attribute effects, namely: Sum of Continuous Attribute Effects and the Difference of Continuous Attribute Effects. In its simplicity, this study applied these node-attribute parameters into the ERG model to explore the effects of the firms’ attributes based on the firm embeddedness measures on the levels of reputation, influence and trust that the firms might receive among the network firms.

In ERGM, networks, even a small one, the numbers of likely configurations of ties are rather large. For example, a network with only \(n = 20\) actors will require a configuration modeling involving up to \(n (n – 1)\) or 1332 possible ties. The following description and step by step implementation of ERGM is adapted from the work of Robins et al. (2006; 2007)

According to Robins et at. (2007) there are five important steps that a researcher must follow in developing an exponential random graph model for a social network. In the first step of ERGM development, the network tie under study is assumed as a random variable. This assumes means that the network ties are not based on ad-hoc formation but also, the relations formations are as well highly probable. Thus, this means that the model that the researcher is trying

\(^2\)Current Prime Minister of Australia as of 24 June 2010
to develop will have some irregularities or unexplainable statistical ‘noise’. In this study, the researcher made the assumption that the formation of four network ties, which are the contractual ties, information sharing ties, referral made and referral received ties have random property.

Second, dependence hypothesis is developed. This hypothesis takes into consideration the normal social processes that are involved in the development of the network relationships. This assumption must be taken into consideration in the formation of the ERGM so that the model can provide a valid response. In this study, the researchers have taken into consideration the local social processes that are assume to exist in the formation of the network ties. In this study, reciprocity of ties are considered dependence hypothesis. By this it is assume that when FIRM A indicate that it has an information sharing tie with FIRM B, it is assume that FIRM B also share information with FIRM A.

Third, the dependence hypothesis implies a particular form to the ERGM. These local social processes are represented by several structural parameters such as reciprocity, in-degree centrality and many more as indicated in the earlier chapter.

Fourth, in order to determine the appropriate model, several parameters in the network need to be reduced. In ERGM process this is done through the development of the homogeneity constraints. In this case, the researcher assumes that certain parameters of the network are similar across the network ties. For example the structural parameters reciprocity are assume to be equal across all network ties.

Finally, after the four earlier processes have been performed (even implicitly), the researcher may conduct the estimation and interpret the parameters using the appropriate programs or software such as PNet or Statnet.

As mentioned, in ERGM, because of these large possible configurations, the probability distribution of the network structural elements must be estimated. The estimation is done using the
Markov Chain Monte Carlo Maximum Likelihood Estimate (MCMC-MLE) methods to sample the
distribution of the structural features of interest among the networks having the same number of
nodes as the observed network.

In general, the Exponential random graph models (ERGM) have the following form (Robins
et al., 2007):

\[
P_r(Y = y) = (1/k) \exp \left( \sum_{A} n_A g_A(y) \right)
\]

Where:

(i) The summation is over all configurations A;

(ii) \(\eta_A\) is the parameter corresponding to configuration A (and is non-zero only if all pairs of
variables in A are assumed to be conditionally dependent);

(iii) \(g_A(y)\) is the network statistic corresponding to configuration A; \(g_A(y) = 1\) if the configuration
is observed in the network \(y\), and is 0 otherwise.

All ERGM models are in the form of equation (1) which describes a general probability
distribution of graphs on \(n\) nodes. The probability of observing any particular graph \(y\) in this
distribution is given by the equation, and this probability is dependent both on the statistics \(g_A(y)\) in
the network \(y\) and on the various non-zero parameters \(\eta_A\) for all configurations A in the model.
Configurations might include reciprocated ties, transitive triads and so on (Robins et al., 2007).
Hence, the model enables us to examine a variety of possible structural regularities (Handcock et
al., 2004). The probability of observing the graph is dependent on the presence of various structural
characteristics introduced in the model. It is worth stressing that a model for the network \(y\) consists
of \(n (n - 1)\) possible network ties. In this study the total research population is comprised of 37
firms. Thus, the total of possible ties under investigation is $37(37-1) = 1332$. The total tie is large enough to provide valid statistical inference of the results.

The model specification for each of the trust, reputation and influence networks is briefly described as follows. First, the researcher includes in the model (1) the pure structural parameters of the network relations. This is done to determine the principal pattern of relations that might exist in the network (the overall list of pure structural parameters that converged in the model is listed in section 4.8.2). After the pure structural parameters have been determined, the researcher includes into the revised model the firms’ embeddedness attributes using the actor-attribute parameters. For all firm network embeddedness attributes, the researcher applied actor-attribute effects of *Sum of Continuous Attribute* as well as the *Difference of Continuous Attribute* effects. Therefore, separate effects for *Sum of Continuous Attribute* and *Difference of Continuous of Attribute* was each included for, respectively: Firm Network Embeddedness Degree Centrality (FNEDC), Firm Network Embeddedness Betweeness Centrality (FNEBC), Firm Network Embeddedness Clique Overlap (FNECO) and Firm Network Embeddedness Multiplixity (FNEM), all of which are continuous variables.

For the ERGM analysis to take place, the researcher adopted the PNet program to run the network data set of each of the ties in the network and the prevailing structural embeddedness variables (i.e. degree centrality) as the model parameters. The following section details the network exploration conducted while using the PNET program.

**ERGM Analysis using PNET**

In this section, the researcher provides step-by-step directions to illustrate how the ERGM steps and processes were performed using the PNET program. PNET was developed by Wang, Robins and Pattison (2006b). It allows the valuation of multiple networks simultaneously into the
estimated model under considerations. The matrices and vectors are stored in individual text documents. For this study, the matrices were created by directly entering, importing and exporting the data using the text editor notepad, Microsoft Excel, as well as the network programs UCINET. In Figure 6.2, a screen shot of the PNET program is shown.

\textbf{Figure 6.2 PNet Screenshot}

Source: Wang, Robins and Pattison (2006b)

First, the researcher enters a \textit{Session Name}. In the context of this study, the session’s names are based on the type of network under consideration (which is trust) and influence network. Next, the researcher specifies the session folder into which all the output files will be saved. Third, the researcher designates the number of actors in the network. In this study, there are 37 firms that reside in the networks. The researcher also indicates the text file containing the main network as

\footnote{It is important to note that whilst the previous chapter concerned the pattern of embeddedness of firms in the supply network, this chapter investigates whether individual firm levels of embeddedness in the four supply ties affect the levels of trust, reputation and influence that they may experience.}

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the *Network File*. The researcher specifies if the network is a Non-directed Network or a Directed Network; all networks under consideration are directed networks. Network is undirected when A shares information *with* B or directed when A seeks advice *from* B.

Once the network to be estimated is identified in the program, the researcher then decides upon the model to be estimated. First, the researcher specified the structural parameters that are to be estimated based on the type of networks. Structural parameters of this study follow the theoretical justification of Robins et al., (2007) who identified the three main groups of network parameters to be included into a model in order for it to be converged. For a detailed list of the parameters, please refer to section 4.8.2. Once the parameters have been determined, the researcher then runs the program. The process is repeated until all parameters are converged to a stage where the t-ratio of the parameters is less than 0.1. These steps will produce the Pure Structural Effects Model which will form the basis for the analysis of the impact of node attributes upon the formation of ties in the trust and influence networks.

Once the Pure Structural Effects model has converged, the researcher enters the node attribute parameters in order to determine the effects of node attribute, i.e., organizational measures of network embeddedness in trust and influence network model. The outcome is known as the Pure Attribute Effects Model.

In the following section, the researcher provides the results of ERGM analysis for each of the network models with the embeddedness attribute. It is important to note that, like other network researchers (for example, example Robins et al., (2007), Shumate and Palazzolo (2010) Lee, Lee and Feiock (2012)), the researcher will first provide a comparative analysis of the trust and influence network maps with and without the node embeddedness attribute. This is to determine whether the data displays any interesting patterning at all (Freeman, 2004). This is conducted by combining the visualization techniques with mathematical algorithms to search for an optimal
arrangement of actors and links. Following the visual analysis results, the ERGM analysis will be conducted to test for the study hypotheses.

6.3 FIRM EMBEDDEDNESS AND TRUST

In this section the researcher presents the visual analysis and the ERGM analysis results involving organizational measures of network embeddedness. The traditional techniques to measure partnership among firms or organizations often utilize methods that gather information related to the characteristics of different firms or organizations to draw comparisons and conclusions about a social linkage. In this research, through social network analysis, the primary data collected are on the relationship between firms in the supply networks, with firms characteristics collected as secondary data (Knoke and Yang, 2000). Through social network analysis, this research utilizes both graphical and statistical methods to present the relational data (Hanneman and Riddle, 2005).

This research performed the social network analysis using graphic and statistical methods. Network graphs based on each of the embeddedness constructs described (which are the degree centrality, betweenness centrality, clique overlapped and multiplexity) were created to depict the relationships in each of the supply networks.

6.3.1 HYPOTHESIS ONE

In this section, the researcher combines analysis of network maps and ERGM in order to analyse the relationship posited in Hypothesis One.

Trust Network Map and Degree Centrality: Visual Analysis Firm Attribute and Trust Relation

In this section, for the analysis of the effects of firms’ embeddedness based on degree centrality, the researcher will first present the network maps of the trust network structure. This network map was developed using the program NetDraw. The result involves firm measures of network embeddedness, i.e.: degree centrality in contract tie, information-sharing tie, referral made
tie and referral received tie on the trust network. Figure 6.3 depicts the trust network with colours on the nodes representing the level of trust (Robins et al., 2007), as follows.

![Trust Network Diagram]

**Figure 6.3 Trust network with color on the nodes representing a high and low trust scores.**
It can be seen immediately from Figure 6.3 that there are several sub-groups or cliques of trust relationship in the network structure. In addition, in almost all the sub-groups or cliques, there exists one firm that has a high trust attribute compared to other nodes. Furthermore, nodes that are periphery in the network are in large part low in their trust score. This network map implies that nodes that are embedded in the core position may experience high levels of trust, while nodes on the periphery have a mainly low trust level. Together, the positioning of the nodes of the trust network indicates the tendency towards a degree-based core-periphery structure. Borgatti and Everett (2000) stated that the core periphery structures implied the existence of two distinct regions in the network, i.e., one that includes dense and cohesive subsets of nodes, and another where connections are looser and sparse. Borgatti and Everett (2000) posited that these particular structures may form in two ways, i.e., one as a result of a high centralization process (indicated by the presence of hubs and spokes nodes, for example, when prominent firms attract most of the other firms) and another, due to high triangulation, which suggests the presence of a large number of overlapping cliques.

It is important not to reach a conclusion without considering the alternative explanations. Other attribute processes could be reasonable explanations for this network. In order to determine the underpinnings of the trust network that contributed to the network structure, the researcher again utilized the UCINET and the Netdraw programs. This was carried out to generate the network map for trust that includes the firms’ embeddedness attributes based on the degree centrality scores across all four ties. This will generate four network maps of trust network, which display the level of embeddedness of firms in the trust network indicated by the size of the nodes in the maps. Using these attribute data, the researcher developed four additional sociograms of the trust network, i.e., contract tie, information-sharing tie, referral made tie and referral received tie. Figures 6.4, 6.5, 6.6 and 6.7 depict the network with node attributes measured based on degree centrality in four supply ties, i.e., the contract tie, information-sharing tie, referral made ties and referral received tie.

The sociograms in Figures 6.4, 6.5, 6.6 and 6.7 incorporated the firms’ measures of network embeddedness (degree centrality) of each of the firms and their level of trust. In each of the figures,
nodes or firms are colored based on the nodes’ level of trustworthiness as reported by other network members. A red square means the firm has high trust; blue is medium and lime green would represent firms that received the lowest score for trust in the network. The rating for trust is based on the score of relationship quality, as nominated by other firms in the APMMHQ-1 upstream supply network structure. Furthermore, the squares that represent the nodes or firms are in different sizes, which correspond to the level of embeddedness measured based on degree centrality. In Figure 6.4, the researcher found a distinct core-periphery structure made up of several overlapping clusters. For example, the core actor in the sociogram i.e., the APMMHQ-1, is also the node or firm with the highest embeddedness score and the highest trust score. On top of that, APMMHQ-1 is moreover observed to be connected to other core actors of the network in other clusters such as WILSEL-12. APMMHQ-1 was also observed to be connected to other core nodes of another cluster, specifically WILUTA-4, in the sociogram. WILSEL-12 (which is central in the clusters) also possessed one of the highest embeddedness scores and trust scores. In addition to that, the periphery network members who appear to be distant in the trust networks represent the nodes or firms which attained either medium or low trust scores. For example, PMMRSNG-17 is one other periphery node of the trust network in the APMMHQ-1 supply system which possessed a low embeddedness score. Similarly, DMKBALU-33 and DMTAWAU-35 are also periphery nodes in trust network and possess low and medium embeddedness scores.
High Trust  Medium Trust  Low Trust

Firm criteria: Degree centrality

Figure 6.4 Trust network with color on the nodes representing trust score and node size representing the degree centrality scores in the contract tie.
Figure 6.5 shows the sociogram of trust network with embeddedness attribute based on degree centrality in information-sharing ties. From an overall perspective, Figure 6.5 shows that the greatly embedded firms in the information-sharing tie are also largely among the central nodes in the trust network of APMMHQ-1 supply system. For example, APMMHQ-1, WILSAB-31, MTUPJAYA-2, WILSEL-12, and WILUTA-4 are among the firms that are considered very central by other firms (red color). The size of the nodes also indicates that they are among the most highly-embedded based on degree centrality in the information-sharing tie. In addition to that, nodes that rate lowest in the trust score also exhibit low embeddedness scores based on degree centrality in the information-sharing tie. These firms include: DMTAWAU-34, DMKBALU-33, MTUKBALU-37, MTUKCHNG-30, PMMRNSNG-17, PMKKURAU-19, DMKKNTAN-21, DMKGANU-22, DMMIRI28, MTUKTAN-24, and DMSDAKAN-22 respectively.

Structurally, this study found one intriguing finding of how highly embedded nodes in the information-sharing tie may not be among the most trusted firms in the trust network, i.e., the MTURAWNG-3. This phenomenon may be because the information-sharing is considered to be an informal form of ties that are forged without any sets of rules or terms, such as in contractual ties. In contractual ties, when there is a set of terms or rules governing the relationships, the firm may tend to forge ties with others that have more resources (such as materials). On the other hand, in the information-sharing ties, the connection between the firms is formed without any rules or regulations governing its informal nature.
**Figure 6.5** Trust network with color on the nodes representing trust score and node size representing the degree centrality scores in the information sharing tie

Firm criteria: Degree centrality
Figure 6.6 shows the sociogram of trust network with embeddedness attribute based on degree centrality in referral made ties. In panel three, it is evident that greatly embedded firms having referral made ties are among the most valued in the trust network of APMMHQ-1 supply system. For example, APMMHQ-1, WILSAB-31, WILSEL-12, and WILUTA-4 are the firms that are very trusted by others (red color). The size of the nodes also indicates that they are among the most highly-embedded based on degree centrality in the referral made tie. In addition to that, nodes that are lowest in their trust score equally important exhibit a low embeddedness score based on degree centrality in the referral made tie. These firms include: DMTAWAU-34, DMKBALU-33, MTUKBALU-37, MTUKCHNG-30, PMMRSNG-17, PMKKURAU-19, DMKKNTAN-21, DMKGANU-22, DMMIRI28, MTUKTAN-24, and DMSDAKAN-22. Structurally, the highly trusted entities are basically the core nodes in the clusters of trust network. For example, WILSAB-31 is the core firm in the WILSAB-31, DMLBUAN-32, DMSDAKAN-34, PMLDATU-36 cluster; APMMHQ-1 is the core firm in the APMMHQ-1, MTUKTAN-24 and WILTIM-20 cluster; WILSEL-12 is the core node in the WILSEL-12, DMPKLNG-14, DMKLGGI-15, and PMBPAHAT-18 cluster, and WILUTA-4 is the core firm in the WILUTA-4, DMLKAWI-5, DMPPINANG-6, DMLUMUT-7, PMKKEDAH-8, PMKKURAU-9, and MTUPINANG-11 cluster. Overall, Figure 6.6 indicates those firms that are greatly embedded in the referral made tie based on degree centrality attribute are also highly trusted firms in the network.
Firm criteria: Degree centrality

**Figure 6.6** Trust network with color on the nodes representing trust score and node size representing the degree centrality scores in referral made tie.
Figure 6.7 shows trust network with embeddedness attribute based on degree centrality in referral received ties. In Figure 6.6, the highly embedded firms are also among the most trusted ones in the trust network. For example, APMMHQ-1, WILSAB-31, MTUPJAYA-2, WILSEL-12, and WILUTA-4 are among the firms that are most trusted by others. The size of the nodes also indicates that they are among the most highly-embedded based on degree centrality.

**Figure 6.7 Trust network with color on the nodes representing trust score and node size representing the degree centrality scores in referral received tie.**
The visual analysis in Figures 6.4, 6.5, 6.6 and 6.7 reveals interesting findings in terms of prominent structural forms and the impact of involvement or embeddedness in formal versus informal supply ties.

Firstly, the researcher found that most firms having a high level of embeddedness in the formal tie, i.e. contract tie, do not necessarily materialize into higher levels of trust from other firms. Although one highly embedded firm (APMMHQ-1) received high trust nominations from others, the visual analysis shows that other organizations (e.g. MTURAWNG-3, MTUJB-19, and MTKNTAN24) acquire lower trust nominations than others with lesser embeddedness or involvement scores (e.g. DMKCHNG-26, WILTIM-20, DMBTULU-29). However, in the informal tie network, the visual analysis also indicates that the majority of firms that have high embeddedness attribute scores based on degree centrality in information-sharing ties are equally important the nodes that are highly trusted in the network. Furthermore, it also indicates that firms with high levels of embeddedness attributes based on degree centrality in referral made ties, and referral received ties are also the firms that are considered trustworthy by other firms in the network.

The following section outlines the ERGM analysis using the PNet program to determine the effects of node attribute embeddedness measured based on the degree centrality in the trust network.

**ERGM Analysis of Trust Network and Embeddedness Based on Degree Centrality**

The earlier section has given a visual description of firm embeddedness or involvement in following the firms’ degree centrality position in the trust network of relations. To test for the effects of node embeddedness attributes in a more systematic way, this study performed a series of ERGM analyses, which allowed the researcher to determine the effects of organizational measures
of network embeddedness upon a trust network (Robins, Pattison and Wang, 2009; Snijders et al., 2006).

For the ERGM analysis, this study adopted the Shumate and Palazzolo (2010) *Pure Structural Effects* and *Pure Attribute Effects* model analysis. Under this process, the researcher first determined the *Pure Structural Model* relevant structural formation of the trust network. Following this, the researcher conducted another ERGM analysis with the firms’ measure of network embeddedness or node attributes included into the model. This model is called the *Pure Attribute Based Network Effect* model. The outcome of this model will enable the researcher to see the impact of the attribute upon the ties’ structural formation propensity inside the relevant network and, more importantly, upon the node attribute parameters. The pertinent node attribute parameter to test for these effects is the Sum of Continuous Attribute, supplemented by the Difference of Continuous Attribute parameters. Using these parameters the researcher will be able to convey the individual effects of the attributes upon the firms in the network.

Following Robins et al., (2007), the researcher analysed the MLE (Maximum Likelihood Estimate) and the standard error. The parameter is significant when absolute value of estimates exceeds twice the standard error outcomes of each model. The sign of the MLE (“+” or “-“) provides an indication of whether the particular network structure occurs more or less likely than predicted by chance. For a model to be considered well-converged, the parameters’ t-ratio must be less than 0.1 and this is absolute value. All the parameters included in the models of this study are under the convergence threshold, indicating that the models fit the data well. The following section of this thesis discusses the analysis results of the ERG model for trust network and embeddedness attributes. They were measured based on degree centrality in the formal contract tie, information-sharing tie; referral made tie, and referral received tie respectively.

The parameter estimates (MLE), and standard error is presented in Table 6.1.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>ML Estimates</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>Arc</td>
<td>-1.101</td>
<td>0.082*</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>1.478</td>
<td>0.401*</td>
</tr>
<tr>
<td>A-in-S</td>
<td>-1.350</td>
<td>0.429*</td>
</tr>
<tr>
<td>A-out-S</td>
<td>0.128</td>
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<tr>
<td>AT-T</td>
<td>1.096</td>
<td>0.259*</td>
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<tr>
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<td>-0.089</td>
<td>0.131</td>
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<td>A2P-T</td>
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<td>0.045*</td>
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<tr>
<td>A2P-D</td>
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<td>0.075</td>
</tr>
<tr>
<td>A2P-U</td>
<td>0.084</td>
<td>0.027*</td>
</tr>
</tbody>
</table>

| **Trust Network Pure Attribute Effects** |       |                 |
| Section 1: FNEDC in Contract tie |       |                 |
| Sum of continuous attributes | -0.064 | 0.017*         |
| Difference of continuous attributes | -0.036 | 0.017*         |
| Section 2: FNEDC in Information-sharing tie |       |                 |
| Sum of continuous attributes | 0.071  | 0.026*         |
| Difference of continuous attributes | 0.028  | 0.014*         |
| Section 3: FNEDC in Referral Made tie |       |                 |
| Sum of continuous attributes | 0.017  | 0.001*         |
| Difference continuous attributes | -0.027 | 0.001*         |
| Section 4: FNEDC in Referral Received tie |       |                 |
| Sum of continuous attributes | 0.031  | 0.012*         |
| Difference continuous attributes | 0.046  | 0.022*         |

Table 6.1: ERGM Analysis Results, Firm Embeddedness, Degree Centrality  
(Asterisks indicate effects where absolute value of estimates exceed twice the standard error)
In Table 6.1, to obtain a converged Pure Structural Effects model for trust network, the structural parameters are included conditionally until the model is converged, i.e., until the t-ratio of each relevant parameter is less than 0.1. Consequently, the parameters that are included in the Pure Structural Effects models of the trust network are as follows: Reciprocity, A-in-S, A-out-S, AT-T, AT-D, AT-U, AT-C, A2P-T, A2P-U, and A2P-D. Structurally these parameters reflect certain forms of structural formations of ties in the trust network. These parameters reflect: density (arc), reciprocation (reciprocity), degree-based or centralization (A-in-S, A-out-S) and multiple transitivity (AT-T, AT-D, AT-U, AT-C, A2P-T, A2P-U, and A2P-D) (Robins, Pattison and Wang, 2009; Wang, Robins and Pattison, 2006b).

First, in the structural effects' section, the Arc ML estimate is a significant and negative parameter (MLE = -1.101, SE = 0.082*) suggesting that fewer trust relationships are expected if the APMMHQ-1 centralized upstream supply networks are observed than would have been expected by chance. In other words, firms of the APMMHQ-1 supply network forges trust relationships with only a few of the potential other firms in the network. This phenomenon is expected as trust relationships are built over time and rely on other endogenous variables such as the size of the participating firms and the length of the relationships (Doney and Cannon, 1997; Jiang et al., 2011; Laaksonen, Jarimo and Kulmala, 2009). According to Jiang et al. (2011) a firm’s size encompasses the firm’s overall size and its market share position. A firm’s size provides a signal to other firms regarding its level of trustworthiness. Overall size and market share indicate that many other businesses trust this firm enough to do business with it. This suggests that the firm consistently deliver on its promises to others, or it would not have been able to maintain its position in the industry (Laaksonen et al., 2009).

Secondly, there is a significant and positive (MLE = 1.478, SE = 0.401*) effect of reciprocity for the trust network model. This indicates that firms are likely to nominate each other in trust relations (i.e. if organization APMMHQ1 trusts WILSEL4, there is also a high likelihood that WILSEL4 will trust APMMHQ1 in return). Reciprocity is an important feature of many other
social network studies, and it is expected in trust relationships (Bamber, Jiang and Wang, 2010; Lusher, 2011; Lusher and Ackland, 2010; Lusher, Robins and Kremer, 2010; Lusher et al., 2012; Robins, Lewis and Wang, 2012; Robins, Pattison and Wang, 2009).

Third, the model shows that the $A-in-S$ parameter is significant but negative (MLE = -1.350, SE = 0.429*). $A-in-S$ parameter is an indication of the presence of highly nominated firms within the trust network. Although there is a significant parameter estimate for $A-in-S$, the negative MLE score indicates that it is unlikely that a trust ties relationship will be forged based on the degree-based structural formation. On top of the structural parameters, Table 6.1 also shows the effects of the continuous attributes upon the ties’ formation propensity between the embedded firms in the trust network in the attribute affects sections.

Section one of Table 6.1 shows the results for FNEDC in the contract tie. The Sum of Continuous Attributes is significant and positive (MLE = -0.064, SE = 0.017*). This shows that, in the trust network, firms that have high FNEDC in the contract tie are more likely to receive trust relations in the network structure compared to other firms that have lower levels of embeddedness. Because the embeddedness score is related to the number of connections that firms have in the network, we could also relate these parameters to the location of these firms in the network structure. Structurally, we would find these firms to be at the center of the network, as it is consistent with firms that have the most connections or ties to other nodes in the network. The Difference of Continuous Attribute is significant and negative (MLE = -0.036, SE = 0.017*). It suggests that the firms with differing levels of embeddedness are less likely to forge ties together. What can be taken from the findings of the ERGM analysis outcome is that, firms that are highly embedded or involved in the contract ties based on their network structure position of degree centrality (FNEDC) will be more likely to be perceived as more trustworthy among the firms in the network structure.
In section two, there is a positive and significant (MLE = 0.071, SE = 0.026*) *Sum of Continuous Attribute* parameter indicating that firms with high FNEDC in the information-sharing tie have a high tendency to receive trust from others. A significant and positive (MLE 0.028, SE = 0.014*) *Differences of Continuous Attribute* parameter shows that there is a strong tendency for firms in the observed network to forge ties or trust other network members when their FNEDC differences are small. When compared to the attribute effects in the contract tie, the distinctions in the attribute effects may relate to the type of ties in question. A formal tie such as the contract tie is governed by terms and regulations. Such conditions may lead to focal organizations becoming dominant in the network. For example, Toyota is the focal organization in the Toyota supply chain with few tiers one organization also considered focal, as they function as the main supplier to the Toyota production facility. The flow of the supplier between upstream suppliers to the focal suppliers and subsequently to the manufacturer itself is governed by agreed rules and regulations with the contracted organizations. These are bound by the demands and needs of the ordering authority (i.e. focal organizations). This phenomenon may create a few focal organizations that become core nodes as indicated by the positive *Sum of Continuous Attribute* effects in the model. On the other hand, positive and significant *Difference Continuous Attributes* may be attributed to the informal nature of the information-sharing tie. In such networks, communication is not based on or bounded by any official regulatory procedures.

Section three of the trust network model shows the attribute effects results for FNEDC in referral made ties. There is a significant and positive (MLE = 0.017, SE = 0.001*) *Sum of Continuous Attribute* effect for the ascertained network, indicating that firms with high FNEDC in the referral made tie tend to forge ties with others. The negative and significant (MLE = -0.027, SE = 0.001*) *Differences of Continuous Attribute* parameter shows that when the difference in their FNEDC is small, there is a lower tendency for the firms of the observed network to forge trust ties with other firms.
Finally, the fourth section shows the result of attribute effects and FNEDC in referral received ties. The *Sum of Continuous Attribute* is found to be positive and significant (MLE = 0.031, SE = 0.012*). This is an indication that firms, which possess high FNEDC in referral received ties are likely to form ties with other with other network members. However, the positive and significant (MLE = 0.046, SE = 0.022*) *Difference of Continuous Attribute* shows that trust relationships are more likely to be forged between network nodes when the differences in FNEDC in referral received ties are small.

The following section discusses the network maps and the ERGM analysis of the trust network, with embeddedness attribute measured based on betweenness centrality index.

**6.3.2 HYPOTHESIS TWO**

In this section, the researcher discusses the results of network map analysis and the ERGM analysis in order to determine the relationships posited in Hypothesis two.

*ERGM analysis of network embeddedness measures betweenness centrality and relational capital performance, trust*

In this section, the researcher presents the ERGM analysis result in the network embeddedness measure based on betweenness the centrality levels in contract tie, information-sharing tie, referral made tie and referral received tie on the trust network.

Figure 6.8 shows the trust network considering a firm’s FNEBC in the contract tie. The sociogram indicates that firms that are highly trusted in the network are focal in the trust network and possess one of the highest levels of embeddedness attribute based on betweenness centrality in the contract tie. For instance, APMMHQ-1 is central and possesses one of the highest trust scores in the network. APMMHQ-1 also possessed one of the highest levels of embeddedness attributes based on betweenness centrality in the contract tie.
Figure 6.8 Trust network with color on the nodes representing trust score and node size representing betweenness the centrality scores in the contract tie.
It can clearly be seen from Figure 6.8 that the central node with the highest level of embeddedness based on betweenness centrality index is also the firm with the highest trust score in the network structure. For instance, APMMHQ-1 is the firm with one of the highest embeddedness attributes, as well as trust levels.

**Figure 6.9** TRUST network with color on the nodes representing trust scores and node size representing betweenness the centrality scores in the information-sharing tie.
Similarly, Figure 6.9 shows that firms that are central in the trust network have a high level of embeddedness attribute based on betweenness centrality in referral made tie. For example, APMMHQ-1 is one of the firms having a high trust level and is also one of the most highly embedded as indicated by the large node size. Although WILSAB-31, WILSEL-12, and WILUTA-4 are not centrally located in the trust network, these nodes are central within their own clusters of trust relationships.

Firm criteria: Betweeness centrality
Finally, Figure 6.10 shows that central nodes in the trust network also possessed high levels of trustworthiness. They further possessed a high level of embeddedness score in the referral received tie based on the parameter betweenness centrality. These findings are consistent with the earlier results that consider other centrality embeddedness parameters such as degree centrality.

**Figure 6.10 Trust network with color on the nodes representing trust score and node size representing betweenness the centrality scores in referral receive tie.**

![Trust Network Diagram](image)

- **High Trust**
- **Medium Trust**
- **Low Trust**

Firm criteria: Betweenness centrality

**Figure 6.11 Trust network with color on the nodes representing trust score and node size representing betweenness the centrality scores in referral made tie.**
The visual analysis of the network maps in Figures 6.8, 6.9, 6.10, and 6.11 shows that a firm’s embeddedness attribute based on its betweenness centrality does play a role in the formation of relations between firms in the centralized upstream supply network structure. Nevertheless, as mentioned earlier, this visual analysis only provides the macro outlook of the connectivity. To provide a valid interpretation of the effects of firm embeddedness, the ERGM analysis was performed on the trust model with firm attribute betweeness the centrality parameters (FNEBC).

In the following section, the researcher discusses the results of ERGM analysis of trust network to test the attribute effects' embeddedness which was measured based on betweeness centrality index in contract tie, information-sharing tie, referral made tie and referral received tie respectively.

**ERGM Analysis of Trust Network and Embeddedness Based on Firm Betweenness Centrality (FNEBC)**

In this section, the researcher discusses the results of ERGM analysis with embeddedness attribute measured based on betweeness centrality index (FNEBC).

In section one of Table 6.2 (MLE = -0.016, SE = 0.002*), section two of Table 6.2 (MLE = -0.078, SE = 0.037*), section three of Table 6.2 (MLE = -0.029, SE = 0.014*) and section four of Table 6.2 (MLE = -0.023, SE = 0.010*), the Sum of Continuous Attribute parameters are significant but negative. This indicates that there are fewer likelihoods for firms that are highly embedded in the contract tie network (based on betweenness centrality) to forge trust ties with other firms that possessed similar levels of embeddedness. The Difference of Continuous Attribute parameters for section one of Table 6.2 (MLE = 0.027, SE = 0.013*), section two of Table 6.3 (MLE = 0.012, SE = 0.008), section three of Table 6.2 (MLE = 0.054, SE = 0.023*) and section four of Table 6.2 (MLE = 0.033, SE = 0.014*) are found to be positive and significant. This indicates that it is the differences in their level of embeddedness that affect trust tie formation, not the sum of embeddedness attribute.
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<td>Sum of continuous attributes</td>
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<tr>
<td>Difference of continuous attribute</td>
<td>0.033</td>
<td>0.014*</td>
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</table>

**TABLE 6.2 ERGM Analysis Results, Firm Embeddedness Betweenness Centrality**
Summary of Visual Analysis and ERGM Analysis of Trust Network

In this section, the results from each exploratory and statistical network analysis are combined and discussed in order to answer the hypothesis one of this study.

Hypothesis 1 tested the relationship between firm network embeddedness measured by degree centrality and betweeness centrality indexes. Specifically, this study predicted that the embeddedness of firms influences the level of trust ties the firms may experience in the network.

First, the effects of FNEDC were examined. The parameter estimates varied slightly for embeddedness in contract tie, information-sharing, referral made tie and referral received tie. In the contract tie the *Sum of Continuous Attribute* parameter is negative but significant. In the embeddedness level measured based on degree centrality in information-sharing tie, referral made and referral received ties, the parameters are positive and significant. When embeddedness is measured based on degree centrality in referral received tie, the parameter is positive and significant. This indicates that firms that are more embedded in the formal inter-firm relations are more likely to have a negative influence on their level of trust. On the other hand, when firms are more embedded in informal inter-firm relations, their level of trust is more likely to increase.

The second embeddedness measure is the FNEBC. The result shows that for embeddedness measured based on betweeness centrality across all four ties the *Sum of Continuous Attribute* parameter is negative and significant. In addition, the *Difference of Continuous Attribute* parameter is, specifically: positive and significant when embeddedness is measured based on betweeness centrality in the contract tie; non-significant when embeddedness is measured based on betweeness centrality in the information-sharing tie; positive and significant when embeddedness is measured based on betweeness centrality in referral made tie and non-significant when embeddedness is measured based on betweeness centrality in referral received tie. The positive and significant *Difference and Continuous Attribute* parameter estimate showed that firms with differences in embeddedness levels are more likely to forge trust relationships together.
Visual analysis of the trust network with node embeddedness (degree centrality and betweenness centrality) attributes to provide discrete visualizations of the trust network with each of the embeddedness attributes in each of the supply ties. Overall, it is noticeable that there is a core periphery structure of firms in the network indicating a strong tendency for centralization structure to take place in the trust network. However, the structure is slightly different when the node embeddedness attribute is measured in more formal supply ties versus informal supply ties. For example, when embeddedness attribute is measured based on centrality in contract tie, nodes that are highly embedded are also the nodes that have high trust scores in the network. In an informal information-sharing tie, the core-periphery structure indicates that larger nodes are mostly the nodes that are highly trusted in the network. Similarly, when embeddedness is measured in the referrals' ties, the core-periphery structure also seems to indicate that greater nodes are mainly the nodes that are highly trusted in the network.

Combining the ERGM analysis results and the exploratory analysis results, it can be seen that when a firm has a high level of embeddedness based on centrality in the supply network, the level of the trust tie that it may acquire in the network also increases. However, the ERGM results to only partially support this hypothesis as there is a negative and significant parameter estimate value involved when embeddedness is measured based on degree centrality in the information-sharing tie, and referral made ties. Thus, the assertions in hypothesis one and hypothesis two of this study are supported.

6.3.3 ERGM ANALYSIS OF A FIRM NETWORK EMBEDDEDNESS CLIQUES OVERLAPPED (FNECO) AND RELATIONAL CAPITAL PERFORMANCE, TRUST.

In this section, the researcher presents the visual analysis and ERGM analysis results involving firm embeddedness measured based on clique overlap (FNECO) and trust. The researcher will first analyse the trust network map that embodies the node attribute, which is the clique overlap.
**Trust Network Map and Clique Overlap**

This section visually analyzed the network maps of trust and firm network embeddedness based on clique overlap parameter. The network maps are displayed in Figures 6.12, 6.13, 6.14, and 6.15.

In Figure 6.12, the central node in the trust network structure, i.e. the APMMHQ-1, is identified as a greatly trusted firm in the network. In addition, APMMHQ-1 is also one of the most embedded nodes in the contract tie based on clique overlap measure, as indicated by the large node size. There are in addition other firms that are considerably trusted in the network, such as: MTUPJAYA-2, WILSEL-12, and WILSAB-31. These are also highly embedded in the contract tie based on clique overlap.
Firm criteria: Clique Overlap

**Figure 6.12** TRUST network with color on the nodes representing trust score and node size representing clique overlap score in the contract tie.

In Figure 6.13, the network map shows the structure of trust network combining each node level of trust and FNCEO in an information-sharing tie. Figure 6.13 shows that APMMHQ-1 is one of the highly trusted firms in the trust network. APMMHQ-1 is also highly embedded in the information-sharing tie structure based on clique overlap measure. Other highly trusted firms in the
network include: the MTUPJAYA-2, WILSEL-12, WILSAB-31 and WILUTA-4. These nodes or firms are centrally located in their respective clusters.

In Figure 6.14, the researcher discusses the network analysis of sociogram that combine the level of trust of each firm and level of FNECO in referral made tie. It shows that the most trusted firms include, among others: the APMMHQ-1, WILSEL-12, WILUTA-4, WILSAB-31,
MTUPJAYA-2, and WILSAR-25. Large numbers of these firms are also highly embedded in the referral made tie based on FNECO, and are, specifically: WILSEL-12, WILUTA-4, WILSAB-31, and APMMHQ-1. In addition, a large number of nodes with low embeddedness levels are found to possess a low level of trust score. These include: DMTAWAU, MTUKBALU-37, MTUKCHNG-30, PMTMANIS-29, and DMTBALI-23.

![Trust Network Diagram]

**Figure 6.14 Trust Network with Color on the Nodes Representing Trust Score and Node Size Representing Clique Overlap Score in Referral Made Tie.**

In Figure 6.15, APMMHQ-1 is the node with the smallest node size but is, however, considered as one of the most trusted firms in the trust network. Similarly, MTUPJAYA is
considered highly trustworthy but possesses a low level of embeddedness attribute. In addition, the size of the nodes in the sociogram is closely similar, indicating an nearly equal level of embeddedness score in the referral received tie of each firm.

**Figure 6.15** Trust network with color on the nodes representing trust score and node size representing clique overlap score in referral made tie.
**ERGM Analysis of Trust Network and Embeddedness Based on Clique Overlap**

In this section, the researcher investigates the effects of Fimr Network Embeddedness Clique Overlap (FNECO) on the trust relationship in the APMMHQ-1centralized upstream supply network. In the following sections, specifically: section one of Table 6.3 (MLE = -0.008, SE = 0.026), section two of Table 6.3 (MLE = -0.016, SE = 0.028), section three of Table 6.5 (MLE = -0.017, SE = 0.0413) and section four (MLE = 0.027, SE = 0.035) of Table 6.3, the *Sum of Continuous Attributes* parameters are non-significant. This, therefore, eliminates the effects of FNECO between firms with high embeddedness level or between high embeddedness and low embeddedness network members. The *Difference of Continuous Attributes* parameters are non-significant in the following, namely: section one of Table 6.3 (MLE = 0.086, SE = 0.046) , section three of Table 6.3 (MLE = 0.045, SE = 0.054) and section four of Table 6.3 (MLE = 0.095, SE = 0.068) . In Section 2 of Table 6.3 (MLE = 0.125, SE = 0.056*), the *Difference of Continuous Attributes* is significant and positive, which shows that trust relationships are forged between firms more frequently when the differences in FNECO in information-sharing ties are small.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>ML Estimates</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arc</td>
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<td>0.082*</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>1.478</td>
<td>0.401*</td>
</tr>
<tr>
<td>A-in-S</td>
<td>-1.350</td>
<td>0.429*</td>
</tr>
<tr>
<td>A-out-S</td>
<td>0.128</td>
<td>0.399</td>
</tr>
<tr>
<td>AT-T</td>
<td>1.096</td>
<td>0.259*</td>
</tr>
<tr>
<td>AT-C</td>
<td>-0.273</td>
<td>0.109*</td>
</tr>
<tr>
<td>AT-D</td>
<td>0.469</td>
<td>0.212*</td>
</tr>
<tr>
<td>AT-U</td>
<td>-0.089</td>
<td>0.131</td>
</tr>
<tr>
<td>A2P-T</td>
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<td>0.045*</td>
</tr>
<tr>
<td>A2P-D</td>
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<td>0.075</td>
</tr>
<tr>
<td>A2P-U</td>
<td>0.084</td>
<td>0.027*</td>
</tr>
</tbody>
</table>

**Pure Structural Effect**

**Pure Attribute Effects**

Section 1: FNECO in Contract tie

- Sum of continuous attributes: -0.008, 0.026
- Difference of continuous attributes: 0.086, 0.046

Section 2: FNECO in Information-sharing tie

- Sum of continuous attributes: -0.016, 0.028
- Difference of continuous attributes: 0.125, 0.056*

Section 3: FNECO in Referral Made tie

- Sum of continuous attributes: -0.017, 0.041
- Difference of continuous attributes: 0.045, 0.054

Section 4: FNECO in Referral Received tie

- Sum of continuous attributes: 0.027, 0.035
- Difference of continuous attributes: 0.095, 0.068

**Table 6.3: ERGM Analysis Results, Firm Embeddedness Clique Overlap**
(Asterisks indicate effects where absolute value of estimates exceed twice the standard error)
Summary of Visual Analysis and ERGM Analysis of Trust Network and clique overlap

In this section, the ERGM analysis tests the effects of firm embeddedness based on firm clique overlap and the trust relations. Hypothesis 3 tested the relationship between firm network embeddedness measured by the clique overlap indexes and trust relationships. This hypothesis posited that the more embedded the firms are in the supply ties based on the clique overlap measure, the higher is the level of trust that these firms may acquire.

For FNECO in contract tie, information-sharing tie, and referral made tie; the Sum of Continuous Attribute parameters are non-significant. For FNECO in referral received tie the Sum of Continuous Attribute parameter is positive but non-significant.

Combining the statistical and visual analysis results, there is a negative effect of embeddedness measured based on clique overlap of the relational capital trust. The finding of the ERGM and the exploratory analysis indicates that trust ties are formed among firms with differences in their level of embeddedness, rather than between both most embedded firms or between greatly embedded and low embedded organizations. Thus, the ERGM analysis and the exploratory analysis showed that hypothesis three is not supported. Overall, the sociogram indicates that, even though firms have great node sizes, these substantial firms only have a high trust score when the embeddedness attribute is measured based on clique overlap in the formal contract tie. For embeddedness measured based on clique overlap in an information-sharing tie, referral made tie and referral received tie, there is a mix of representations of smaller and larger nodes that have high trust scores in the network.

6.3.4 HYPOTHESIS 4

In this section, the researcher discusses the results of network map analysis and the ERGM analysis to determine the relationships posited in Hypothesis Four.


**Trust Network Map and Multiplicity of Tie**

In this section, the researcher makes visual analysis of the trust network map with and without the embeddedness attribute multiplicity of ties. The network map is depicted in Figure 6.15.

![Trust Network Map with Multiplicity of Ties](image)

**Figure 6.15** The trust network with embeddedness attribute based on multiplicity of ties represented.
The sociogram shows that nodes or firms that have high levels of embeddedness attribute based on multiplicity of ties may not be the most trusted nodes in the trust network. For example, MTURAWNG-3 has the largest node size, which indicates the level of embeddedness, but does not possess the highest level of trustworthiness. On the other hand, smaller nodes such as APMMHQ-1, WLIUTA-4 and MTUKTAN-24 are highly trustworthy but are lower in terms of embeddedness attributes. These conditions indicate that the level of embeddedness based on multiplicity of ties does not necessarily reflect on the level of trust that a particular firm could acquire.

**ERGM Analysis of Trust Network and Embeddedness Based on Multiplicity of Ties**

In this section, the researcher discusses the results of ERGM analysis of the trust network, and the embeddedness attribute measured based on multiplicity of ties. In the attribute-based model (Table 6.3), this study found that embeddedness based on multiplicity of ties is non-significant in determining trust relationships in the observed network. This statistical analysis supports the visual analysis finding in the earlier section. Both the *Sum of Continuous Attributes* and the *Difference of Continuous Attribute* were found to be non-significant in the model.
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<tr>
<th>Parameter</th>
<th>ML Estimates</th>
<th>Standard Error</th>
</tr>
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<td><strong>Trust Pure Structural Effects</strong></td>
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<td></td>
</tr>
<tr>
<td>Arc</td>
<td>-1.101</td>
<td>0.082*</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>1.478</td>
<td>0.401*</td>
</tr>
<tr>
<td>A-in-S</td>
<td>-1.350</td>
<td>0.429*</td>
</tr>
<tr>
<td>A-out-S</td>
<td>0.128</td>
<td>0.399</td>
</tr>
<tr>
<td>AT-T</td>
<td>1.096</td>
<td>0.259*</td>
</tr>
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<td>AT-C</td>
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<td>AT-D</td>
<td>0.469</td>
<td>0.212*</td>
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<tr>
<td>AT-U</td>
<td>-0.089</td>
<td>0.131</td>
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<tr>
<td>A2P-T</td>
<td>-0.163</td>
<td>0.045*</td>
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<tr>
<td>A2P-D</td>
<td>-0.124</td>
<td>0.075</td>
</tr>
<tr>
<td>A2P-U</td>
<td>0.084</td>
<td>0.027*</td>
</tr>
</tbody>
</table>

**Trust Pure Attribute Effects**

**Section 1: FNEM**

<p>| | | |</p>
<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
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<tr>
<td>Sum of continuous attributes</td>
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</tr>
<tr>
<td>Difference of continuous attributes</td>
<td>0.003</td>
<td>0.010</td>
</tr>
</tbody>
</table>

**Table 6.3 ERGM Analysis Firm Embeddedness Multiplexity of Ties and Trust**
(Asterisks indicate effects where absolute value of estimates exceed twice the standard error)

The results from each exploratory and statistical network analysis were combined to provide support for Hypothesis four.

Hypothesis four tested the relationship between firm network embeddedness measured using the multiplicity indexes (FNEM). This hypothesis posited that the more embedded the firms are in the supply ties based on the multiplicity of ties, the higher is the level of trust that these firms may experience. Additionally, sociograms of trust network with a node level of embeddedness and node trust scores were generated to provide a visual perspective of the relationships.
The effects of *Sum of Continuous Attribute* parameter are negative and non-significant (MLE = -0.007, SE = 0.006). The *Difference of Continuous Attribute* parameter is also non-significant (MLE = 0.003, SE = 0.010). The visual analysis also indicated that nodes or firms that have high levels of embeddedness measured based on their multiplicity of ties score do not possess high levels of trust in the network.

Combining the statistical and visual analysis results, there are negative effects of embeddedness measured based on the multiplicity index on the relational capital trust. Thus, the ERGM analysis and the exploratory analysis showed that Hypothesis 4 is not supported.

### 6.4 Embeddedness and Reputation

In this section, the researcher presents the ERGM analysis results involving network embeddedness and reputation. The researcher begins with the embeddedness attribute measured based on degree centrality across contract tie, information-sharing tie, referral made tie and referral received tie. Figure 6.16 shows that central nodes of the reputation network, such as APMMHQ-1, MTURAWNG-3, and MTUPJAYA-2 are central in the network structure and also have a high level of reputation score. However, periphery nodes indicated a low level of reputation compared to the core nodes. Although Figure 6.16 indicates the effects of centrality and periphery in the network, it is still important not to reach a conclusion without considering the alternative explanations. Other structural factors or attributes, such as the firms’ degree centrality processes, could be a reasonable explanation for this network.
**Figure 6.16**

The reputation network reputation score represented.
(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)

**6.4.1 Hypothesis Five**

In this section, the researcher discusses the results of visual analysis and ERGM analysis of firm embeddedness and reputation.
Reputation Network Map and Degree centrality

The following network maps incorporated both the embeddedness attribute of each of the firms measured based on their degree centrality (FNEDC) in across contract tie, information-sharing tie, referral made tie and referral received tie and their level of reputation score.

Figure 6.17 shows the sociogram of reputation network with organizations’ embeddedness attributes and the level of reputation experienced by the embedded firms.

**Figure 6.17** The reputation network reputation score represented by colors and firm embeddedness based on degree centrality in contract tie represented by node size
(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)
The sociogram shows that there are two clusters; a main one and a periphery cluster. The periphery cluster is not connected to the main clusters, as there is no tie connecting them to the others. This cluster is made up of MTUKBALU-37 and MTUKCHNG-30. The rest of the network members are connected in the main reputation network clusters. In this cluster structure, we could see an increased level of reputation score as we move into the centre of the cluster. For example, the outer positions of the reputation network are occupied largely by nodes or firms that are coloured in blue and green, such as PMMRSNG-17, PMKKURAU-9, PMTMANIS-29 and PMLDATU-36 respectively. As we moved into the centre of the cluster, the colour of the nodes changed into purple, black and red, indicating their high level of reputation score in the network.

For instance, MTURAWNG-3 has drawn two important points from this sociogram. First, central nodes of the network have high reputation scores. Second, although some of these nodes have high levels of embeddedness based on degree centrality in contract tie such as APMMHQ-1 and MTURAWNG-3, there also nodes or firms that are high in embeddedness levels but not correspondingly high in their reputation score. These nodes or firms include: MTUKTAN-24, MTUJB-19 and MTUPIJAYA-2.

Figure 6.18 shows that the highly embedded firms in the information-sharing tie are also largely among the firms that received high reputation scores in the reputation network of APMMHQ-1 supply system.
For example, APMMHQ-1 is a firm that has a high reputation score in the network structure (red color). The size of the nodes also indicates that they are among the most highly embedded based on degree centrality in the information-sharing tie. However, there are also firms that, despite being highly involved in information-sharing ties, receive a low reputation score from other buyer-organizations such as MTUPJAYA-2. These phenomena may be due to the fact that information-sharing is considered as an informal form of ties that is forged without any set of rules or terms, such as in contractual ties. In contractual ties, when there is a set of terms or rules governing the relationships, the firms may tend to forge ties with the firms that have more resources, such as materials. On the other hand, in the information-sharing ties, the connection between the firms is formed without any rules or regulations governing its informal nature. Thus, Figure 6.18 indicates

**Figure 6.18 The reputation network reputation score represented by colors and firm embeddedness based on degree centrality in information sharing represented by node size**

(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)
that firms occupying the central position in the network are not necessarily the firms with the highest reputation in the network.

Figure 6.19 shows that, largely, the highly embedded firms in the referral made ties are among the firms with high reputation scores in the reputation network.

**Figure 6.19**

The reputation network reputation score represented by colors and firm embeddedness based on degree centrality in referral made ties represented by node size

(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)
For example, APMMHQ-1, WILSAB-31, WILSEL-12, and WILSAR-25 are firms that have high reputation scores and are highly embedded in the referral made tie measured based on degree centrality in referral made tie. In addition to that, nodes that are low in their reputation score also exhibit low embeddedness scores based on degree centrality in the referral made tie. These nodes or firms include: DMTAWAU-34, DMKBALU-33, MTUKBALU-37, MTUKCHNG-30, PMMRSNG-17, PMKKURAU-19, DMKKNTAN-21, DMKGANU-22, DMMIRI28, MTUKTAN-24 and DMSDAKAN-22.

Figure 6.20 shows the sociogram of reputation network with embeddedness attributes based on, namely: degree centrality in referral received ties, depicted in nodes sizes and the reputation score of each of the firms (depicted in different colours of nodes). In Figure 6.20, the highly embedded firms in the information-sharing tie also number among the organizations having the highest reputation score. For example, APMMHQ-1, WILTIM-20, WILSEL-12, and WILUTA-4 are among the firms that have high reputation as indicated by the color of the nodes. The size of the nodes also indicates that they are among the most highly-embedded based on degree centrality in the referral received tie.
Figure 6.20

The reputation network reputation score represented by colors and firm embeddedness based on degree centrality in referral received ties represented by node size
(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)

ERGM Analysis of Reputation Network and Embeddedness Based on Degree Centrality

Following the visual analysis, the research conducted ERGM analysis to statistically determine the impact of a firm’s embeddedness based on its degree centrality on the reputation relation tie.

The researcher discusses the ERGM analysis of reputation network with node embeddedness attribute measured based on degree centrality in contract tie, information-sharing tie, referral made tie and referral received tie. In this section, the researcher presents the result of
statistical network analysis of the reputation network with node embeddedness attribute measured based on their degree centrality (FNEDC) score across four supply ties as shown in Table 6.4.

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<th>Parameter</th>
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<td></td>
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<tr>
<td>Arc</td>
<td>-3.196</td>
<td>0.538*</td>
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<tr>
<td>Reciprocity</td>
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<td>A-in-S</td>
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<td>A-out-S</td>
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<td>AT-TDU</td>
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<td>Section 1: FNEDC in Contract tie</td>
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<tr>
<td>Sum of continuous attributes</td>
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<tr>
<td>Sum of continuous attributes</td>
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<tr>
<td>Sum of continuous attributes</td>
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<td>0.049</td>
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<tr>
<td>Diff of continuous attributes</td>
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<td>0.019</td>
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<td>Section 4: FNEDC in Referral Received tie</td>
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<td></td>
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<td>Sum of continuous attributes</td>
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<tr>
<td>Difference of continuous attributes</td>
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</table>

**TABLE 6.4 ERGM ANALYSIS BASED ON FIRM EMBEDDEDNESS DEGREE CENTRALITY AND REPUTATION**

In Table 6.4, the *Arc* ML estimate is a significant and negative parameter (MLE = -3.196, SE = 0.538*) suggesting fewer reputational relationships are observed than would have been
expected by chance. In other words, firms of the APMMHQ-1 supply network form reputation relationships with only a few of the other potential firms in the network.

In addition, in Table 6.4, for the Purely Structural Parameter effects, there are non-significant effects of reciprocity for reputation ties (MLE = -0.0001, SE = 0.496*). Therefore, relative to chance and given the other effects in the models, firms are unlikely to have mutual reputation ties with each other. For example, MTUKBALU-37 may have a high reputational value of AMPPHQ-1, but APMMHQ-1 does not necessarily have the same evaluation of MTUKBALU-37. In addition, the Pure Structural Parameter model shows that the A-in-S parameter is significant and positive (MLE = 0.752, and SE = 0.248). The positive MLE score indicates that it is likely that reputational tie relationships will be formed in centralized structural formations. Results also show that there is a propensity for reputational ties to be forged in a closure and multiplicity structure, as indicated by the significant and positive AT-TDU and A2P-TDU parameters. It is important to note that the tendency for this structural formation to take place does not include the embeddedness attribute that became the explanatory variable of this study.

To determine the respective node attribute, embeddedness measured based on the degree centrality index, the researcher included two nodes’ attribute parameters, i.e. the Sum of Continuous Attributes and the Difference of Continuous Attributes. Section one of Table 6.4 demonstrates the impact of FNEDC in contract tie upon the level of reputation of each firm in the reputation network. The Sum of Continuous Attributes is non-significant (MLE = 0.006, SE = 0.009), indicating no effects of embeddedness on the propensity of influence ties to be formed. The Difference of Continuous Attribute is also non-significant (MLE = -0.002, SE = 0.013). Section two of Table 6.4 indicates that the actor attribute parameters, i.e. Sum of Continuous Attribute (MLE = -0.002, SE = 0.013) are non-significant, which means that no effects of embeddedness on the propensity of reputation ties exist in the formation. The Difference of Continuous Attribute is also non-significant (MLE = 0.027, SE = 0.019). Section three of Table 6.4 also indicates that the actor attribute parameters, i.e. Sum of Continuous Attribute are non-significant (MLE = -0.027, SE = 0.049), which
means that no effects of embeddedness impact on the propensity of reputation ties formation. The *Difference of Continuous Attribute* is also non-significant (MLE = 0.027, SE = 0.019). Section four of Table 6.4 indicates that the actor attribute parameters, i.e. *Sum of Continuous Attribute* are non-significant (MLE = -0.014, SE = 0.022), which means that no effects of embeddedness on the propensity of reputation ties formation occur. The *Difference of Continuous Attribute* is also non-significant (MLE = 0.023, SE = 0.034).

In the next section, the researcher discusses findings of the ERGM analysis concerning the node attribute embeddedness measured based on the betweeness centrality index score.

Overall, Hypothesis Five tested the impact of the level of embeddedness of firms measured based on degree centrality across the formal and informal continuum of supply ties.

The overall ERGM results show that when the embeddedness is measured based on degree centrality in contract ties, the parameters are non-significant in the models. The ERGM analysis shows that being embedded based on degree centrality does not necessarily affect the level of reputation firms may experience.

Combining the ERGM analysis results and the exploratory analysis results shows that when firms have a high level of embeddedness based on degree centrality in the supply network, the level of reputational tie is not affected. Thus Hypothesis 5 of this study is not supported.

**6.4.2 HYPOTHESIS SIX**

In this section, the researcher presents the ERGM analysis results involving the network embeddedness measure based on betweeness centrality in contract tie, information-sharing tie, referral made tie and referral received tie on the propensity of reputation tie formation.

Figure 6.21 shows the reputation network with the nodes or firms attribute using NetDraw. Evident in the sociogram is the two main clusters that exist in the reputation network structure.
In the main cluster, we see a closer linkage between the network members in the cluster as indicated by the overlapping of nodes. Large nodes in the cluster still remain in the central positions and include the APMMHQ-1, MTUPJAYA-2, and MTURAWNG-3. Other nodes that have low embeddedness scores are located farther away from the core of the reputation network. These nodes comprise the PMTMANIS-29, DMTAWAU-35 and PMLDATU-36. In addition, the central nodes in the reputation network are the ones that are highly embedded nodes in the contract.
tie; some of these nodes do not have high reputation scores as expected. In Figure 6.21, only APMMHQ-1 and MTURAWNG-3 have high reputation scores and also have high embeddedness levels measured based on betweenness centrality in contract tie. Another firm, i.e. MTUPAJAYA-2, has a reputation score of zero. This indicates that a firm’s reputation in the centralized upstream supply network is not necessarily related to its network structural position of betweenness centrality. Figure 6.22 shows the reputation network map with betweenness centrality in an information-sharing tie.

**Figure 6.22** The reputation network reputation score represented by colors and firm embeddedness based on betweenness centrality in information-sharing tie represented by node size
(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)
Figure 6.22 shows that the most central node in the network, i.e. APMMHQ-1, is also one of the firms with the highest embeddedness score in the network. APMMHQ-1’s node colour of red indicates that it is also one of the highly embedded nodes in the network structure.

Figure 6.23 shows that APMMHQ-1 is one of the nodes or firms that are highly embedded and is also the node with the highest level of reputational score.

**Figure 6.23** The reputation network reputation score represented by colors and firm embeddedness based on betweenness centrality in referral made tie represented by node size

(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)

Nodes that are largely low in the embeddedness level are located further out from the network central positions. These nodes include the PMTMANIS-29, PMLDATU-34 and DMKGANU-22 respectively.
Figure 6.24 shows the sociogram of reputation network with node attribute level of embeddedness based on betweenness centrality in referral made tie and the reputational score of each firm in the network structure.

Figure 6.24 THE REPUTATION NETWORK REPUTATION SCORE REPRESENTED BY COLORS AND FIRM EMBEDDEDNESS BASED ON BETWEENNESS CENTRALITY IN REFERRAL RECEIVED TIE REPRESENTED BY NODE SIZE
(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)

Although we see in the sociogram the increasing size of nodes as we move into the centrality of the network structure, the level of reputation of each of the firms does not conform entirely to the level of embeddedness. In the central position, the largest node with the highest reputational score is the MTURAWNG-3. On the other hand, two other firms, i.e. WILUTA-4 and
APMMHQ-1, are slightly lower in size but each has the top two reputational scores in the network. The results of ERGM analysis for firms’ embeddedness based on betweenness centrality and reputation are presented in Table 6.5.

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<tr>
<td>Sum of continuous attributes</td>
<td>0.0007</td>
<td>0.001</td>
</tr>
<tr>
<td>Difference of continuous attributes</td>
<td>-0.00006</td>
<td>0.002</td>
</tr>
<tr>
<td><strong>Section 4: FNEBC in Referral Received tie</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of continuous attributes</td>
<td>0.0008</td>
<td>0.001</td>
</tr>
<tr>
<td>Difference of continuous attributes</td>
<td>-0.0005</td>
<td>0.002</td>
</tr>
</tbody>
</table>

**Table 6.5 ERGM Analysis Based on Firm Embeddedness Betweenness Centrality and Reputation**
Section one of Table 6.5 shows that there are occurrences of a non-significant *Sum of Continuous effects* (MLE = -0.00003, SE = 0.004) and *Differences of Continuous Attributes* (MLE = 0.003, SE = 0.004). Section two of Table 6.5 also shows that there are occurrences of a non-significant *Sum of Continuous effects* (MLE = -0.0005, SE = 0.009) and *Differences of Continuous Attributes* (MLE = 0.010, SE = 0.011). Section three of Table 6.5 shows that the *Sum of Continuous effects* (MLE = 0.0007, SE = 0.001) and *Differences of Continuous Attributes* (MLE = -0.00006, SE = 0.002) remain non-significant, indicating no effects of being highly embedded in the referral made tie measured based on the betweeness centrality index on the propensity of reputation ties. Section four of Table 6.5 shows that the *Sum of Continuous effects* (MLE = 0.0008, SE = 0.001) and *Differences of Continuous Attributes* (MLE = -0.0005, SE = 0.002) remain non-significant, indicating no effects of being highly embedded in the referral made tie measured based on the betweeness centrality index on the propensity of reputation ties. Other parameters are non-significant in the ERG model. The results indicate that when the node attribute and embeddedness based on betweeness centrality index in referral received ties are included into the model, the propensity for ties structural formation leans towards a centralization and closure of ties in structural formation. In addition, embeddedness measured based on betweeness centrality index in the referral received tie does not affect the level of reputation ties experienced by each of the firms in the network.

Overall, hypothesis six tested the impact of the level of embeddedness of firms measured based on the betweeness centrality index.

The ERGM results show non-significant results in the models. The ERGM analysis shows that being embedded based on betweeness centrality does not necessarily affect the level of reputation firms may experience.

Thus, Hypothesis Six of this study is not supported.
6.4.3 HYPOTHESIS SEVEN

In this section of the analysis chapter, the researcher presents visual analysis and the ERGM analysis results involving node attribute embeddedness measured based on clique overlap and reputation in the APMMHQ-1 supply network. Figure 6.25 shows the reputation network map with the continuous attribute clique overlap in contractual tie.

**Figure 6.25** THE REPUTATION NETWORK REPUTATION SCORE REPRESENTED BY COLORS AND FIRM EMBEDDEDNESS BASED ON CLIQUE OVERLAP IN CONTRACT TIE REPRESENTED BY NODE SIZE
(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)

In Figure 6.25, nodes that are central in the reputation network are also highly embedded in the contract ties measured by the clique overlap index. In addition, they are largely the nodes or firms with the high reputation scores. These nodes include the APMMHQ-1, WILTIM-20, and DMLKAWI-5 respectively. However, there is also a node that is small in size but received a high
reputation score, namely, WILUTA-4. Otherwise, node sizes and reputation scores increase proportionately as we move into the centre of the reputation network structure.

Figure 6.26 indicates the level of firms’ embeddedness measured based on clique overlap in information-sharing tie and the reputation score of each of the firms.

**Figure 6.26 The reputation network reputation score represented by colors and firm embeddedness based on clique overlap in information-sharing tie represented by node size**
(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)

The structure of the reputation network shows that, as the network structure moves into the central part of the network, the level of embeddedness of the firm’s increases proportionately. For instance, the level of embeddedness measured based on clique overlap of APMMHSQ-1 is higher than the nodes of buyer–supplier organizations that are peripheral in the network structure, such as
PMLDATU-36. In addition to that, the reputation scores of the central nodes are also higher compared to the periphery firms such DMMIRI-28.

Figure 6.27 shows the level of firms’ embeddedness measured based on clique overlap in referral made tie and the reputation score of each of the firms.

**Figure 6.27 The Reputation Network Reputation Score Represented by Colors and Firm Embeddedness Based on Clique Overlap in Referral Made Tie Represented by Node Size**

(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)

When considering embeddedness measured based on the clique overlap index in the referral made tie, the overall structure of the reputation network reveals a different pattern of node embeddedness. Although node sizes increase proportionately as we move into the centre of the
reputation network, the reputation score of each of the firms did not follow the same pattern entirely. For example, WILSEL-12 is one of the firms with the highest level of embeddedness, but their reputation score is only 2. However, another node, i.e. APMMHQ-1, with a smaller node size has the highest reputation score of 14. In relation to this phenomenon, it may be argued that being highly embedded in the referral made tie measured based on clique overlap index does not influence the level of reputation that a firm may experience in the network.

Figure 6.28 demonstrates the reputation scores and the level of embeddedness of each firm in a referral received tie.

**Figure 6.28**

*The reputation network reputation score represented by colors and firm embeddedness based on clique overlap in referral received tie represented by node size*  
(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)
The sociogram shows that the level of embeddedness measured based on clique overlap in the referral received tie is not necessarily attributed to increase reputation score. For instance, it is visible in the sociogram that, although APMMHQ-1 is the smallest node in the network structure, it is also the firm with the highest reputation score. In addition, the figure also shows that nodes that are highly embedded in the referral received tie measured based on the clique overlap index do not necessarily achieve this solely by attribution to a high level of reputation.

**ERGM Analysis Firms Embeddedness Based on Clique Overlap and Reputation**

The results of the ERGM analysis are given in Table 6.6. Section one of Table 6.6 shows that there are non-significant *Sum of Continuous Attribute effects* (MLE = 0.025, SE = 0.043) and *Differences of Continuous Attributes* (MLE = . Section two of Table 6.6 shows that the *Sum of Continuous effects* (MLE = 0.027, SE = 0.049) and *Differences of Continuous Attributes* (MLE = 0.112, SE = 0.069) parameters are non-significant, indicating that the firm embeddedness level measured based on the clique overlap index in the information-sharing tie does not influence the propensity of reputational ties formation in the network. Section three of Table 6.6 indicates that the *Sum of Continuous effects* (MLE = 0.029, SE = 0.044) and *Differences of Continuous Attributes* (MLE = 0.121, SE = 0.073) parameters are non-significant. This signifies that the firm’s embeddedness level measured based on the clique overlap index in the referral made tie does not influence the propensity of reputational ties formation in the network. Section four of Table 6.6 denotes that the *Sum of Continuous effects* (MLE = 0.041, SE = 0.043) and *Differences of Continuous Attributes* (MLE = 0.101, SE = 0.068) parameters are non-significant. This suggests that the firm embeddedness level measured based on the clique overlap index in the referral received tie does not influence the propensity of reputational ties formation in the network.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>ML Estimates</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pure Structural Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arc</td>
<td>-3.372</td>
<td>0.516*</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>-0.010</td>
<td>0.508</td>
</tr>
<tr>
<td>A-in-S</td>
<td>0.709</td>
<td>0.244*</td>
</tr>
<tr>
<td>A-out-S</td>
<td>0.399</td>
<td>0.273</td>
</tr>
<tr>
<td>AT-TDU</td>
<td>0.920</td>
<td>0.158*</td>
</tr>
<tr>
<td>A2P-TDU</td>
<td>-0.638</td>
<td>0.087*</td>
</tr>
<tr>
<td><strong>Pure Attribute Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section 1: FNECO in Contract tie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of continuous attributes</td>
<td>0.025</td>
<td>0.043</td>
</tr>
<tr>
<td>Difference of continuous attributes</td>
<td>0.116</td>
<td>0.067</td>
</tr>
<tr>
<td>Section 2: FNECO in Information-sharing tie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of continuous attributes</td>
<td>0.027</td>
<td>0.049</td>
</tr>
<tr>
<td>Difference of continuous attributes</td>
<td>0.112</td>
<td>0.069</td>
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<tr>
<td>Section 3: FNECO in Referral Made tie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of continuous attributes</td>
<td>0.029</td>
<td>0.044</td>
</tr>
<tr>
<td>Difference of continuous attributes</td>
<td>0.121</td>
<td>0.073</td>
</tr>
<tr>
<td>Section 4: FNECO in Referral Received tie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of continuous attributes</td>
<td>0.041</td>
<td>0.043</td>
</tr>
<tr>
<td>Difference of continuous attributes</td>
<td>0.101</td>
<td>0.068</td>
</tr>
</tbody>
</table>

**TABLE 6.6 ERGM ANALYSIS BASED ON FIRM EMBEDDEDNESS CLIQUE OVERLAP AND REPUTATION**

Overall, Hypothesis seven tested the relationship between firms’ network embeddedness measured by clique overlap indexes. This hypothesis posited that the more embedded the firms are in the supply ties based on the clique overlap measure, the higher is the level of reputation that these firms may acquire. The ERGM analysis shows that being embedded based on clique overlap in referral received ties does not influence the level of reputation firms may experience in the network. Thus hypothesis seven is not supported.
6.4.4 HYPOTHESIS EIGHT

This section analyzed the reputation network by considering firms’ embeddedness attributes based on multiplicity of ties. Figure 6.29 is the network map of reputation network with embeddedness attributes based on multiplicity of ties.

![Network Map](image)

**Figure 6.29** The reputation network reputation score represented by colors and firm embeddedness based on multiplexity of ties  
(0 – lowest score, 14 - highest score, Unit of Analysis: nomination)

The result of the visual analysis is an indication that embeddedness based on multiplicity of ties affects the level of influence that a node may experience in the network. To ascertain this visual analysis the following ERGM analysis is performed. The sociogram revealed that the nodes
of some of the highly embedded entities in the referral receive tie also have high reputational scores. These nodes or firms include the APMMHQ-1, MTURAWNG-3, WILTIM-20, and DMLKAWI-5 respectively. However, there are also large nodes such as MTUPAJAYA-2, PMBPAHAT-18, and PMKKEDAH-8 that have high levels of embeddedness but have reputational scores of zero.

**ERGM analysis of Multiplexity and reputation network**

Table 6.7 shows the ERGM analysis result for embeddedness based on multiplicity of ties in the reputation network.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ML Estimates</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pure Structural Effects</td>
<td></td>
</tr>
<tr>
<td>Arc</td>
<td>-3.446</td>
<td>0.551*</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>-0.102</td>
<td>0.554</td>
</tr>
<tr>
<td>A-in-S</td>
<td>0.757</td>
<td>0.249*</td>
</tr>
<tr>
<td>A-out-S</td>
<td>0.401</td>
<td>0.257</td>
</tr>
<tr>
<td>AT-TDU</td>
<td>0.874</td>
<td>0.167*</td>
</tr>
<tr>
<td>A2P-TDU</td>
<td>-0.623</td>
<td>0.098*</td>
</tr>
<tr>
<td></td>
<td>Pure Attribute Effects</td>
<td></td>
</tr>
<tr>
<td>Section 1: Embeddedness Based on Multiplexity of Ties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of continuous attributes</td>
<td>0.031</td>
<td>0.043</td>
</tr>
<tr>
<td>Difference of continuous attributes</td>
<td>0.110</td>
<td>0.063</td>
</tr>
</tbody>
</table>

**Table 6.7 ERGM Analysis Based on Firm Embeddedness Multiplexity and Reputation**

Table 6.7 indicates that the *Sum of Continuous Effects* (MLE = 0.031, SE = 0.043) and
*Differences of Continuous Attributes* (MLE = 0.110, SE = 0.063) parameters are non-significant.
This reveals that a firm’s embeddedness level measured based on the multiplicity of ties does not influence the propensity of reputation ties formation in the network.

Hypothesis 8 tested the relationship between firms’ network embeddedness measured using the multiplicity indexes and the level of reputation that the firms may influence in the supply network. This hypothesis posited that the more embedded the firms are in the supply ties based on the multiplicity of tie measure, the higher is the level of reputation that these firms may experience. The ERGM analysis shows that being embedded based on multiplicity of ties does not influence the level of reputation firms may experience in the network.

A combination of the statistical and visual analysis results, the ERGM analysis and the exploratory analysis showed that hypothesis 8 is not supported.

6.5 EMBEDDEDNESS AND INFLUENCE

In this section, the results of ERGM analysis regarding the relationship between firm embeddedness and influence are presented.

6.5.1 HYPOTHESIS NINE

In the following section, the researcher discusses the ERGM analysis of influence network with node embeddedness attributes measured based on degree centrality in contract tie, information-sharing tie, referral made tie and referral received tie.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>ML Estimates</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pure Structural Effects</strong></td>
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<td></td>
</tr>
<tr>
<td>Arc</td>
<td>-2.481</td>
<td>0.614*</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>1.347</td>
<td>0.536*</td>
</tr>
<tr>
<td>A-in-S</td>
<td>-0.249</td>
<td>0.264</td>
</tr>
<tr>
<td>A-out-S</td>
<td>0.704</td>
<td>0.429</td>
</tr>
<tr>
<td>AT-T</td>
<td>0.824</td>
<td>0.366*</td>
</tr>
<tr>
<td>AT-C</td>
<td>-0.354</td>
<td>0.146*</td>
</tr>
<tr>
<td>AT-D</td>
<td>0.635</td>
<td>0.266*</td>
</tr>
<tr>
<td>AT-U</td>
<td>-0.163</td>
<td>0.142</td>
</tr>
<tr>
<td>A2P-T</td>
<td>-0.272</td>
<td>0.062*</td>
</tr>
<tr>
<td>A2P-D</td>
<td>-0.488</td>
<td>0.177*</td>
</tr>
<tr>
<td>A2P-U</td>
<td>0.063</td>
<td>0.026*</td>
</tr>
<tr>
<td><strong>Pure Attribute Effects</strong></td>
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<td></td>
</tr>
<tr>
<td>Section 1: FNEDC in Contract tie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of continuous attributes</td>
<td>0.071</td>
<td>0.029*</td>
</tr>
<tr>
<td>Difference of continuous attributes</td>
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<td>0.012</td>
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<tr>
<td>Section 2: FNEDC in Information-sharing tie</td>
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<td></td>
</tr>
<tr>
<td>Sum of continuous attributes</td>
<td>0.042</td>
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</tr>
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<td>0.014</td>
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<td></td>
</tr>
<tr>
<td>Sum of continuous attributes</td>
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<td>0.001*</td>
</tr>
<tr>
<td>Difference of continuous attributes</td>
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<td>0.025</td>
</tr>
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<td>Section 4: FNEDC in Referral Received tie</td>
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<td></td>
</tr>
<tr>
<td>Sum of continuous attributes</td>
<td>0.061</td>
<td>0.024*</td>
</tr>
<tr>
<td>Difference of continuous attributes</td>
<td>0.001</td>
<td>0.013</td>
</tr>
</tbody>
</table>

**Table 6.8 ERGM Analysis Based on Firm Embeddedness Degree Centrality and Influence**
In this chapter, the researcher presents the results of statistical network analysis of the influence network with node embeddedness attribute measured based on their degree centrality score across four supply ties. The results are presented in Table 6.8. Table 6.8 will discuss the result of the *Pure Structural Effects* model first, before discussing the ERGM analysis outcomes on the node attribute parameters. There is a significant and positive effect of reciprocity for influence upon relationships.

Therefore, relative to chance and given the other effects in the models, firms are likely to nominate each other. In addition, the *Pure Structural Parameter* model shows that the $A$-$in$-$S$ parameter is significant but negative. The negative MLE score indicates that it is unlikely that an influence tie relationship will be formed in centralized structural formations. All multiple transitivity parameters are significant, except for the $AT$-$U$ parameter, indicating that influence network is formed out of many triangles of connection between the firms.

Section one (MLE = 0.071, 0.029*) and Section two (MLE = 0.042, SE = 0.011*), in addition to section four (MLE = 0.061, SE = 0.024*) of Table 6.8 present the results of the ERGM analysis when the embeddedness attribute measured based on degree centrality index in contract tie and information-sharing tie are entered into the model. The result shows that the *Sum of Continuous Attributes* is significant, indicating effects of embeddedness on the propensity of influence ties to be formed. Section three (MLE = -0.011, SE = 0.001*) of Table 6.8 shows there is a negative but significant *Sum of Continuous effects* upon the influence tie formation among the firms of the network. In Section four of Table 6.8, the parameter is significant. Taken together, the *Sum of Continuous Attributes* score indicates that embeddedness based on degree centrality in information-sharing ties effects the formation of influence ties. Thus, the ERGM output implies that when firms are highly involved or embedded in the network structure following their high degree centrality position are more likely to be perceived as influential by other firms in the centralized upstream supply network.
6.5.2 HYPOTHESIS TEN

In this section, the researcher presents the ERGM analysis results involving the network embeddedness measure based on betweenness centrality in contract tie, information-sharing tie, referral made tie and referral received tie on the propensity of influence tie formation.

**Figure 6.30 The influence network and firm embeddedness based on betweenness centrality in contract tie**

In Figure 6.30, the researcher found that the influential firms of the network are also the nodes or firms having the highest embeddedness scores and the highest trust scores. For example, APMMHQ-1 is observed to be highly influential with an influence score of 20 and also highly
embedded in the contract tie based on betweenness centrality, as indicated by the large node size. In addition to that, the periphery network members are also the less influential among the firms. For example, PMKURAU-9, DMKLLIGI-15, and PMMRSNG-17 are among the less influential firms which also possessed low embeddedness scores based on betweenness centrality in contract tie.

Figure 6.31 shows the sociogram of influence network with organizations’ embeddedness based on betweenness centrality in information-sharing tie and the respective level of influence of firms.

**Figure 6.31 The influence network and firm embeddedness based on betweenness centrality in information sharing tie**

From a visual perspective of the sociograms in Figure 6.31, it can be seen that the influential firms of the network are also the nodes or firms with the highest embeddedness scores and the
highest trust scores. For example, APMMHQ-1 is observed to be highly influential with an influence score of 20 and also highly embedded in the contract tie based on betweeness centrality, as indicated by the large node size. In addition to that, the periphery network members are also less influential in the firms.

Figure 6.32 shows the sociogram of influence network with organizations’ embeddedness based on betweeness centrality in referral made tie and the respective level of influence of firms.

**Figure 6.32 The influence network and firm embeddedness based on betweeness centrality in referral made tie**

Figure 6.32 shows that firms which are highly embedded based on betweeness centrality in referral made ties are also influential in the network, particularly the respective cluster of clique that the firms belongs to. For example, AMPPHQ-1 is highly embedded in the referral made tie and is
also highly influential in the network, particularly in its own cluster, with MTUPJAYA-2, MTURAWNG-3, and WILTIM-20. In addition, WILUTA-4 is highly embedded in the referral made tie and also highly influential in the influence network; more specifically, its cluster of PMKKEDAH-8, DMLKAWI-5 and DMLUMUT-7. Similarly, WILSAB-31 is highly embedded in the referral made tie and is also influential in its cluster with PMLDATU-36, DMSDAKAN-34, DMKABALU-33, and DMLBUAN-32 respectively. Thus, the visual analysis indicates that the level of firms’ embeddedness in the network could impact upon the level of reputation that a firm may experience from other network members. Figure 6.33 shows the network maps of influence network with firm embeddedness attributes based on betweenness centrality in referral received tie.

![Network Map](image)

**Figure 6.33 The Influence Network and Firm Embeddedness Based on Betweenness Centrality in Referral Received Tie**

In Figure 6.33, embeddedness based on betweenness centrality in referral received tie has mixed effects upon firms. In the majority of clusters, it was found that there is one highly
embedded firm that is considered influential in the clusters or network or clusters as a whole. Similarly, this study also found that one firm that is less embedded in the referral received tie (based on betweenness centrality index) possessed one of the highest influence ratings in the network, i.e. APMMHQ-1.

**ERGM Analysis of Betweenness Centrality and Influence Network**

In this section, the researcher presents the result of statistical network analysis of the influence network with node embeddedness attribute measured based on their betweenness centrality score across four supply ties (Table 6.9).

Table 6.9 shows that the *Sum of Continuous Effects* of Section Two (MLE = 0.027, SE = 0.016*) and Section Four (MLE = 0.094, SE = 0.017*) are significant. The parameters are non-significant in Section One and Section Three. ERGM analysis shows that embeddedness based on betweenness centrality affects the level of influence firms may experience in the network.
### Table 6.9 ERGM Analysis Based on Firm Embeddedness Betweenness Centrality and Influence

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ML Estimates</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pure Structural Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arc</td>
<td>-2.481</td>
<td>0.614*</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>1.347</td>
<td>0.536*</td>
</tr>
<tr>
<td>A-in-S</td>
<td>-0.249</td>
<td>0.264</td>
</tr>
<tr>
<td>A-out-S</td>
<td>0.704</td>
<td>0.429</td>
</tr>
<tr>
<td>AT-T</td>
<td>0.824</td>
<td>0.366*</td>
</tr>
<tr>
<td>AT-C</td>
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<tr>
<td>AT-D</td>
<td>0.635</td>
<td>0.266*</td>
</tr>
<tr>
<td>AT-U</td>
<td>-0.163</td>
<td>0.142</td>
</tr>
<tr>
<td>A2P-T</td>
<td>-0.272</td>
<td>0.062*</td>
</tr>
<tr>
<td>A2P-D</td>
<td>-0.488</td>
<td>0.177*</td>
</tr>
<tr>
<td>A2P-U</td>
<td>0.063</td>
<td>0.026*</td>
</tr>
</tbody>
</table>

*Pure Attribute Effects*

**Section 1: FNEBC in Contract tie**
- Sum of continuous attributes: 0.034 (0.025)
- Difference of continuous attributes: -0.015 (0.033)

**Section 2: FNEBC in Information-sharing tie**
- Sum of continuous attributes: 0.027 (0.016*)
- Difference of continuous attributes: 0.043 (0.082)

**Section 3: FNEBC in Referral Made tie**
- Sum of continuous attributes: 0.017 (0.013)
- Difference of continuous attributes: -0.034 (0.025)

**Section 4: FNEBC in Referral Received tie**
- Sum of continuous attributes: 0.094 (0.017*)
- Difference of continuous attributes: -0.057 (0.022*)
The second embeddedness measure lies in the betweenness centrality index. The results show that, for the contract tie, the *Sum of Continuous Attribute* is positive and nearly significant. In the information-sharing tie, the parameter is positive and significant. In a referral made tie, the *Sum of Continuous Attribute* parameter is also positive but non-significant. In the referral received tie, the parameter estimate is also positive and significant.

In addition, the exploratory network analysis of the influence network provides discrete visualizations of the influence network with every one of the embeddedness attributes in each of the supply ties. Overall, it is noticeable that there is a core periphery structure of firms in the network indicating the strong tendency for a centralization structure to take place in the influence network. When an embeddedness attribute is measured based on centrality (i.e. degree centrality and betweeness centrality indexes) in contract tie, nodes that are highly embedded are also the nodes that have high trust scores in the network.

In an informal information-sharing tie, the core-periphery structure indicates that larger nodes are mostly the nodes that are highly trusted in the network. Similarly, when embeddedness is measured in referrals ties, the core-periphery structure seems to also indicate that larger nodes are mostly the nodes that are highly trusted in the network.

Combining the ERGM analysis results and the exploratory analysis results shows that when firms have high levels of embeddedness based on centrality in the supply network, the level of influence ties that it may acquire in the network also increases. Thus Hypothesis Ten is supported.

The summary of the analysis is encapsulated in Table 6.10 as follows.
### 6.6 SUMMARY OF HYPOTHESIS RESULTS

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis 1: Firms's embeddedness following their degree centrality position in the centralized upstream supply network through different inter-firm relations impact the level of trust that the firm may acquire from other network members.</td>
<td>Supported</td>
</tr>
<tr>
<td>Hypothesis 2: Firms's embeddedness following their betweeness centrality position in the centralized upstream supply network through different inter-firm relations impact the level of trust that the firm may acquire from other network members.</td>
<td>Supported</td>
</tr>
<tr>
<td>Hypothesis 3: Firms's embeddedness following their clique overlap position in the centralized upstream supply network through different inter-firm relations impact the level of trust that the firm may acquire from other network members.</td>
<td>Not Supported</td>
</tr>
<tr>
<td>Hypothesis 4: Firms's embeddedness following their multiplexity position in the centralized upstream supply network through different inter-firm relations impact the level of trust that the firm may acquire from other network members.</td>
<td>Not Supported</td>
</tr>
<tr>
<td>Hypothesis 5: Firms's embeddedness following their degree centrality position in the centralized upstream supply network through different inter-firm relations impact the level of reputation that the firm may acquire from other network members.</td>
<td>Not Supported</td>
</tr>
<tr>
<td>Hypothesis 6: Firms's embeddedness following their betweeness centrality position in the centralized upstream supply network through different inter-firm relations impact the level of reputation that the firm may acquire from other network members.</td>
<td>Not Supported</td>
</tr>
<tr>
<td>Hypothesis 7: Firms’s embeddedness following their clique overlap position in the centralized upstream supply network through different inter-firm relations impact the level of reputation that the firm may acquire from other network members.</td>
<td>Not supported</td>
</tr>
<tr>
<td>Hypothesis 8: Firms’s embeddedness following their multiplexity position in the centralized upstream supply network through different inter-firm relations impact the level of reputation that the firm may acquire from other network members.</td>
<td>Not supported</td>
</tr>
<tr>
<td>Hypothesis 9: Firms’s embeddedness following their degree centrality position in the centralized upstream supply network through different inter-firm relations impact the level of influence that the firm may acquire from other network members.</td>
<td>Supported</td>
</tr>
<tr>
<td>Hypothesis 10: Firms’s embeddedness following their betweeness centrality position in the centralized upstream supply network through different inter-firm relations impact the level of influence that the firm may acquire from other network members.</td>
<td>Supported</td>
</tr>
</tbody>
</table>

**Table 6.10: Summary of hypotheses results**
The ERGM analysis indicates that a firm’s embeddedness in the centralized upstream supply network influences two relational capital items, which are trust and influence. However, a firm’s level of reputation is not influenced by its level of embeddedness or involvement in the centralized upstream supply network structure. In the following chapter, the researcher discusses and highlights the impact of these findings for management and body of knowledge.
CHAPTER SEVEN
DISCUSSION

7.1 INTRODUCTION

Both the exploratory and the ERGM analyses gave interesting insight into the implication of firm embeddedness upon its relational capital outcomes in a centralized upstream supply network structure. The objective of this chapter is to discuss the findings of this study and how it contributes to theory and practice. This chapter will discuss the findings of this study through the lens of network embeddedness theory.

7.2 DISCUSSION OF THE EXPLORATORY NETWORK ANALYSIS RESULTS

This study draws attention to firms’ embeddedness or involvement in the various types of relationships in a centralized upstream supply network and the underlying impacts of this embeddedness. More specifically, the researcher examined the relationship between a firm’s level of embeddedness, based on its network structural positions in the centralized upstream supply network and the relational capital influence, trust and reputation in the context of the ship building industry.

In the context of a centralized upstream supply network inter-firm relationship, it can be seen that related parties in the network of relationships encounter conflicts through goal incongruence and suspicions of asset abuse. Similarly, where a party considers it has been unfairly treated by another party, there will be a higher chance of a more complex supply network resulting from these inter-firm relationships. Organizational study scholars such as Powell (1996) and Putnam (1998) have proposed the adoption of a network form of organizational governance. They posit that this is an acceptable means to the inter-firm relations complexity as it can create numerous relational capital outcomes, such as trust, influence and reputation. Further, it can also
contribute to an increase of competitive advantage and economic performance in the context of decentralized network structure to the firms embedded in the network structure.

Consequently, the researcher addressed the issue of inter-firm relationships in the centralized upstream supply network by investigating the pattern of firm embeddedness through its network structural positions in the four types of inter-firm relations. It was evident to the exploratory network analysis of the network maps and network embeddedness measures that firm embeddedness in the centralized upstream supply network was related to the degree of formality of the network tie.

The results found in the exploratory network analysis regarding the relationship of firm embeddedness and the formality or informality of the tier coordination mechanism indicate a different stance compared to the traditional view of embeddedness. As the researcher discussed in chapter 2 (section 2.3.1 and section 2.3.2), the traditional perspective of the embeddedness depends upon the strength of the multiple ties (Uzzi 1997).

The difference between the perspectives of embeddedness found in this study, and the traditional perspective of embeddedness begs the question of how can these divergences be elucidated. If anything, what is fundamentally different about the centralized upstream supply network from the voluntarily formed network structure, i.e. the decentralized network structure that could account for these diverse findings? The explanation that the researcher provides here will focus on the unique form of the firms and the dynamics of the centralized upstream supply network.

Using exploratory network analysis, the researcher first developed the network maps of four network ties which are: the network contract tie, network information-sharing tie, network referral made tie and network referral received tie in order to determine the network embeddedness pattern of the four ties. This provides a general outlook of the upstream supply network embeddedness structure. It is important to note that, in this analysis, based on earlier findings of organizational
studies (Cousins et al., 2001); the four network ties are viewed on a continuum of tie’s coordinations (formal versus informal relations).

Findings of network structural measures of embeddedness (such as density, centralization, reciprocity and k-core) both supported and were in line with the second general research question (RQ2) developed for this study. Accordingly, the following three arguments (i.e. based on the types of network relation of coordinations, heterogeneous form of firms and hub-and-spoke sub network structure) were discovered, discussed and applied to answer research question two of this study.

The first argument relates to the pattern of embeddedness of firms based on the types of network relations. In the context of the centralized upstream supply network structure, firms were found to be more embedded or involved in network relations that require fewer formal coordination approaches than in the network relations that were formally managed through terms and regulations. An example of this is the contract tie, as evidenced through the increased level of connectivity among firms shown in Figure 5.4 (contract tie network map), Figure 5.6 (information-sharing tie network map), Figure 5.8 (referral made tie network maps) and Figure 5.10 (referral received tie network map) compared to Figure 5.3.

On top of the visual analysis of the network maps, the statistical analysis of network structural measures of embeddedness have also given a similar indication of the pattern of firm embeddedness across all four network ties. For instance, the upward trend of the line graphs for the network structural indexes such as reciprocity (Figure 5.11), centralization (Figure 5.17), density (Figure 5.18), and clustering coefficient (Figure 5.20) shows that firms are more embedded or involved in network relations that are based on informal coordination approaches than in a formal one. Although two other indexes line graphs, i.e. k-core and geo-desic distance, indicate a downward line graph k-core (Figure 5.16), geo-desic distance (Figure 5.20), the results are interpreted in the same manner as the other indexes, as the negative relations are an indication of higher involvement.
However, network plots and network structural measures of embeddedness indicate that in formal relationships, such as contract ties, the extent of firms’ embeddedness is lower. On the other hand, in informally integrated relationships, the results show a high level of embeddedness or involvement, as indicated by the high score of network structural measures of embeddedness.

The results of the exploratory network analysis conformed to similar findings in the literature. For example, Polanyi (1957) posited that the embeddedness of economic actions was supplemented by market approach in the post-industrial societies. In addition, Granovetter (1985) reiterated this position in his study, wherein the author posited that all economic actions were embedded in networks of social relations. Following that, Uzzi (1997) found that in the apparel business, although contracts govern the transactions between firms, the author found that firms rely most upon the web of social exchanges.

The finding of the exploratory network analysis adds to the views of Polanyi (1957), Granovetter (1985) and Uzzi (1997). Similar to these authors, this study found that, at least in the APMMHQ-1 upstream supply network for RHIB; formal coordinative relations (such as the contract tie) only represent a small part of the actual interaction that exists in the upstream supply network structure. It was also determined that the other (or maybe the larger) portion of the network economic action is transmitted through a network of social relations.

Second, the finding of the exploratory network analysis also indicates that in the context of the upstream supply network, firms are embedded or involved with other firms in the network structure. This is accomplished through a united form of a network of formal and informal inter-firm relations. Furthermore, a study by Uzzi (1997) of the New York apparel industry also confirmed that contractors in the said industry formed an integrated structure of embedded ties (informal relations) and arms-length ties (formal relations) when dealing with other manufacturers or contractors. The existence of an integrated form of relations coincides with Uzzi (1997), who argued that an integrated structure of embedded ties (informal relations) and arms-length (formal
relations) is the optimal form of integrated structure. In addition to that, Cousins et al., (2001) also posited that, in the supply network, both informal and formal relations exist towards ensuring an efficient and effective management of the supply network.

Consequently, this finding means the existence of a heterogeneous form of firms in the context of the centralized upstream supply network structure. As the firms are embedded in distinctive types of network ties, such as the formal contractual tie network and informal information-sharing tie network, these distinct ties impact upon the embeddedness nature of the organization in the network. The reason for this is that, although the two ties are distinct, it is essentially an overlapping network structure which created an organization having a different characteristic to attend to both the formal and informal ties at the same time in the network. Essentially, we could refer to these organizations as heterogeneous organizations (of formal and informal characteristics) as they are both formally and informally embedded based on the type of ties.

Third, our examination of the structure of the contractual tie network map (Figure 5.4) and the network structural analysis score reciprocity (Figure 5.11), centralization (Figure 5.17), density (Figure 5.18) and clustering coefficient (Figure 5.20) respectively reveals the existence of a hub and spoke structure in the centralized upstream supply network structure.

This study proposition of the hub-and-spoke sub-network structure rests on several important findings in this thesis. Firstly, our examination of the structure of the contractual tie network map (Figure 5.4) and the network structural analysis score reciprocity (Figure 5.11), as well as centralization (Figure 5.17), density (Figure 5.18) and clustering coefficient (Figure 5.20) reveals that the respective networks are highly centralized on certain firms, namely, the APMMHQ-1 and MTUPJAYA. The centralizations of these organizations mimic a hub and spoke network structure. Using a hub and spoke network, this study discovered that, instead of having a large amount of ties to connect all the firms in the contract tie network; the majority of the organizations
are connected to each other through the APMMHQ-1 and MTUPJAYA. Such a condition would necessitate fewer ties to have full connectivity between the firms. For instance, let us suppose that the contract tie network consists of organizations A, B, C, D, E and F. With site A as the hub and B, C, D, E, F as the spoke, the spoke would connect to site A and use site A to get to each other in the contract network. The pattern of connectivity of the firm in the contract network would suggest a core and periphery structure existing in the centralized upstream supply network.

This core and periphery network lends evidence to the argument that, in a centralized upstream supply network, sometimes the contracts themselves are the replacement or substitution of a hierarchical control. In such a case, the contracts are filled with terms and clauses relating to the effective functioning of a hierarchical organization. Moreover, the finding that the informal links between the firms in the information-sharing network occurred in a decentralized structure is considered as proof of the organizational commitment to the norm of collaboration for better management of the supply network.

Combining the results of the network maps and the statistical results of network structural measures of embeddedness, the network plots and network structural measures indicate that in informally integrated ties, firms are more involved or embedded in the informal network structure than in formal ones. Thus, this would suggest that firms’ embeddedness in the centralized upstream supply network differ based on the different types of inter-firm relations.

Therefore, in answering Research Question Two, it is clear from the exploratory network analysis, and the analysis of network structural measure of embeddedness, that in the centralized upstream supply network structure, firms are more embedded or involved in a network of relations that requires less formal coordination than in a formal network of relations.

What this answer also indicates is that, in the centralized upstream supply network structure, both the formal relationships and informal relationships co-exist. This can inadvertently mean the presence of both the formal and informal forms of management or coordination approaches to inter-
firm relationship management. Thus, practically, the ideal strategy of management goals of inter-firm relations complexity may be achieved by the application of the formal and informal coordination strategies at the inter-firm level. Thus, this could lead to the creation of a heterogeneous form of the firm.

The heterogeneous structure is useful, because of the synergy of both the formal and informal structures of the network. The formal structure provides increased control, coordination and responsibility; while the informal network increases confidence, flexibility and responsiveness. Conceptualizations of organizational forms have focused on the market, hierarchy and networks (Powell, 2003). However, researchers have argued that the three different types of organization form can be combined into a more synergistic plural. For example, in the field of organizational studies, Adler (2001) found a mix of informal and formal mechanisms when managers attend to issues of business management. This research suggests a mix of formal and informal coordination mechanisms in business arrangements in the context of supply networks. The combination of formal and informal relations in the supply network can be a new addition to the mode or form of organization in the context of supply chain management.

In summary, while answering research question two of this study, the researcher found that, in the context of the upstream supply network structure, firms’ embeddedness or involvement is contingent upon the type of network relations. Clearly, the exploratory network analysis has given a strong indication that, in the centralized upstream supply network structure, more attention and resources (as forming new alliances requires time and even money) of the embedded firms are dedicated to informal networks of relations than to the formal ones.

Through the utilization of exploratory network analysis (network maps and network structural measures tests) of the four firms’ relationships, i.e.: contract ties, information-sharing, reference and made reference received tie; it is clear that the network embeddedness of firms in the supply network is related to the nature of the type of ties or firm relationships that are being
considered. The findings of the exploratory network analysis indicated that, in a more formal form of firms’ relationships; such as the contract tie, the firms are less embedded in the network structure. However, in the less formal ties or firm relationships (such as the information-sharing ties), firms are more embedded in their network structure as indicated by the network structural measures of embeddedness. For example, the directions of the network structural measures (i.e. reciprocity, k-core, density, centralization, geo-desic distance and clustering coefficient) shows that the more formal the firm’s relationship, the lesser the degree of embeddedness of a firm in comparison with the informal ties, such as the information-sharing tie. More importantly, because the definition of embeddedness relates to the degree of involvement of firms in the firm’s relationship, this finding suggests that firms are less involved within the network of formal ties compared to the informal inter-firm relations.

Overall, the summarized findings and the literature supports for research question two are given in Table 7.1.

<table>
<thead>
<tr>
<th>Study findings</th>
<th>Supporting Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream supply network relations involved an integration of formal and informal relations</td>
<td>Uzzi (1997); Cousins et. al. (2001); Adler (2001); Powell (2003)</td>
</tr>
<tr>
<td>Embeddedness relates to the type of inter-firm relations not just the strength of ties</td>
<td>Uzzi (1997)</td>
</tr>
<tr>
<td>Firms are more embedded in networks of informal social relations than in the formal ties</td>
<td>Polany (1957); Uzzi (1997);</td>
</tr>
</tbody>
</table>

**Table 7.1: Literature Support for Research Question Two**

Table 7.1 indicates that the finding of the exploratory network analysis is supported by the extant literature. For example, Uzzi (1997), Cousins et al., (2001), Adler (2001) and Powell (2003) found that, in inter-firm networks of relationships; firms are connected to each other through multiple types of inter-firm relations. Through our findings, this study found similar conditions in the upstream supply network, where firms are embedded in contract ties, information-sharing,
referral made and referral received ties respectively. In addition, this study also went a step further by classifying these inter-firm relations into the formal and informal nature of its coordinations. The results indicate that, in the upstream supply chain, firms having inter-firm relationships are more embedded in the informal network of inter-firm relationships than in the formal inter-firm relations (Uzzi, 1997). Although this finding contradicts the work of Granovetter (1985) (which argues that the strength of tie's influences actor embeddedness in networks), our finding is in line with the work of Uzzi (1997) who found that in inter-firm networks, firms are embedded in arms-length (formal relations) type of ties and embedded ties (informal relations).

Thus, overall, the researcher found that, in the context of the upstream supply network structure, firms’ embeddedness or involvement is contingent upon the type of network relations. Firms are more embedded in informal networks of relations than in formal ones.

In the following section, the researcher discusses the findings of the exploratory network analysis in relation to research question one of this study.

7.3 DISCUSSION: EXPONENTIAL RANDOM GRAPH MODEL ANALYSIS RESULTS

In this section of the chapter, the researcher discusses the findings of this study and its implications in answering research question one (RQ1): “is the embeddedness of firms in the centralized upstream supply network structure related to its relational capital outcomes?”

This study’s finding via the exploratory network analysis revealed that firms in an upstream supply network structure are more embedded in informal ties than in formal ones. This also relates to the existence of a heterogeneous form of firms in the centralized upstream supply network. Even though the benefits of the heterogeneous form of firms are numerous and cover areas such as administrative strategy, speed and flexibility, governance by network relationships still posed some threats to the embedded firms. These can include the issues of commitment, goal incongruence and opportunistic acts (Section 2.5.2).
This research seeks to address the complexity of these inter-firm relationship issues by examining and understanding that firms’ embeddedness or involvement in the centralized upstream supply network structure is vital to the management of the complexity in the supply network (Borgatti and Li, 2009; Choi and Kim, 2008; Kim et al., 2010). As a result, understanding the embeddedness aspect of firms in the centralized upstream supply network can give an supplemental lens and other strategy to the traditional-attribute based lens of complexity to drivers regarding management of the complexity and the supply network as a whole.

Thus, the pattern of embeddedness or involvement of firms in the centralized upstream supply network will surely have different impacts on firms’ relational capital such as reputation, trust influence and, consequently, its economic outcomes.

Regarding research question two and the hypothesized relationships between conceptual elements of embeddedness and relational capital, this study found that some relationships were supported providing insights into research question one. The outcomes of the hypotheses' testing will help answer the prediction in research question one as we seek to analyze the outcome of the hypotheses' testing of four embeddedness variables upon three relational capital outcomes variables. Discussion of the hypotheses result is presented in the following sections.

**7.3.1 IMPACT OF EMBEDDEDNESS IN SUPPLY NETWORK STRUCTURE**

The section below discusses the hypotheses related to the effect of the embeddedness in the supply network on the conceptual element of relational capital (mainly trust, influence and reputation). The effects of organizational embeddedness are evaluated in terms of firm network position, i.e. **degree centrality, betweeness centrality, clique overlapped** and **multiplexity** across contract ties, information-sharing ties, referral made ties and referral received ties. These network positions are valuable because they represent positional advantage that a firm may acquire in its relationship with other firms in the supply network structure. A summary of the hypothesis is presented in Table 7.2.
In Table 7.2, the individual impact of firms’ embeddedness in the four different types of inter-firm relations that made up the centralized upstream supply chain network is presented. As it can be seen in Table 7.2, there are significant positive and negative effects of firms’ embeddedness on its levels of trust and influence when firms are embedded based on their centrality positions (H1, H2, H9, and H10). However, other types of firm levels of embeddedness do not impact the level of influence (H3, H4). In addition, firm embeddedness has no impact on its level of reputation (H5, H6, H7, H8).

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Contract tie</th>
<th>Information-Sharing tie</th>
<th>Referral Made Tie</th>
<th>Referral Received Tie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational Embeddedness in Supply Network</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H1: Degree Centrality → Trust</td>
<td>Positive</td>
<td>Negative</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td>Significant Effects</td>
<td>Significant Effects</td>
<td>Significant Effects</td>
</tr>
<tr>
<td>H2: Betweenness Centrality → Trust</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td>Significant Effects</td>
<td>Significant Effects</td>
<td>Significant Effects</td>
</tr>
<tr>
<td>H3: Clique Overlap → Trust</td>
<td>Not significant</td>
<td>Not significant</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td>H4: Multiplexity → Trust</td>
<td>Not significant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H5: Degree Centrality → Reputation</td>
<td>Not significant</td>
<td>Not significant</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td>H6: Betweenness Centrality → Reputation</td>
<td>Not significant</td>
<td>Not significant</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td>H7: Clique Overlap → Reputation</td>
<td>Not significant</td>
<td>Not significant</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td>H8: Multiplexity → Influence</td>
<td>Not significant</td>
<td>Not significant</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td>H9: Degree Centrality → Influence</td>
<td>Positive</td>
<td>Positive</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td>Significant Effects</td>
<td>Significant Effects</td>
<td>Significant Effects</td>
</tr>
<tr>
<td>H10: Betweenness Centrality → Influence</td>
<td>Positive</td>
<td>Negative</td>
<td>Not significant</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td>Significant Effects</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 7.2 Summary of Hypotheses and Results of Statistical Network Modeling**
### 7.3.2 THE IMPACT OF DEGREE CENTRALITY ON TRUST

The ERGM analysis revealed that there were significant, positive effects of firms’ embeddedness based on degree centrality in information-sharing ties and trust. This means that firms that are highly embedded in the information-sharing tie network, based on their degree centrality network structural position, have a high likelihood of being perceived as trustworthy by other network members. The results are similar in the referral made ties, and the referral received ties. This also indicates that, as firms are more embedded in the centralized upstream supply network based on the degree centrality network structural position, their level of trustworthiness as well improves. However, the Maximum Likelihood Estimate (MLE) is significant but negative when firms are highly embedded in the contract tie. What this means is that the more embedded a firm is in the upstream supply network based on the formal contract tie, the less is the likelihood that it will be perceived as trustworthy by other network members.

This suggests that hypothesis one can be accepted. As a firm becomes more embedded in the upstream supply network structure, it will experience varying levels of relational capital depending on the type of activity that the firm is involved in. Thus, the more embedded a firm is in the supply network based on degree centrality network position, the more likelihood there is that the firm will be perceived as trustworthy by other firms embedded in a similar network structure. This implies that firms in an upstream supply network relationship trust the firms that occupy the central position in the supply network structure; alternatively, by definition, the firms that receive the most ties or connections from other firms.

Overall, it appears that firm embeddedness in the supply network structure contributes to the level of trust that one firm may receive from other network members. Moreover, the trustworthiness level that a firm receives from other colleagues may be helpful in the collaborative development of a new-product innovation or services. The level of trust can also influence the development and training of personnel; for example, to qualify them to deal with the partners’ or
customers’ technology or system. The results of the parameter estimations are in line with the results of the trust network visual analysis (Figures 6.3, 6.4, 6.5, 6.6 and 6.7). In this case, this study also found that, in the sociogram of trust network, firms that have a high level of embeddedness based on degree centrality are also the central firms in the trust network structure.

This finding is consistent with Uzzi (1997). Uzzi (1997) found that, in inter-firm relationships, active relational governance such as information-sharing is associated with trust. Further, it was found that firms resort to trusted firms in the network with whom they have dealt multiple times in the past to obtain information regarding a potential partner before collaboration activities can be carried out. More importantly, Zaheer et al., (1998) confirm that this leads to improved performance of inter-firm exchanges. An important implication of this is that these findings provide support that firm commitment into information-sharing activities enhances the perception of trust that the firm may receive from other network members. In addition, referral relationships are regarded as being a firm’s high level of goodwill (Anderson, 1998). Referral relationships often involve sending human resources, or participating in programs to make certain of issues regarding clients or processes. As receiving referrals can be interpreted as receiving resources from other network members, others may regard the act of sending referrals to other firms as an act of goodwill. Consequently, firms that receive a high number of referrals will also be perceived as highly trustworthy by other firms in the network structure.

Thus, the findings of ERGM analysis for the hypothesis one lend support to the argument that firms are more embedded in the centralized upstream supply network.

7.3.3 THE IMPACT OF BETWEENNESS CENTRALITY ON TRUST

In this section, the researcher investigates the impact of firm embeddedness or involvement in the centralized upstream supply network structure on its level of trust. Here, the ERGM model shows interesting results. The model estimated for the contract tie, information-sharing tie, referral
made tie and referral received tie presents significant negative effects to the concept of embeddedness on trust.

Because betweenness centrality relates to firms’ brokerage positions in the centralized upstream supply network structure, these findings imply that, as firms are more embedded or involved in the centralized upstream supply network structure based on its betweenness centrality, its level of trust reduces accordingly. One possible explanation can be derived from these results. What this means is that firms that are viewed as brokers in the centralized upstream supply network structure and may be regarded as less trustworthy by other firms in the network. This is so because the firm becomes the connector between two unconnected firms in the network.

An explanation to findings is related to a possible threat of opportunistic acts taken by the brokerage firms. Because betweenness centrality represents a brokerage position of a particular firm in the network, firms that appear to be brokers may also be perceived as opportunist by others, as it may place rent on the access to other firms that the broker is connected to. In addition to that, firms that occupy the brokerage position may equally important make leverage on these available resources in negotiations or dealings.

Thus, such an embeddedness position may confer many informational resources upon the firm, but it may also increase wariness of others regarding the firms’ possible opportunistic actions. Thus, this would reduce its perceived trustworthiness by other network members.

This finding is similar to Burt (2000; 2004) who argues that firms in a network acquire resources through brokerage positions between ‘holes’ or gaps in the overall network structure. The fact that these firms are bridging the gap in the structural holes also increases the firms’ control and power in the network; which could besides result in creating caution among other network partners.
In the following section, the researcher discusses the results of ERGM analysis for hypothesis three of this study.

**7.3.4 The impact of the clique overlapped on trust.**

For hypothesis three, in the estimated model, there were no significant effects of the clique overlap in contract tie, information-sharing tie; referral made tie and referral received tie respectively. This result suggests that the clique overlap position does not influence the level of trust that a firm may receive in the supply network. This finding is contrary to the proposition of this study. A possible explanation can be derived from the works of Coleman (1988). Coleman (1988) argues that network closures in cliques are more constrained in their attitudes and behaviour. One main reason for these constraints is that cliques reduce individual actors’ power and give checks on the opportunist individual interest (Krackhardt, 1999). As such, trust developed more easily in cliques.

Similarly, Wicks, Berman and Jones (1999) documented that trust in a firm’s relationship might be stronger with the context of the closer dyadic ties, rather than the larger ties’ structures such as cliques.

What this means is that trust develops more easily in closer tie structures, such as dyads, rather than in structures of distance, such as overlapping cliques. Because of the direct interactions between two firms in dyads, the intensity of the connections may be higher than in triads or cliques, which can be attributed to the non-significant effects in the model.

This non-significant relationship shows that firm embeddedness or involvement based on clique overlap is not the necessary element by which to increase trust in the centralised upstream supply network structure. Thus, firms are not perceived to be more trustworthy from a clique overlap position in the supply network structure.
In the following section, the researcher discusses the results of ERGM analysis for hypothesis four.

7.3.5 The Impact of Multiplexity on Trust

Hypothesis four describes the relationship between the organizational embeddedness based on multiplexity and trust.

In this study’s estimated model, the researcher found no significant relationship between firm embeddedness or involvement in the centralized upstream supply network structure and its level of trust. Clearly the firm’s embeddedness in the supply network based on multiplexity of ties does not influence its level of trust.

What this result means is that firms that are embedded or involved in the centralized upstream supply network structure in multiple types of relations will not had their level of trust affected by these multiple relations.

This suggests that firms having access to other firms through multiple ties do not have their levels of trust impacted.

This result is further supported by the trust network sociogram (Figure 5.7). In the sociogram, firms with a high multiplexity index are not necessarily the firms that have a high trust score.

This finding is similar to those of Burt (2000) and Burt (2004) which emphasizes that in network relations, firms do not need to be in connection with all the firms in the network structure in order to be able to assume social capital. However, it is sufficient to be connected to certain powerful firms in the network structure, as spill-over effects may reward the firm with related social capital as well (Anderson, 1999).
In the following section, the researcher discusses the impact of firms’ embeddedness and the relational capital reputation.

7.3.6 The impact of degree centrality on reputation

The finding of the estimated ERG model indicates that there is no significant relationship existing between firm embeddedness and involvement in the centralized upstream supply network structure, based on the degree centrality on the firm level of reputation. Firm reputation, it appears, is not related to the level of embeddedness in the supply network structure. This suggests that firms that are the centre of the upstream supply network do not necessarily receive high reputational ties from others in the network.

This research finding is contrary to the works of Galaskiewicz and Marsden (1978) and Fombrun (1996). The authors posited that centrality results in a high degree of visibility, which results in valid reputational perceptions. In addition to that, the central actors are rewarded from their indirect relations to other actors in the network by notice of their good reputation travelling the network via direct and indirect connectivity.

The result for hypothesis five implies that, although firms may have many ties connecting them to other firms in the network (directly or indirectly), the level of reputation that these firms may experience is not influenced by their high involvement with other firms in the supply network. This result may be related to issues of relations versus attributes and spill-over effects.

First, as this study is largely concerned with a firm’s embeddedness in social networks, it may have different effects on reputation compared to the effects of firm attribute such as size. Firm size is a good visible indicator of performance, innovativeness and success, which, consequently, improves the firm’s prestige in the market (Damanpour 1998). Thus, the greater the size of the firms, the more prestigious they may appear to others. On the other hand, relationships are rather tacit and known only to the involved parties. Accordingly, this thesis confers with the work of
Damanpour (1998) which documented that a firm’s attributes, such as size, is a greater indicator of reputation than the firm’s network structural position.

Second, the researcher argues that the effect of embeddedness on reputation may be disrupted by the spill-over effects (Anderson, 1999) that firms may experience through connections to firms having injurious rapport in the network structure. Although spills over effects are not tested in this study (potentially for future research), the consequences resulting from a firm with a bad history spilling over to other network members whom it is connected to are well-known in the literature. Consequently, caution must be taken when forging new partnerships or collaborations. Histories of performance and actions of the potential partners must be factored in before decisions of collaborations are forged.

In the next section, the researcher discusses the implication of firms’ embeddedness in the centralized upstream supply network structure based on betweenness centrality and its relational capital outcome reputation.

7.3.7 The Impact of Betweenness Centrality on Reputation

For hypothesis six, the ERGM results show no significant effects of firms’ embeddedness in the centralized upstream supply network structure in relation to the firms’ reputation levels across the entire model in Table 6.6. The results of the ERGM analysis show that there is no support for the hypothesized relationships.

This means that the fact that firms that are more embedded in the centralized upstream supply network structure based on their betweenness centrality position will have no effects on their level of reputation. As such, being embedded in a brokerage position in the supply network structure does not influence the firm’s level of reputation in the network.

The non-significant effects of firm embeddedness based on its betweenness centrality position reiterate the relevance of firm attributes as a sign of prestige or reputation in the network.
structure. This is actually more so than the level of embeddedness or involvement that a firm may have in a network relationship. Visible firm attributes, such as large firm size and age of the firms, may reflect more on the firm’s level of reputation than its network structural position.

However, as Anderson (1999) argued with regard to the spill-over effects, a firm may experience an improved level of reputation from being seen to be connected to other firms that possess prestigious attributes. Firms may experience a reduction in reputation if the firms are tied to other firms that have a low reputation level in the network structure. Galaskiewicz and Marsden (1978) also stated that reputation tends to be socially developed. Because social relationship is related to horizontal or informal relationships, the researcher argues that the imposition of the focal firm in the upstream supply network reduces the potential of horizontal relationships among firms, which, consequently, reduces the level of social relationship between the firms. As a result, firms that are highly embedded in the centralized upstream supply network structure do not experience an increased level of reputation.

In the following section, the researcher discusses the ERGM analysis for hypothesis seven of this study.

7.3.8 THE IMPACT OF THE CLIQUE OVERLAPPED ON REPUTATION.

In this section, the researcher discusses the outcomes of the ERGM analysis investigating the impact of firm embeddedness based on its clique overlap network structural position in the centralized upstream supply network structure in relation to the firm’s level of reputation.

Hypothesis seven described the relationship between the firm cliques overlap and its level of reputation in the supply network. In Table 6.7, the ERGM analysis shows no significant relationship. Burt (1995) argues that a firm will experience high reputation through its brokerage position. However, the ERGM result indicates that a firm’s level of reputation in the centralized
upstream supply network structure is not affected by the firm’s level of embeddedness or involvement through its clique overlap with other firms in the network.

Contrary to the arguments put forward by Burt (1995), the finding suggests that being embedded or involved with other firms in the centralized upstream supply network through this brokerage does not necessarily translate into good reputational value.

One logical explanation for this situation relates to the potential Machiavellian or opportunistic image conferred upon these brokerage firms. It helps other firms navigate through the complex upstream supply network structure by using their broker position as leverage. Thus, being visualized by other firms as the broker or middle man between other firms may present a risk to the firm’s level of relational capital outcomes and consequently, its potential to obtain the relevant competitive advantage, as well as its ability to increase economic performance (Zaheer et al., 1998).

In the following section, the researcher discusses the outcome of ERGM analysis for hypothesis eight, which tests the impact of firm embeddedness based on multiplexity of ties and reputation.

7.3.9 THE IMPACT OF MULTIPLEXITY ON REPUTATION

In this section, the results of the ERGM analysis for hypothesis eight are discussed. Hypothesis eight describes the relationship between firms’ embeddedness or involvement in the centralized upstream supply network structure and the firms’ level of reputation. Similar to the previous ERGM analysis results for relational capital reputation, the ERGM analysis (Table 6.8) shows no significant relationships existing between firm multiplexity and level of reputation. Multiplexity refers to a firm’s connections to other firms in the centralized upstream supply network structure through more than one type of network relation (e.g. contract ties and information-sharing ties). Similarly, the non-significant ERGM results show that, as firms are more embedded in the centralized upstream supply network, multiple types of network ties have no effect on its level of reputation. Thus, the results also indicate no support for the hypothesized relationship.
Contrary to the argument of Coleman (1980), that closure generates increased power to the related party; this research determined that closure (through being connected to multiple firms via various ties) does not improve the individual firm’s prestige or reputation. This has great implication to the management of resources devoted to networking activities, as firms need to balance between achieving power and gaining reputation.

Similar to previous arguments on the effects of firms’ embeddedness on reputation in the centralized upstream supply network structure, the non-significant results that this study discovered with regard to the effects of embeddedness and reputation may suggest that, essentially, attributes of the firms are what actually drive the firms’ level of reputation. For example, the size of the organizations may indicate that the firms are successful, thus this could possibly translate into enhanced reputation. This claim presents another area of research for interested readers.

In the next section, the researcher discusses the ERGM analysis results of firms’ embeddedness in the centralized upstream supply network structure, and relational capital outcomes influence.

### 7.3.10 The Impact of Degree Centrality on Influence

The results of the ERGM analysis in Table 5.9 indicate support for hypothesis nine of this study. The findings of this study confirm the prognosis that firms that have high levels of embeddedness in network relationships and hence will have better perceptions of influence in the network.

As degree centrality network structural position refers to firms that occupy a central position or ‘gate-keeper’ position in the centralized upstream supply network structure, it follows that firms that have high levels of degree centrality in the supply base will have a better level of influence. This would be due to their respective gate-keeping position as the central node in the upstream supply network.
This finding is consistent with the arguments of Emerson (1962), Freeman (1979) and Hager et al. (2004). Emerson (1962) argued that a resourceful firm becomes more powerful when it has multiple firms in the network depending upon it for resources. Freeman (1979) found a significant impact of a firm’s high centrality on, and its power in, a community network structure. Actors of the community network that became a central figure in the community network through its position, are considered more powerful as they became the centre of reference for other actors in the community network structure.

In line with Freeman (1979), it is relevant to claim that firms in the centralized upstream supply network structure that occupy central positions in the various network ties are considered more influential than other network members. The results indicate support for the hypothesized relationships. This suggests that a firm’s central position in the supply network structure contribute to its level of influence.

7.3.11 The impact of betweeness centrality on influence

In this section, the researcher discusses the outcome of the ERGM analysis concerning firms’ embeddedness based on betweeness centrality in the centralized upstream supply network structure and influence.

The overall results of the ERGM analysis in Table 6.10 indicate support for hypothesis ten of this study. As betweeness centrality is related to a firm brokerage position in the centralized upstream supply network, this study found positive significant effects on influence when a firm occupies the brokerage position in the contract tie and negative significant position in the information-sharing tie (Freeman, 1979, Galaskiewicz et al., 2006, Nahapiet and Ghoshal, 1998, Mehra et al., 2001).

The different effects indicate that a firm that has a brokerage position in the formal contractual relationship has more power upon other firms than those in the informal information-sharing relationships.
To comprehend this phenomenon, a visit to the nature of the centralized upstream supply network structure is warranted. As indicated by Choi and Krausse (2006), in an upstream supply network structure or the supply base, the management or administration of the transactions in the upstream supply chain is often under the surveillance of a central firm. This central firm function as the broker between other firms in the upstream supply network structure. This occurs largely through contractual ties that it has upon other firms in the tiers or the dictations that it enforces upon its contractual suppliers for other potential suppliers. As such, the firm’s influence over others in the network structure is enforced through these types of relations rather than through other means from among the web of social exchanges.

The overall literature results relating to the hypothesis results and the revised model of relationships between firm embeddedness and relational capital outcomes are given in Table 7.3. In Table 7.3, Osman’s (2013) findings regarding the implication of firms’ embeddedness in a centralized network structure indicated the following. Osman (2013) found that firms which were actively sharing information and making referrals with other firms in the supply base were perceived as highly trustworthy by the network members. This finding is consistent with that of Zaheer et al. (1998). In their work, Zaheer et al. (1998) found that, in inter-firm relationships, active relational governance such as information-sharing is associated with trust. More importantly, Zaheer et al. (1998) confirm that this leads to improved performance of inter-firm exchanges. An important implication of this is that these findings provide support for the concept that firm commitment for information-sharing activities enhances the perception of trust that the firm may receive from other network members. In addition, Osman (2013) also found that referral relationships are regarded as an indication of a firm’s high level of goodwill. Referral relationships often involve sending human resources, or participating in programs to make certain of issues regarding clients or processes. As receiving referrals can be interpreted as receiving resources from other network members, others may regard the act of sending referrals to other firms as an act of goodwill. Consequently, firms that received a high number of referrals will also be perceived as
highly trustworthy by other firms in the network structure.

The third set of findings reveals that firm embeddedness in the contract ties, information-sharing and referrals ties respectively have no effect upon the level of reputation. In this case, the findings of Osman (2013) contradict other earlier findings in the literature, such as those by Burt (1995) and Anderson (1999). Osman (2013) argued that the effect of embeddedness on reputation may be disrupted by the spill-over effects (Anderson, 1999) that firms may experience through their connections to firms with bad rapport in the network structure. Although spill-over effects are not tested in this study (potentially for future research), the consequences of how firms with bad history may spill over to other network members to whom they are connected are well-known in the literature. Consequently, caution must be taken when forging new partnerships or collaborations. Histories of performance and actions of the potential partners must be factored in before decisions of collaborations are forged. In addition, the centralized nature of the upstream supply network may alter the effects on relational capital outcomes, as found in the studies of Burt (1995) and Anderson (1999).

The fourth set of findings of this study confirm the prognosis that firms having high levels of embeddedness in network relationships will have best perception of influence in the network (e.g. Emerson, 1962; Freeman, 1979; and Podolny, 1993a). Osman (2013) found that firms with high levels of centrality in the upstream supply chain will have a better level of influence, due to their respective gate-keeping position as the central node in the upstream supply network.

Following these findings, a revised relationship of this research model is given in Figure 7.1.
<table>
<thead>
<tr>
<th>Embeddedness Impact Prediction In Centralized Upstream Supply network</th>
<th>Literature Review</th>
<th>Based on Osman (2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embeddedness relationship to trust in the centralized upstream supply network based on centrality</td>
<td>Uzzi (1997) documented that extensive interactions between firms improve trust. Gulati (1995) and Zaheer et al. (1998) highlighted that the extent of years of communications between firms generate trust between them.</td>
<td>Extensive communication relates to the centrality of firms in communication activities that the firms received in the network. The researcher’s findings indicate support for the firms’ centrality through extensive communications involvement. This can be seen to have improved the firm level of trust in the centralized upstream supply network. As such, heavy involvement in the centralized upstream supply network rewards firms with high trust.</td>
</tr>
<tr>
<td>Embeddedness relationship to trust in the centralized upstream supply network based on clique overlap</td>
<td>Coleman (1988) posited that a closed network structure promotes and maintains the trustworthiness of other actors in the network.</td>
<td>In a centralized upstream supply chain, being embedded or involved in a close network structure, such as clique overlap, does not impact upon the firm level of trust.</td>
</tr>
<tr>
<td>Embeddedness relationship to trust in the centralized upstream supply network based on multiplexity</td>
<td>Uzzi (1997) argued that the embedding of commercial transactions with social relationships promotes trust in inter-firm networks. Provan, Isett and Milward (2004) argue that familiarity breeds trust.</td>
<td>Osman (2013) found that, in the centralized upstream supply network, although firms may be highly embedded or involved with other firms in the centralized network structure through more than one tie, this heavy involvement in different tie networks does not necessary translate into high trust for the firms.</td>
</tr>
<tr>
<td>Embeddedness relationship to reputation in the centralized upstream supply network based on centrality</td>
<td>Anderson (1999) argued that firm degree of visibility improves as it occupies the more central position in the network, often leading to better evaluation.</td>
<td>Osman’s (2013) ERGM analysis revealed that in the centralized upstream supply network, firm involvement in network relationships does not necessarily result in high reputation level. Instead, reputation is related more to attributes such as the firm’s size.</td>
</tr>
<tr>
<td>Embeddedness Impact Prediction In Centralized Upstream Supply network</td>
<td>Literature Review</td>
<td>Based on Osman (2013)</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Embeddedness relationship to reputation in the centralized upstream supply network based on clique overlap</td>
<td>Burt (1995) argued that members of multiple cliques have multiple access to information and resources resulting in benefits from these multiple groups.</td>
<td>Osman (2013) found that even though firms may be the bridge to other groups through multiple connectivity with other groups in the centralized upstream supply network, firms’ reputation levels in the centralized network structure are not affected by this pattern of embeddedness.</td>
</tr>
<tr>
<td>Embeddedness relationship to influence in the centralized upstream supply network based on multiplexity</td>
<td>Podolny (1993a) stated that multiplex ties tend to promote goodwill.</td>
<td>Osman (2013) determined that, in the centralized upstream supply network, reputation of firms is not related to the number of ties that the firms are involved in. In other words, in the centralized upstream supply network, a high level of firm embeddedness does not translate into reputation.</td>
</tr>
<tr>
<td>Embeddedness relationship to influence in the centralized upstream supply network based on centrality</td>
<td>Freeman (1979) argues that centrality breeds power. Emerson (1962) found that firms that are resourceful are more central and more powerful from their central position</td>
<td>Osman (2013) found support for the literature that argues that when firms are more embedded or involved in the centralized upstream supply network, based on their centrality experience, influence levels improve accordingly.</td>
</tr>
</tbody>
</table>

**TABLE 7.3 EXTENSION OF PREVIOUS RESEARCH BASED ON OSMAN (2013)**
FIGURE 7.1 REVISED MODEL OF RELATIONSHIP OF FIGURE 3.2

Firm Embeddedness Based on Network Structural Position

Degree Centrality

Betweenness Centrality

H1

H3

H4

H5

Relational Capital Outcomes

Trust

Influence
## 7.4 SUMMARY OF REVISED MODEL OF RELATIONSHIP

As the researcher highlighted in section 2.3.2, some of the main issues with network management relate to the commitment, opportunism and goal incongruence among the firms. This means that the effective and efficient management of the complex supply chain may be difficult to be achieved.

This research seeks to address the issue with this complexity by investigating the relationship between firms’ embeddedness and relational capital outcomes in the context of the centralized upstream supply network structure.

In the section results of the exploratory network analysis (Chapter Five), this study shows evidence of existence of the heterogeneous form of firms in the centralized upstream supply network structure. Although there are plenty of advantages that a firm can gain from this heterogeneous form, network governance poses some issues regarding individual firm commitment and goal incongruence. This study addresses this issue by answering research question one of this study. By examining the relationship between firms’ embeddedness in the centralized upstream supply network and relational capital outcomes, the researcher contends that if firms trust their partners and admire each other’s works, the cost of governance may be lessened.

Following the data analysis in Chapter Five, a revised model of relationship between firm embeddedness in the centralized upstream supply chain (Figure 7.1) is given as the alternative to initial model in Figure 3.2.

Overall, in Figure 3.2, the study finding indicates that firm embeddedness is related to two types of social capital, i.e., trust and influence; when embeddedness is measured based on the centralization of the firms in the supply network structure. More specifically, this study used two measures of centrality, namely, the degree and betweenness centrality indexes.
Between the degree centrality and betweenness centrality indexes, the exponential random graph modeling results indicate that degree centrality is a more significant predictor of trust ties than the betweenness centrality index. Firms that have a high degree of centrality have the highest number of connections in the network. This means that, based on our definition of network embeddedness, these particular firms are also very involved with other members of the network.

As Freeman (1979) argued, degree centrality is the most appropriate measure of capturing an individual actor’s access to resources, information and knowledge. Consequently, the more embedded a firm is in the supply network, the more connections it has with other firms and the more trustworthy than a firm is seen in the network. Relational capital outcomes (i.e., trust and influence) occur in a centralized upstream supply network context in which a central or focal firm may have more connections with other members of the network. This, in turn, may increase the firm’s competitive advantage (Zaheer et al., 1998).

A significant relationship was also found to exist between the betweenness centrality index and firms’ level of trust and influence in the structure of the network. As indicated in Chapters two and three, betweenness centrality index measures the rate at which a firm falls between other members of the network. If a firm has a high betweenness centrality scores, this indicates that many other firms must go through the central firm in order to reach others. This means that the firms that are rich in betweenness centrality have access to distinctive types of information and skills from different areas of the network. As Freeman (1979) put it, a firm that has been high betweenness centrality has more control over the information, in addition to having access to various knowledge and skills. In this case, network ties can serve as a channel through which information about new insights to problems or technical breakthroughs can be accessed from different areas of the network. This access to various information and skills, in combination with the ability to manage the flow of information, are seen as more reliable and powerful in the network. In other words, when firms are
embedded in the supply network via a brokerage position, it may result in positive influential effects.

The non-significant relationship between clique overlapped, and relational capital resources mean that firms’ network involvement in cliques is not related to the relational capital resources that the firms can receive in the structure of the network. This can probably be explained by the fact that there are no direct links between the firms that are embedded in the supply network. As Powell (1996) pointed out, for a firm to raise awareness of the network environment, it should also expand its formal relationships with other firms in the network. The expanding of these formal relationships with other firms of the network requires that organizations have direct ties with other members of the network. The clique overlapped index indicates that a firm’s organizations are connected to other members of the network, but not through direct ties. Rather, they are connected through other members of the network belonging to the general population of the cliques. Thus, the absence of a direct link between the embedded organizations (indicated by the clique overlap score) affects the non-significance of network embeddedness (measured by the clique overlap index) on social capital.

There was also a non-significant relationship between multiplexity of ties and relational capital. This means that a firm’s embeddedness based on multiplexity of relationships did not influence its relational capital. Putnam (1993) and Borgatti et al., (1998) argue that relational capital is affected by direct links in the network structure. Direct relationship between firms’ organizations in the network greatly facilitates communication, coordination and ensures a rapid exchange of information and resources between them. Thus, the non-significant multiplexity of ties is partly due to the lack of direct interactions between the firms. This study found no statistical support for the relationship between embeddedness (measured in terms of the clique overlap or multiplexity of ties) and reputation.
Firm embeddedness or involvement in the network is characterized by its network positions in four different firms’ relationships, i.e.: contract tie, information-sharing tie, referral made tie and referral received tie. By being embedded in a certain position of the supply network, the firm is likely to obtain useful relational capital resources from other members of the network, including trust and reputation.

In addition to that, Adler and Kwon (2002) stated that network researchers had primarily dedicated network embeddedness studies in the context of horizontal, informal, naturally-occurring networks. However, an increasingly important area of network is the centralized network structure. As elaborated upon in Chapter two, the centralized network is often categorized as the hierarchical or top-down network compared to the bottom-up nature of the horizontal network. An important issue is whether the hierarchical or centralized network structure can be facilitated by the informal institutions. The results of the ERGM analysis indicated that collaboration is not necessarily reduced when the networks are more rigid and centralized. For instance, the dense information-sharing network and the referral network structure indicate the resilience of inter-firm collaboration, even in the centralized network structure.

The results of this study show that, when a firm is deeply embedded or involved in the supply network, it is more likely to have access to relational capital through network positions. Reagans, Zuckerman, and McEvily (2004) argued that, in addition, network could reduce costs, as well as increasing performance and innovativeness of the related parties (Tsai, 2001). Theoretically, the firms with a high embeddedness are seen as more reliable and influential than other network actors (Wasserman and Faust, 1994). This means that the firms that have higher involvement, in the sense that they have the most ties with others, are more likely to be seen as trustworthy and influential.
Thus, overall, in answering research question one of this study, the visual analysis and the ERGM analysis show that the firm network embeddedness in the supply network is contingent upon the type of firms’ relationship and is a source of relational capital in the form of trust influence.

The findings from the exploratory network analysis and the ERGM analysis presented in the earlier sections described the interesting pattern and effects of firms’ embeddedness. The findings also illustrated the contingent relationship between the firms’ embeddedness and the relational capital resources in the centralized upstream supply network structure. This has a resultant impact upon knowledge and management of the upstream supply network. In the following chapter, the researcher continues with the implications and contributions of the results.
CHAPTER EIGHT
RESEARCH CONTRIBUTION AND CONCLUSION

8.1 INTRODUCTION

The objectives of this research are implied in its two research questions, which seek to determine how firms’ embeddedness in the centralized upstream supply network is related to the type of inter-firm relations, as well as how firms’ embeddedness may impact upon firms’ level of relational capital outcomes accordingly.

Overall, the findings of this study indicate that firms are more embedded in inter-firm relations that rely on a looser type of coordination mechanism or an informal type of inter-firm relations. In addition, this study also found that firms’ embeddedness or involvement is based on its centrality impact with regard to the firms’ level of influence and trust, but not on the firms’ respective reputation levels.

These findings have implications on knowledge and the management of the supply chain. Thus, this chapter discusses the contributions of this research to the body of knowledge and the management of the supply network. Following that, the limitations of this research are provided, which lead to future research opportunities. Lastly, the conclusion of this research is given.

8.2 RESEARCH CONTRIBUTION

This study contributes to the extant body of relational capital, strategy and network literature. First, this study contributes to the relational capital literature by showing that the relations among firms in the centralized upstream supply network structure constitute an important inter-firm network. It also demonstrates this by proving that the embeddedness of firms in this centralized network structure affects its relational capital outcomes. Second, this study contributes
to the literature on the performance effects of network structural position by showing that network position based on firm degree centrality, and betweenness centrality is related to the firms’ relational capital outcomes of trust and influence. Third, it contributes to the embeddedness literature by showing that firms’ formal commercial relations complement the firms’ webs of informal social exchanges in the context of the centralized upstream supply network structure. Fourth, this study also contributes to the network literature by showing how firms in the supply chain are part of multiple networks and that their positions in the centralized upstream supply network structure affect the relational capital that firms accrue from their respective positions in the network.

In the following section, the researcher discusses the contributions of this research to the literature of relational capital.

8.2.1 CONTRIBUTION TO THE RELATIONAL CAPITAL LITERATURE

The relationship between inter-firm relations and relational capital has long been studied, but the empirical proof of a relationship in the context of a centralized network of relations was limited (Provan 2004). With the advancement of globalization, the upstream supply network has become more complex over the years. As the upstream supply network has become more complex, focal firms tend to monitor and administer the transactions and activities in the network, thereby creating a centralized network structure. Although Putnam (1990) argues that relational capital exists in a network structure of relations, the context of this research mainly focuses on the decentralized network structure. Choi (2008) made a number of propositions regarding several benefits that occur when firms are embedded in the centralized upstream supply network structure. This includes understanding which firms can be trusted and relied upon for resources. They warn the readers against dismissing partners in the centralized upstream supply network structure, based on accounting measures, when these firms are actually more trustworthy and reliable with regard to their resources and connections.
Relational capital exists in networks of inter-firm relations, such as in the centralized upstream supply network structure (Putnam, 1999). Being related to other firms in the upstream supply network is beneficial to firms subject to their holistic understanding of their embeddedness in the network structure. The inter-firm relations in the upstream supply network structure not only emerged from the formal administrative, but were also initiated through other webs of social exchanges. Among the firms that are embedded in the centralized upstream supply chain, some will gain more benefits compared to others as a result of firm embeddedness or involvement based on the respective network structural positions.

In this study, the researcher argues that the amount of benefits or the relational capital is related to the firms’ level of embeddedness or involvement in the centralized upstream supply network. Specifically, the firm network centrality, clique overlapped and its multiplexity will impact upon firms’ relational capital outcomes, such as trust, reputation and influence. Centrality, clique overlapped and multiplexity increase the transferability of interactions in a network structure and, consequently, the firms’ relational capital outcomes.

In addition, this research has tested and confirmed the presence of relational capital outcomes in the context of a centralized network structure. This refers, at least, to the relational capital trust and relational capital influence in the context of a centralized upstream supply network structure. Organizational network researchers such as Putnam (1993) and Uzzi (1997) have examined cooperation in naturally-occurring horizontal network or decentralized network structures. Supply network, in its original form, is related to a managed organization network or centralized network, as initial formations are motivated by the needs of the focal firm to manage and administer the transactions of materials based on certain agreements. The difference between the naturally-occurring decentralized network structure and centralized network can be described as the bottom-up and top-down approach of cooperation. The top-down approach is facilitated by
formal criteria. As this study’s analysis indicates, cooperation is not totally antagonistic towards formal control. For instance, a high density index of the network structure of the informal information-sharing ties compared to the formal contract network indicates the high connectivity of firms in the information-sharing network rather than the contract network. The intensity of ties may represent the adaptability of cooperation in the centralized upstream supply network. These findings reaffirm the contention that even the formal, hierarchical institutions do not impede cooperation activities between the firms in the network and consequently, the creation of relational capital (Ostrom and Walker, 2000).

In other words, this study’s finding suggests that stocks of relational capital do exist in the context of a centralized network structure, even though the hierarchical network has been considered as an impediment to growth.

Another indicator of relational capital is the high degree of involvement of supplier organizations in the network’s cliques. In his seminal work, Coleman (1988) put forth two important effects of a closed network structure. First, the author contends that it affects access to information. Second, the network closure creates sanctions, which make it easier or less risky for the actors in a network to trust each other. However, since this study found no significant relationships between cliques and social capital (to the extent that firm’ organizations have different and divergent goals as well as diverse asset value's orientation), the clique overlapped position may not necessarily be the best strategy to develop relational capital outcomes.

The most significant contribution of this study to relational capital is that it extends the work of Choi (2008) by arguing and showing that inter-firm relations in the centralized upstream supply network structure constitutes the inter-firm network. This contribution further demonstrates that the embeddedness or involvement of firms in the centralized upstream supply network affects its level of relational capital trust and relational capital influence.
8.2.2 CONTRIBUTION TO THE INTER-FIRM NETWORK LITERATURE

One stream of literature of the inter-firm network looks at inter-firm relationships as formal contractual ties such as alliances and joint ventures (Ahuja, 2000; Gulati, 1995; Stuart, 2000). Another stream of research of the inter-firm network looks at inter-firm relationships as informal relationships such as advice, referrals and information-sharing (Uzzi, 1996; Von Hippel, 1987). This study contributes to the literature by testing the implications of firms’ embeddedness in formal and informal networks of inter-firm relations simultaneously. It also tests the interaction implications of the positions in the two classifications of inter-firm relations. Firms’ positions in both types of network affect its relational capital outcomes. To the best of the researcher’s knowledge, research has not yet looked at the embeddedness effects of the firms in the two networks in the context of the centralized upstream supply network. Thus, this research makes the initial step into understanding of the impact of multiple inter-firm networks on the firms in the centralized network structure.

The discussion of the results of the analysis in Sections 6.1 and 6.2 certainly has had an impact on the body of knowledge. This has occurred at least from the perspective of, namely: confirming the presence of relational capital in the context of a centralized network versus a decentralized network, the relationships between firms’ embeddedness and trust and influence, the different effects of the clique overlap on relational capital in centralized networks versus the decentralized network structure, the debate between the complementary versus substitute roles of formal and informal relations and to the argument that the analytical level of the supply network should no longer be viewed from the traditional individual dyadic ties, but rather from the extended networks' relations.

The empirical findings of this also tested and confirmed an increase in the level of trust and influence from firms’ embeddedness in the centralized upstream supply network structure. By
examining our network data, this study found, in the analysis of the centralized upstream supply network, that firms’ embeddedness in the supply network fosters trust and influence. Thus, the results of the exploratory network analysis and the exponential random graph modeling provided sufficient evidence to support the theoretical contribution at hand.

8.2.3 CONTRIBUTION TO THE EMBEDDEDNESS LITERATURE

This research was triggered by the initiatives of Borgatti and Li (2009) and Choi (2008), who claim that embeddedness is a relevant antecedent of supply network complexity and, consequently, deserves special attention. The results of this study showed that embeddedness in the centralized upstream supply network affects the level of relational capital trust and influence of firms in the network. As such, this study contributes to relational capital literature by providing empirical support for the arguments developed by Putnam (1990).

This research then isolated embeddedness as being the involvement of firms in a centralized upstream supply network on a firm’s relational capital. This study characterized firm embeddedness and network embeddedness by certain network position indexes of the social network analysis and the relational capital by the level of trust, reputation and influence that it engendered. Findings showed that network positions occupied by firms in the supply network have effects on the levels of trust and influence of the firms in the supply network structure.

The finding of this study contributes to popular debate in the field of embeddedness theory as to whether or not formal commercial transactions and informal social exchanges are substitutes or complements in the context of network structure. Results of the exploratory network analysis, e.g. contractual network map, information-sharing network map, referral made network maps and referral received network map, in addition to the supposition of the heterogeneous form of organizations lend support to the argument of complement instead of substitutes. The findings suggest (Section 6.1), and the significant and positive effects of firm's embeddedness in contract
ties and information-sharing ties on trust and influence (Table 5.4 and Table 5.9) add support to the arguments, that commercial transactions and web of social exchanges complement each other instead of merely acting as a substitute (Poppo and Zenger, 2002).

Furthermore, this study found empirical evidence to support the theoretical discussions of Cook and Emerson (1978), Granovetter (1985) and Powell (2003) who claimed that in network structure, an exchange in one tie results in an exchange or non-exchange in the other. Using embeddedness as the theoretical underpinning, this study also confirmed the theoretical suppositions of Choi and Kim (2008) and Borgatti and Li (2010) regarding the relational aspects of the embeddedness of firms in the supply network structure. In earlier studies, the theoretical visualization of firms’ embeddedness in the supply network has been centred on the dyads (Bozarth et al., 2009; Gottinger, 1983; Hofer and Knemeyer, 2009; Holmström, 1998). Therefore, this study contributes to the inter-firm relational literature in the context of the supply network by investigating and confirming that the analytical level of the supply network has evolved from the traditional individual dyadic ties to the extended networks of relations. As a consequence, with the revelations of the exploratory network analysis, also contributes to the theoretical arguments of Choi and Kim (2008) that in supply chain relationships, relations are no longer restricted between a dyad of two firms, but have rather, evolved into a larger entity of a minimum of three firms or triads and higher. Thus, firms’ relationships must be regarded as an element of a greater network of business relationships, not just as an isolated entity itself.

In the following section, the researcher discusses the managerial contributions that the findings of this study can contribute to the field of operations and supply chain management.
8.3 MANAGERIAL IMPLICATIONS

The overall findings of this study have implications for the supply base management strategy, at least within the context of the SBSR in Malaysia.

The APMMHQ-1 upstream supply network, as with other supply networks, is known for its complexity. Although the APMMHQ-1 supply network was within national boundaries, it is important to note that firms of any supply network are either knowingly or unknowingly connected to the larger network picture through the relevant firm relationships. There is also the issue of geographical dispersions of the firms in the supply network, since the production and distribution points are mostly far away from each other. These, as well as similar issues must be considered when evaluating and managing the complexity in the supply chain.

Achieving success in a supply network is essential. Understanding how and why some business relationships succeed and why others fail is perhaps among the most critical issues facing firms in the supply network. Thus, from a manager’s standpoint, it is important to know how to improve firms’ overall performance. Based on the findings of this thesis, the following implications are highlighted: firms’ involvement with others in the upstream supply network increases their level of trust and influence; the findings can become the barometer of involvement for firms to optimize involvement resources and creation of relational capital outcomes, partnership evaluation and forecasting strategy respectively.

First, the researcher could demonstrate that firm network involvement, or its embeddedness in the centralized upstream supply network or supply base, is extensively related to the firm’s key relational capital resources (ERGM analysis of Table 6.4 and 6.6). More specifically, it is beneficial to know that firms which become aware of, and are involved in the centralized upstream supply network relations, will widely experience increased levels of trust and influence. Even though it is not the goal of this study to explore the impact of network involvement on accounting or financial indicators, it is, however, important to note that Reagans et al. (2004) argued that
relational capital such as trust and reputation facilitates transactions. As a result, it could reduce costs, as well as increase performance and innovativeness of the related parties. What this means for managers of the supply chain is the ability to identify and capitalize on the important network structural position that can contribute to increase relational capital outcomes. The findings of this study have indicated the relevant position or degree of involvement for the generation of trust and influence; it is the initiative of managers to determine their respective positions in the centralized upstream supply network structure and make the necessary adjustments.

Second, the findings of this study can also be applied by managers of the supply chain as the barometer by which to evaluate the necessary degree of involvement in the centralized upstream supply network structure in order to optimize the generation of relational capital outcomes. Firm embeddedness plays an important role in the way business is conducted in a firm’s relationship. The findings of this study suggest that firms that increase their degree of embeddedness in the different formal and informal relationships may substantially enhance their chances of success by establishing their trustworthiness and influence differently. Managers may then adopt the empirical evidence of this study as a check on the adequacy of their involvement within their existing networks. More importantly, Zaheer (1998) found that firms with adequate relational capital contribute to a firm’s competitive advantage and consequently, its economic performance.

In addition, the findings of this study also showed that the relationship between network involvement and relational capital is reasonably high, even in the highly centralized upstream supply network structure. Thus, managers of firms in the supply network should not be discouraged from involving themselves with other firms in the supply network structure. The relational capital resources still flow to other firms despite the existence of a central focal firm managing and administering transactions between firms in the network structure. This highlights the needs for managers and firms to have the ability to examine and understand other firms’ patterns of embeddedness as this may be the key to capturing the dynamics of inter-firm relationships that
might be beneficial or lead to future concerns. As firms are able to understand this concept, it might help the firm to avoid the danger of dismissing a certain firm based solely on poor accounting measures, when, in fact, this firm is connected to other highly powerful or resourceful ones. The quantitative analysis results of this study may shed light on the type of relations that may have influence upon firms’ relational capital and become the knowledge needed for managers to comprehend the dynamics.

Fourth, the findings of this study may shed light on the ‘myth of downsizing’ in the context of inter-organizations. Choi (2011) described the upstream supply chain complexity or supply base complexity as being a ‘beast’ that requires understanding in order to tame it. Rather than by harsh actions such as removal of a part or elements that formed the whole network. This study attempted and succeeded to investigate and provide others with an additional lens through which to comprehend the complexity and consequently, bring new means to tame the beast. Since it has been a known empirical fact that downsizing does not improve performance of intra-organizations, the findings of this study may prove similar effects. It may also explain in part why, in the context of inter-organizations, a ‘reductionist’ approach (based on accounting measures) to suppliers’ management may not be the answer. It follows that it seems ill-guided reductionist may remove the influential, resourceful firms that do not appear on the firms’ radar of good accounting measures (Choi et al., 2006).

Strategically, the supportive effects of embeddedness on relational capital, i.e. trust and influence, imply an alteration to the supply chain complexity management strategy, specifically with regard to inter-firm relationships. Supply chain managers can no longer consider the complex supply network structure as a constraining context that contributes little to the firms’ relationships management. In actual fact, it possesses a positive climate for firms to be embedded in networks of formal and informal relationships with other firms. The capital that results from this embeddedness is valuable because it permits and adds to the evaluation of existing and potential partners.
Moreover, it is a rather cheap means of access and does not need large monetary investments. In this sense, the relational capital trust and influence must be properly appreciated and enhanced by managers through safeguarding and close coordination of the supply network.

Moreover, the findings of this study have also made an important contribution to the partnership evaluation strategy in the operation and supply chain management. Traditionally, firms have relied upon other partners’ internal capabilities and stabilities when determining the type of partners with whom to forge short-term and long-term partnerships. The findings of this study indicate that, on top of the inward capabilities, the potential partners’ embeddedness or involvement with other firms in the network also requires empathic scrutiny and strategic considerations. This involvement may certainly indicate the level of dependency of the firms upon their directly or indirectly-connected partners.

The results of this study also indicate that the network embeddedness of firms in the supply network can equally important serve as an supplemental lens that a firm may adopt to study their existing or potential partners. The knowledge of who can be trusted and is influential in the network structure can be obtained through the investigation of other firms’ network embeddedness which may give the investigating firm leverage and additional data in making decisions regarding forging new relationships.

This study also indicated the importance for firms and, more specifically, managers of firm operations and supply chain management functions to be able to understand and analyze the embeddedness of other firms in the supply network structure, as well as their own. To understand the nature of other firms’ embeddedness in the supply network structure, managers need to have the ability to determine the direct and indirect ties that the firms have with other network members. Thus, firms must possess potent network awareness in order to manage the complexity resulting from multiple direct and indirect ties. For example, a firm with heightened network awareness
ability should not simply cut ties with low performing partners in the network merely assuming low accounting returns, as these partners may actually be connected to a more influential network of members. Network theorists refer to this phenomenon as the strength of weak ties (Granovetter, 1973; Ruef, 2002).

These implications suggest that interrelationships play an equal role in determining supply management success. In other words, if companies are to manage their supply chain effectively, they must understand the true complexity of that supply network, as well as the involvement of firms in the different types of firms’ relationships. Although the reductionist approach to the number of firms in a supply network makes intuitive sense when managing complexity, the importance of the network inter-relationships is not always as obvious to managers. The level of interaction among firms in the supply network is an important aspect of complexity. Learning to cultivate the type of involvement in formal and informal types of inter-relationships that work best for business strategies is another level of complexity management that supply managers must master (Choi and Krause, 2006). Consequently, the traditional, attribute-based, internally-driven strategy of evaluating other firms when combined with the network embeddedness strategy allows a firm to evaluate its existing and potential customers more accurately.

Relatedly, balancing between the traditional attribute-based internally-driven strategy and network embeddedness strategy requires full understanding of the true nature of the related relational capital and its management in the context of the centralized upstream supply network structure. To do this, the researcher refers back to the argument of Putnam's (1993) that trust, reciprocity and norms developed in overlapping associations and organizational preferences are an prominent indicator of social capital. Similarly, this study suggests that two important relational capital outcomes that exist in an inter-firm relations network (particularly in the context of centralized upstream supply network) are those of relational capital trust and relational capital influence. The positive and significant support between network embeddedness of firms’
organizations in the network and trust, as measured by their degree centrality index and betweenness centrality index scores, is the evidence that relational capital is present in the centralized upstream supply network structure. Applying Putnam’s (1993) premise to a centralized upstream supply network structure, this study proposes the adoption of Putnam (1993) classification or divisions of the relational capital into exclusive versus inclusive relational capital.

Exclusive relational capital is the similarity among actors, such as age; while inclusive relational capital refers to the connection with actors who are different (such as supporters of another football team). Putnam argues that these two forms of social capital are mutually reinforcing. Consequently, a decrease in the exclusive capital inevitably leads to the decrease of the inclusive capital and vice versa.

In addition, an important contribution of Putnam (1993) is that the author recognizes the limitations of exclusive social capital. Putnam argues that exclusive social capital is largely inward, hence benefiting only the actors with internal access to the network structure. In the case of the centralized upstream supply network, the study’s analysis indicates that social capital exists across the network structure, but the overall network is rather fragmented. A remedy that Putnam suggests for such a fragmented structure is the acknowledgement of the inclusive social capital, i.e. relational capital that developed through external inter-firm relations. Thus, the researcher suggests an additional management strategy for the complexity in the context of centralized upstream supply network. This suggested strategy acknowledges the existence of, and organization between, both the inclusive and exclusive relational capital outcomes.

Resource forecasting is another managerial area to which this study contributes. The results of this study can be used by managers as a guideline for forecasting purposes. Because managers are capable to determine which firms are more trustworthy or powerful in the centralized upstream supply network structure, they are now competent to add to the forecasting tools the level of commitment that partners are ready to contribute to the forecasting activities. The data on
trustworthiness and influential potential may indicate the degree to which the partners are willing to commit for the supply of the related materials and resources. Consequently, coupled with traditional accounting measures, this will improve the focal firm’s manufacturing and production planning as well as its customer services. Knowing who can be trusted in complex inter-firm relations can also serve as a guide for determining future commitment of firms, thus assuring stability and consistency in resource availability.

Corporate espionage is an ever-present threat that can jeopardize a firm’s well-being. The findings of this study can be used as a guide by managers as an intelligence-gathering tool in the complex world of business interactions. As corporate espionage is a constant threat to a firm’s well-being, the findings of this study can help managers to guard against probable threats. It can also assist in gaining prospective resources by knowing and understanding the strategic positions in the networks, or realizing which firms are more trustworthy or influential. In addition, the findings can identify which firms could either be considered a threat or help to identify a potential threat. One example of a firm’s ability to identify threats in its network structure is the case of Honeywell, the first-tier supplier to Boeing. Unknown to Honeywell, several second and third-tier suppliers who supplied parts to Honeywell grouped together in collaboration and made a successful attempt in a negotiation with Boeing for the supply of parts and materials that Honeywell had been supplying to Boeing. The collaborative is now known as the Arizona Manufacturing Company.

This study also contributes to the resource allocation and management strategy in the supply chain. Resource allocation problems in supply chain management may take place during portfolio management optimization. Owing to the complexity inherent in these systems, the search for optimal solutions can be a difficult task. Since sharing of information is central to the resource allocation activities in supply chain management, understanding the pattern of the resulting network structure can help managers to use this preliminary finding to channel the resources for relationship
management based on the type of both organizations and relationships. More focused relationship management would ultimately improve cost savings and performance of the supply chain.

Thus, overall, on top of the normal accounting measures commonly applied to the management of the supply network structure, results from this study can add to the much needed tacit, intangible knowledge of complexity arising from inter-firm relations. Accordingly, the knowledge of embeddedness of firms in the upstream supply network structure can be another strategic tool for managers when dealing with the complexity in the supply network that arises from inter-firm relations. The researcher posited that by understanding and knowing firms’ patterns of embeddedness in the different network ties, managers will be equipped with an additional tool when evaluating current and potential partners, as well as determining optimum resource’s allocation strategy and forecasting purposes.

In the following section, the researcher discusses the methodological contribution that this research contributes to, specifically in the field of operation and supply chain management.

8.4 METHODOLOGICAL IMPLICATIONS

Methodologically, this study has applied several new techniques of data collection and data analysis, i.e. SNA and ERGM which both have high potential and application for operation and supply chain management research.

The adoption of these methods answers the call from several scholars who stated that “the time is right for a general review of key concepts in social network analysis that could be useful to supply chain researchers in further elaborating the potential of the network concept” (Borgatti and Li, 2009 p.6). They also suggested that SNA was relevant for the management of inter-firm relations as firms attempt to share information, coordinate their schedules, and develop products and services together as presented in the complex supply network (Galaskiewicz, 2011).
Following is the detailed methodological contributions that this study has provided via the field of operations and supply chain management.

First, to the best of knowledge, this study is among the preliminary to adopt the quantitative social network analysis method to expand the realm of understanding the nature of supply chain complexity. As it is apparent from the findings of this study, the supply network and firms’ relationships have become increasingly complex. The rapidly changing business environment has exposed the limit of analytical framework and standard statistical analysis of existing supply network complexity research. Previous studies have methodologically concentrated upon the attributes of the firms when, in fact, another prominent element, i.e. the relations between the firms, are also the sources of the complexity in the globalized business environment. More importantly, typical statistical methods and analysis applied in the many attributes-focused studies of supply chain complexity research such as Bozarth et al. (2009) and Milgate (2000) inherits one consequential characteristic that deemed it ill-equipped to study and analyses data that concern relations between firms. That characteristic is the assumption of independent observation that is widely assumed in standard statistical method and analysis.

However, the essence of relations is not independence, but rather the interdependency between two or more firms that are connected to each other, and yet the standard statistical method and analysis disavow the existence of relations between the firms through the assumption of independence of observations. The question then became “how best can we study and analyses these inter-firm relations in order to understand the complexity in the supply network?”

This study’s application of the SNA in designing the research, data collection and data analysis may be the solution to the problem at hand. Through the application of SNA the researcher could demonstrate how data of relations between firms can be collected and analysed without disregarding the attributes of the firms. Moreover, the ability of SNA to map the various relations that exist in the upstream supply network, while simultaneously visualizing the firms’ attributes,
provides the operations and supply chain management researcher with a new research tool that has not yet been widely explored. This is not to say that the standard statistical methods and analysis of previous complexity studies of the supply network are irrelevant; on the contrary, this study adds to the current methodological proposition of network analysts such as Borgatti and Li (2010) and Mueller (2000) by confirming the suitability of the SNA in the context of supply chain complexity research. Rather, SNA’s ability to measure relations and interdependency among firms is a unique talent who can provide a more accurate and holistic picture of the complexity in the supply network.

Using SNA, this research could demonstrate a technique to literally map the actual network map of the supply network structure beyond the flow of materials from the upstream suppliers. Through SNA, the researcher could map seven other networks of relations that exist in the upstream supply network. This was achieved via the following ties, namely: contract, information-sharing, referral made, referral received, trust, influence and reputation, on top of the map of the tiers of firms in the APMMHQ-1 upstream supply network structure. What this means is that researchers that are interested in mapping other forms of inter-firm relations that exist in the supply network (and its implication) may follow the methodological procedure set up in this study to arrive at the correct map of interrelations.

In addition, the application of SNA also allows the researcher to provide the means by which to visualize and analyses the implications of the individual relations and attributes between firms in the upstream supply network structure. It further allows analysis of its implication in the larger network structure. SNA allows the researcher to assign attributes of firms to the nodes using different sizes or colours while simultaneously exploring the various relations that exist between firms. What this gives to the researcher is a visual tool by which to analyses how certain attributes of the firms may implicate the formation or dismantling of relations. For example, the researcher can visually analyse how the size or age of the firms relates to the type of relations that a firm may
have in the network structure. Such exploratory ability of SNA is not available in other traditional and standard research method and analysis tools.

Third, this study also highlighted the suitability of the statistical model ERGM (an analysis technique which originated in the field of sociology) in supply chain complexity research. Although ERGM (like SNA) has been around since the early 1980s, its application is still limited in the field of operation and supply chain management despite its relevancy (Borgatti and Li, 2010, Choi, 2008). Using the ERGM analysis technique, the researcher could incorporate the interdependent nature of firms in the supply network into the analysis; a principle violated by normal statistical analysis technique, and models the effects of firms’ embeddedness attributes upon the interdependency of firms in the particular network structure.

Furthermore, the ability of ERGM to assess any attribute of firms in the model made it function like a standard regression analysis, but with an added edge; i.e. incorporating the existence of interdependence between firms. Interested researchers may apply the ERGM to analyses the impact upon other firms attributed in the propensity of formation of other types of inter-firm relations that exist in the complex supply network structure. Although this study did not attempt to make comparisons of findings with other analysis techniques, the goodness-of-fit index of the results indicates a strong support for the study findings. Thus, this study provides a new technique of data analysis of complex inter-firm relations, one that considers the inter-dependency between firms and not just the attributes.

Thus, methodologically, the adoption of SNA and ERGM are suitable by which to expand the horizon of a supply chain complexity researcher to one that can analyses the existence of relations between firms, as well as interdependency and firm attributes. The capability of SNA to visualize and statistically analyses the existence of relations between firms beyond the visible, immediate, dyadic connections, coupled with ERGM capability to investigate and model the impact
of firm's attributes on the propensity of relation formations, presents an unknown potential of application to explore new gaps in the body of knowledge.

8.5 RESEARCH LIMITATIONS

Due to constraints on time, resources and access, this research encountered limitations that may have affected the quality of data and depth of analysis. Firstly, Cross and Parker (2004) stated that qualitative interviews of key actors as identified by social network analysis would have been desirable in order to validate survey-based information. Due to the nature of this research and methodology relying so heavily on interpersonal relationships and social factors, qualitative interviews would have added further sophistication, depth and clarity to the network analysis. Validity of network research is also increased when boundaries are expanded by replicating populations (Hanneman and Riddle, 2005); repeating the study in multiple sample sites would allow for comparison of findings and increased validity of conclusions. Finally, as is true for all social science research, the process of conducting a valid social network analysis is “as much an art as a science” (Cross and Parker, 2004). Group selection, survey design and administration, data analysis and feedback sessions all require a great deal of time, discretion and experience and are therefore, subject to the limited expertise of the analyst as well as human error.

To the best of the researcher’s knowledge, this study is among the first to provide empirical evidence for a holistic firm relationship analysis using the social network perspective together with the structural embeddedness approach. Nevertheless, this thesis is not without its limitations, namely, demanding further empirical and exploratory endeavor. As such, certain elements of this thesis finding and conclusion need to be apprehended in light of these constraints.

The first limitation of this study is the nature, and the size of the sample used for this social network study. This study focuses on the APMMHQ-1 centralized upstream supply network or supply base used to gather data on the firms’ relationships. There are some benefits when focusing
on a single supply base, such as controlling for possible external variances that relate to crossing
industry differences when compared with targeting the broad spectrum of supply network
relationships. Such an approach, however, raises concerns about the generalizability of the findings.
Furthermore, the singular supply base approach is restricted to a small number of firms and
organizations in a unique supply base. This may have impacted the generalizability of the results
across the general population of the firms’ relationships as a whole. However, in defense of this
thesis, it extracted a high response rate of over 90% from the implementation of the network survey.
Further, while this is a concern, it is also important to point out that the small sample created a
rather conservative test of our hypotheses, suggesting that the effects find were especially strong.
In addition to that, because the focus of this research is centred on the firms’ relations, the possible
number of relations between 37 firms investigated can reach up to \( n (n-1) \) or \( 37 (37-1) = 1332 \) ties.
Such a high number of ties is considered large enough to provide valid and statistically strong
analytical outcomes.

Secondly, this research is based on a single industry. By focusing on a singular industry, the
research can control other industry effects, but the results are limited in general applicability.
There will be a need to re-test the findings of this study in other industrial contexts. Thus, it still
remains to be seen whether the result will hold across other industries such as the electronics
industry.

In addition, the basis on which most of the data were collected, i.e. individual respondent’s
self-reporting, was based on their own perceptions and subjective judgement. This use of
managerial perceptions arguably has limitations in terms of accuracy of response and recall. In
defense of this study, the network data used for this study are based on the judgements of key
decision-makers or respondents in each firm’s organizations. They pertain to the current state of its
relationships with other embedded firm, which complies with previous studies such as Krause (2008) and Borgatti and Li (2010).

Another limitation to this study is the nature of the social network analysis itself. First, social network researchers continue to question the construct validity of the sociometric measures. However, even though there is little research that has been conducted on the construct validity of the social network measures, several seminal works have suggested that these measures are valid (Borgatti and Foster, 2003; Borgatti et al., 1998; Burt, 1995; Burt, 2000; Cross et al., 2002; Marsden, 1990).

Fourth, as indicated in the exploratory and ERGM analysis chapter of this thesis, the social network approach necessarily entails a high level of illustration. A high level of illustration has both benefits and drawbacks. The illustration, inherent in this network study, is necessary as well as beneficial in uncovering the structural nature of certain relationship conditions. However, it may be deficient when it comes to providing a context for it. Nonetheless, it is the belief held by the researcher that every methodology has its own drawbacks, and the perspectives provided by the social network analysis make an important contribution to the study of firms’ relationships.

Although the research limitations may in some ways limit the impact of this study, the researcher believes that the extreme lack of empirical examinations of supply network based on the embeddedness approach makes this study a valuable and useful contribution to the literature on related topics.

In the following section, the researcher discusses future research opportunities derived from the outcomes and limitations of this study.
8.6 FUTURE RESEARCH

In this section, the researcher discusses other research opportunities for interested researchers following the outcomes of this research.

First of all, it is believed that another round of data collection on the APMMHQ-1 supply network will provide the ability to evaluate the impact of firms’ embeddedness over time. An application of the event study methodology may be suitable for such assessment. Even though this study has confirmed and ascertained the relationship between firm embeddedness and relational capital in the context of centralized upstream supply network, such as conclusions are limited by the evaluation of the relations in one point in time only. The researcher suggests that an evaluation that includes the context of growth of relations (that is, data collection that is spread between two periods of time) be conducted to analyses the effects of growth of relations upon relational capital outcomes. This is because networks, as a source of constant interaction between firms over the years, may have improved conditions and legitimized the ties in the supply network. For example, Human and Provan (2000) found that networks ultimately legitimized previously uncertified forms, entities and interactions as the networks grow and evolve over time. Based on this, the researcher proposes to other interested researchers to study when the network ties between different entities in the supply network become legitimized, as well as the drivers or factors. This may subsequently allow the firms in the supply network to work more efficiently and effectively to sustain the network stock of relational capital. Thus, more empirical work on the evolution of the supply network is required.

Second, the researcher proposes that the framework of this study be investigated in other fields. The ship building industry context of the upstream supply chain, upon which this study has conducted an investigation, may characteristically differ from another industry and fields. As such, the researcher proposes that the design of this research be tested in the context of other industries or
fields. The framework of this study can be tested in other industries, for example, to a more dynamic, fast cycle industry such as the electronics industry. The degree of uncertainty and required rate of innovation in the electronics industry may influence the pattern of strategic behaviour of embedded organizations and appropriate network configurations. Firms embedded in a rapidly changing network may achieve a competitive advantage through different forms of network embeddedness. This can result from firms in a lasting environment, such as the shipping industry (Rowley, Behrens and Krackhardt, 2000). In a volatile, rapidly-changing environment, the level of uncertainty will also be higher compared to that of a more stable industry. With this increased volatility and uncertainty, organizations are expected to take decisions that are based less on economic parameters but more on relationships and the resources at hand. Hence, ascertaining whether the findings of this study would also hold in a different industry would be an interesting undertaking and would add to the generalizability of this study.

Because this study tested and confirmed that networks are heterogeneous, this, inadvertently, opens a new area of future research opportunity. What this study suggests is a network analysis that collapses two or more networks together and analyses the impact on firm performance. Technically, network analysis refers to this type of network as the bipartite or the tripartite network that has two or three relations in one network respectively. Firms’ level of embeddedness or involvement in the bipartite or tripartite network can provide a more comprehensive analysis of the implications. For the interested researcher, this study proposes the newly developed XPNet program for ERGM analysis that is capable of conducting analysis upon bipartite and tripartite network structures.

Further, it would also be valuable to view the dynamic of firms’ relationships; for instance, to see how firms’ relationships are linked to one another through time as industries, technology and other factors evolve. Because inter-organizational relationships are dynamic rather than static, the nature and form are expected to change over time. The ability to see which conditions would result
in different outcomes would provide significant implications for the management of the firms’ relationships and inter-organizational relationships in general as well as to the general theory of embeddedness in explaining the implications of firm embeddedness and relational capital outcomes.

8.7 CONCLUDING REMARKS

This study, in essence, revolved around the development of firm embeddedness in the centralized upstream supply network context. Embeddedness is a popular topic in the sociology and organization's discipline. It has stimulated a tremendous volume of empirical research and captured the imagination of many scholars and managers. One plausible reason for the adoption of the network embeddedness to this study is that it appears to parsimoniously provide a different perspective for describing complex organization forms and for explaining outcomes. Perhaps the greatest advantage offered by the embeddedness theories is that they allow the researcher to move beyond the linear perspective of the supply network.

Chapters one, two and three of this study discuss the fact that embeddedness has become an important part of today’s complex supply network. The researcher defined two research questions and a number of hypotheses to explain the need to capture the essence of embeddedness in the supply network structure. Based on the analysis of the exploratory network analysis and the statistical network modeling, the analysis and discussion chapter conclusively addressed these research questions and hypotheses.

Regarding the first research question, this study found that firms’ embeddedness in the supply network differs depending on the type of ties or firms’ relationships. Firms tend to be more embedded in informal social networks rather than in a formal firm's relationship network. A network may be compared to a pool of potential resources or benefits. The ability to understand and access these resources is an effective source of competitive advantage. By examining the pattern of organizational network interactions and the resulting embeddedness in the supply
network structure, this study shows that firms’ organizations that are embedded in the centralized upstream supply network structure experience increased relational capital outcomes. Thus, a firm’s network position should not be discounted as a source of competitive advantage.

The discussions of the impact of embeddedness form the core of this research. One of our theoretical elaborations is the distinction between the dimensions of “bad” complexity and “good” complexity of the supply network. This study found that certain embeddedness positions in the supply network influences the level of trust and influence of the embedded firms.

The methodological implications of this lie in the unique data analysis technique adopted. This study utilized the rare analysis from the sociology field, i.e. the social network analysis, to analyse the network data obtained from the respondents. Using this technique, the researcher could apply exploratory network analysis and statistical network modeling to aptly analyse the network data.

This study also offers some suggestions for future research based on the limitations and strengths of this study. From this study, it is evident that network embeddedness has the potential of shaping the nature of competition. In particular, the results of this study show the dominant effects of degree centrality on trust and influence. These findings on degree centrality suggest that firms’ organizations that keep high, direct connections with other firms’ organizations in the supply network are more likely to be perceived as trustworthy and influential. Indeed, it is not enough of simply possess many direct ties in the supply network in order to have high social capital resources of trust and influence. It may require other factors, such as human intellect, financial resources, and absorptive capacity. However, from this study, it may be proposed that being highly connected and interacting with many other firms organizations in the supply network can increase access to information and knowledge and in turn, enhance its capability. Therefore, having a large number of ties is important for social capital resource's attainment.
In addition, this study has also presented a view of the supply network as a social system and has pointed out that network embeddedness plays a prominent role. Our results suggest that embeddedness impact upon the organizational level of social capital. This implies that the supply management function can, to some extent, shape the supply network structure around particular organizations. More research is needed to determine the extent, to which embeddedness of an organization can control, or more likely influence, the development of networks and how much leverage the supply network has in this process. The results also suggest that supply network embeddedness may have much to contribute towards strategy development. Supply network embeddedness cannot only support strategy, but may also be able to influence it by bringing social capital resources to the strategy process. However, because social capital is based on closeness of relationships, any actions toward change may disrupt the network’s social fabric.

In conclusion, by considering the overall implications of our study, we may conclude that complexity is not all bad. Managers need to consider their firm’s existing embeddedness in order to exploit the competitive advantage of supply network inter-organizational relationships. Firms that fail to understand the underpinnings of these relationships stand to face more difficulties within the network itself. For this reason, managers that intend to obtain competitive advantages from the network must engage with other partners more effectively. No doubt, some firms are at an adequate standing, while others are struggling in some areas. The framework of this study can be applied by managers who are committed to engaging other network members.
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APPENDIX A
DATA ANALYSIS
## APPENDIX A1: SAMPLE CONTRACT-TIE NODE DATA WORKSHEET

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APPENDIX B
DATA COLLECTION AND SUBJECT SOLICITATION INSTRUMENTS
In the next few days, you will receive a package containing a letter and a questionnaire for an important research study. The survey is conducted under the auspices of the Royal Melbourne Institute of Technology (RMIT) University, Melbourne Australia. In summary, this study focused on the organization and management factors that may affect the performance of the logistics of the organization.

This letter is being forwarded to the host in advance as early notification since, according to many studies, participants are more comfortable being informed a request for their participation before receiving any survey forms. This research is important because it is envisaged that it will help the organization to better understand the management of supply chain and logistics activities.

Thank you for your time and your cooperation. Only with your generous assistance and cooperation will this research be successful.

Sincerely,

Lokhman Hakim Osman

PhD student
APPENDIX B2: INVITATION LETTER IN ENGLISH

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

PROJECT INFORMATION STATEMENT

Plain language Statement of Network Survey

PROJECT TITLE: INVESTIGATING THE IMPACT OF FIRM EMBEDDEDNESS IN A COMPLEX UPSTREAM SUPPLY NETWORK

Investigators:

Mr. Lokhman Hakim Osman
(PhD degree student, s3264084@rmit.edu.au, 03 99255937),

Dr Konrad Peszynski
(Project supervisor: RMIT University, konrad.peszynski@rmit.edu.au, 03 9925 1654)

Dr Siddhi Pittayachawan
(Project supervisor: RMIT University, siddhi.pittayachawan@rmit.edu.au 03 9925 5850)

School of Business IT and Logistics (BITL)
RMIT University
Level 17, Building 108
239 Bourke Street
Melbourne VIC 3000
AUSTRALIA
Dear Participant,

You are invited to participate in a PhD research project being conducted by RMIT University. This survey will take approximately 20 to 40 minutes to complete. This letter is to provide you with an overview of the proposed research. Please read these pages carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators identified above.

Who is involved in this research project?

My name is Lokhman Hakim Osman. I am currently a research student in the School of Business IT and Logistics at the RMIT University. This project is being conducted as a part of my PhD degree. My principal supervisor for this project is Dr Konrad Peszynski. The project has been approved by the RMIT Business College Human Ethics Advisory Network. You have been selected to participate in this research as your firm is one of the materials and part suppliers of APMMHQ-1 logistics network for the product RHIB. The higher authority of the APMMHQ-1 has given permission for this survey to be conducted.

Why is it being conducted?

The aim of the research project is to evaluate how the structural position of organizations in a complex supply network influences the organizational relational capital outcomes. You, as the supply chain and logistics manager, are invited to be a participant in this research to provide feedback on the impact of the organizational structural position and the organizational relational capital outcomes respectively.

Why have you been approached?

You have been approached because you are the supply chain and logistics officer of this organization, which is responsible for the logistics activities of the organization. Your participation is important for this study. You are part of a supply network for the product RHIB and can thus best comment on how your participation in the APMMHQ-1 supply network impacts upon the performance of the organization.
If you agree to participate, what do you need to do?

If you agree to participate in this project, you are asked to complete a survey which will take approximately 20 to 40 minutes. This survey will ask you about your firm (number of personnel, address, age of your unit), and the relationship pattern you have with the rest of the firms in the APMMHQ-1 supply network for the product RHIB. Participation in this study is entirely voluntary and responses will remain confidential and anonymous. You may withdraw your participation and any unprocessed data concerning you at any time, without prejudice.

What are the benefits associated with participation?

There is no direct benefit to the participants as a result of their participation. However, I will be delighted to provide you with a copy of the research report in the form of an executive summary upon request as soon as it is available.

What are the risks associated with participation?

There are no perceived risks associated with participation outside the participants’ normal day-to-day activities. The participants in this research are assured of confidentiality. Your responses will contribute to understanding the impact of firm embeddedness on relational capital outcomes using the perspective of social network analysis.

Your privacy and confidentiality will be strictly maintained in such a manner that you will not be identified in the research report or any publication. Any information that you provide can be disclosed only if: (1) it is to protect you or others from harm, (2) a court order is produced or (3) you provide the researchers with written permission.

I assure you that responses will remain confidential and anonymous.

If you are unduly concerned about your responses or if you find participation in the project distressing in any way, you should contact my supervisor as soon as convenient. My supervisor will discuss your concerns with you confidentially and suggest appropriate follow-up, if necessary.

Security of the data
To ensure that data collected is protected, the data will be retained for five years upon completion of the project, after which time paper records will be shredded and placed in a security recycle bin and electronic data will be deleted/destroyed in a secure manner. All hard data will be kept in a locked filing cabinet and soft data in a password-protected computer in the office of the investigator in the research lab at RMIT University. Data will be saved on the University network system where practicable (as the system provides a high level of manageable security and data integrity, can provide secure remote access and is backed up on a regular basis). Only the researcher will have security access to the data. Data will be kept securely at RMIT University for a period of five years before being destroyed.

What are your rights as a participant?

You have the right to withdraw participation at any time, without prejudice. You have the right to have any unprocessed data withdrawn and destroyed, provided it can be reliably identified and it does not increase risk for the participant. Participants also have the right to have any questions, in relation to the project and their participation, answered at any time.

If you have any queries regarding this project please contact me at phone +61 399255937 (Australia)/6092462329(Malaysia) or email me at s3264084@rmit.edu.au. You may also contact my principal supervisor Dr Konrad Peszynski, RMIT University, phone +61 3 99251654, konrad.peszynski@rmit.edu.au

Thank you very much for your contribution to this research.

Yours faithfully,

Lokhman Hakim Osman

PhD Candidate

School of Business IT and Logistics

P.S. If by some chance we have made a mistake and you are neither directly involved in nor able to observe logistics management activities, please return this blank questionnaire. Thanks a lot!
APPENDIX B3: CONSENT FORM

RMIT HUMAN RESEARCH ETHICS COMMITTEE

Prescribed Consent Form for Persons Participating In Research Projects Involving Interviews, Questionnaires, Focus Groups or Disclosure of Personal Information

PORTFOLIO OF
Business, Information Technology and Logistics

SCHOOL/CENTRE OF

Name of Participant:

INVESTIGATING THE IMPACT OF FIRM EMBEDDEDNESS IN A COMPLEX UPSTREAM SUPPLY NETWORK

Name(s) of Investigators:
(1) Lokhman Hakim Osman Phone: 61(03)992 55937
(2) Dr. Konrad Peszynski Phone: 61(03) 992 51654
(3) Dr Siddhi Pittayachawan Phone: 61(03) 9925 5850

1. I have received a statement explaining the interview/questionnaire involved in this project.
2. I consent to participate in the above project, the particulars of which - including details of the interviews or questionnaires - have been explained to me.
3. I authorise the investigator or his or her assistant to interview me or administer a questionnaire.
4. I give my permission to be audio taped: ☐ Yes ☐ No
5. I give my permission for my name or identity to be used: ☐ Yes ☐ No
6. I acknowledge that:

(a) Having read the Plain Language Statement, I agree to the general purpose, methods and demands of the study.
(b) I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied.

(c) The project is for the purpose of research and/or teaching. It may not be of direct benefit to me.

(d) The privacy of the information I provide will be safeguarded. However should information of a private nature need to be disclosed for moral, clinical or legal reasons, I will be given an opportunity to negotiate the terms of this disclosure.

If I participate in a focus group I understand that whilst all participants will be asked to keep the conversation confidential, the researcher cannot guarantee that other participants will do this.

(e) The security of the research data is assured during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be provided to Lokhman Hakim Osman. Any information which may be used to identify me will not be used unless I have given my permission (see point 5).

Participant’s Consent

Name: ___________________________ Date: ________________

(Participant)

Name: ___________________________ Date: ________________

(Witness to signature)

Where participant is under 18 years of age:

I consent to the participation of ___________________________ in the above project.

Signature: (1) __________________________ (2) __________________________ Date: ________________

(Signatures of parents or guardians)
Any complaints about your participation in this project may be directed to the Executive Officer, RMIT Human Research Ethics Committee, Research & Innovation, RMIT, GPO Box 2476V, Melbourne, VIC 3001. Details of the complaints procedure are available at:
http://www.rmit.edu.au/rd/hrec_complaints
APPENDIX B4: FIRST REMINDER IN ENGLISH

Dear Mr. ........,

A week ago, you received a questionnaire concerning your opinion of supply chain and logistics management in the APMMHQ-1. I would like to thank you for taking the time to complete the survey. However, if you have yet to complete the form, I wish to request your help to spend some time filling in the form. I appreciate the heavy workload that you have, but your response will determine the success of this research. If by chance, you are not the appropriate authority to answer the survey, please extend this form to those concerned. Or, if you have not received a survey form, please contact me at or email s3264084@rmit.edu.au. A new package of the survey will be sent to you today.

Thank you again for your participation.

Sincerely

Lokhman Hakim Osman

PhD Student

P.S. If you have any questions, please feel free to contact me at phone
Dear Mr ……….,

About three weeks ago, I sent a questionnaire to you asking for your opinions of the state of supply chain and logistics in the APMMHQ-1 supply network. To date, we have not received it. The comments of people who have already responded revealed a wide variety of management issues in regard to the interaction in the APMMHQ-1 supply network. Many have described their opinions, both positive and negative, of the current state of supply chain and logistics in their organizations. We think the results are going to be very useful to decision-makers in organizations. We are writing again because of the importance that your questionnaire will have for helping to obtain accurate results. Although we sent questionnaires to the respective heads of units throughout the APMMHQ-1 supply network, it is only by hearing from everyone in the sample that our results are truly representative.

We hope you will return the questionnaire soon.

Sincerely,

Lokhman Hakim Osman
PhD Student

P.S. If you have any questions, please feel free to contact me at phone
Dear Mr………,

During the last two months, we have sent you several mailings about an important research study we are conducting on the APMMHQ-1 supply network. Its purpose is to help organizations understand what organizational and managerial factors they can use in order to improve the APMMHQ-1 supply network. The study is drawing to a close, and this is the last contact that will be made with the managers whose positions are closely related to the issues. We are sending this final contact by priority mail because of our concern that people who have not responded may have had different experiences than those who have. Hearing from everyone in the APMMHQ-1 supply network helps to ensure that the survey results are as accurate as possible. This would be very helpful. Finally, we appreciate your willingness to consider our request as we conclude this effort to better understand information systems security. Thank you very much.

Sincerely,

Lokhman Hakim Osman
PhD Student

P.S. If you have any questions, please feel free to contact me at phone
Tarikh: 2011

Salam Sejahtera

Dalam beberapa hari lagi, pihak tuan akan menerima bungkusan yang mengandungi surat dan soal selidik untuk satu kajian penyelidikan yang penting. Kaji selidik ini adalah di bawah kelolaan Royal Melbourne Institute of Technology (RMIT) University, Melbourne Australia. Secara ringkas, kaji selidik ini menjurus kepada faktor – faktor organisasi dan pengurusan yang mungkin memberi kesan kepada prestasi logistik sesebuah organisasi.

Surat ini dimajukan kepada pihak tuan terlebih dahulu sebagai pemberitahuan awal kerana mengikut kajian ramai peserta kaji selidik lebih selesa dimaklumkan terlebih dahulu akan penglibatan mereka sebelum menerima sebarang borang kaji selidik. Penyelidikan ini adalah amat penting kerana ia akan dapat membantu organisasi lebih memahami perkara – perkara yang kritikal terhadap pengurusan logistik dan cara – cara untuk memperbaiki pengurusan sedia ada.

Terima kasih atas masa dan kerjasama tuan. Hanya dengan bantuan murah hati dan kerjasama orang-orang seperti tuan penyelidikan ini akan boleh berjaya.

Ikhlas,

Lokhman Hakim Osman

Penuntut PhD
APPENDIX B8: INVITATION LETTER IN MALAY

JEMPUTAN UNTUK MENYERTAI PROJEK PENYELIDIKAN

PENYATA MAKLUMAT PROJEK

Penyata Kaji Selidik Jaringan

TAJUK: KAJIAN IMPAK INTERAKSI SOSIAL DALAM RANTAIAN BEKALAN (LOGISTIK) OLEH ROYAL MELBOURNE INSTITUTE OF TECHNOLOGY (RMIT) UNIVERSITY DAN UNIVERSITI KEBANGSAAN MALAYSIA (UKM)

Penyelidik:

Lokhman Hakim Osman
(Calon PhD, University RMIT, s3264084@rmit.edu.au, 019 9287039),

Dr Konrad Peszynski
(Penyelia 1: Universiti RMIT, konrad.peszynski@rmit.edu.au, 603 9925 1654)

Dr Siddhi Pittayachawan
(Penyelia 2: Universiti RMIT, siddhi.pittayachawan@rmit.edu.au 603 9925 5850)

Pusat Pengajian Perniagaan, Teknologi Maklumat dan Logistik
RMIT University
Level 17, Building 108
Assaalamualikum dan Salam Sejahtera,


Siapa yang terlibat dalam projek penyelidikan ini


Tujuan kajian ini dijalankan

Matlamat penyelidikan ini adalah untuk menilai bagaimana kedudukan struktur organizasi dalam rantaian bekalan yang kompleks memberi impak kepada prestasi sosial organisasi. Tuan/Puan sebagai pegawai yang terlibat dalam pengurusan logistik yang berkaitan pembekalan alat ganti dan peralatan kapal adalah terpilih untuk menjadi peserta penyelidikan ini untuk memberi maklum balas mengenai impak kedudukan organisasi dalam rantaian bekalan ke atas prestasi sosial organisasi.

Kenapa Tuan/Puan dipilih untuk penyelidikan ini
Tuan/Puan adalah dipilih kerana Tuan/Puan dipertanggungjawabkan ke atas urusan urusan logistik organisasi ini yang berkaitan pembekalan alat ganti dan peralatan kapal. Penyertaan Tuan/Puan adalah penting untuk kajian ini. Sebagai orang yang bertanggungjawab terhadap aktiviti – aktiviti logistik organisasi, Tuan/Puan adalah calon terbaik untuk mengulas mengenai bagaimana kedudukan struktur organisasi Tuan/Puan dalam rantai bekalan APMM memberi impak kepada presatasi sosial organisasi Tuan/Puan.

Jika anda mempunyai sebarang pertanyaan mengenai projek ini, sila hubungi saya di talian 019 9287039 (Malaysia) atau email di alamat s3264084@rmit.edu.au atau hubungi terus penyelia saya Dr. Konrad Peszynski (61399251654) atau email konrad.peszyzki@rmit.edu.au.

Terima kasih di atas penyertaan anda.

Yang benar,

LOKHMAN HAKIM OSMAN

Pensyarah/Penyelidik RMIT
Pusat Perniagaan, Teknologi Maklumat dan Logistik, RMIT Universiti
APPENDIX B9: SURVEY INSTRUMENT IN ENGLISH

SURVEY

Name: _______________________
Organization: _______________________
Address: _______________________
Years of Operation: _______________________
What is your position/job title: _______________________

General Information

To start, please indicate the size of your firm according to the following categories. It is fine to provide an estimate if the exact figures are not available.

1. Please provide the number of employees working in your firm? If you do not know the exact number please provide the estimate.

Answer: ______________

2. Approximately how many hours are spent on logistics services or task (with regards to the supply of ships’ spares) on a typical day in your firm?

Answer: ______________
3. How many different end users do you provide services for with regard to the supply of ships’ spares and parts?

Answer: _____________

4. Overall, how important would you say are the logistics services or tasks (with regard to the supply of ships’ spares and parts) to the overall mission of your firm? Please use a scale ranging from 1 = very little importance to 7 = great importance.

Importance: _______ (rate 1 to 7)

Part 2: Links to firms in the (APMMHQ-1) supply network.

5. Listed below is a list of all firms (including your firm) in the APMMHQ-1 upstream supply network that are involved in the provision of materials and services for the production of Rigid Hull Inflatable Boat (RHIB). Although these firms are located in different regions and localities, they also serve and provide services to many other firms in the APMMHQ-1 supply network. We would like to know what links or ties your firm maintains with the other firms on the list.

We have listed four types of involvement your firm might have with other firms in the APMMHQ-1 upstream supply network for the product RHIB. These include links through formal service contracts with other firms, through exchange of information only or through referrals (both sent and received, but no formal contract). Referrals would include any routine sending and/or receiving of materials or services from one firm to another. However, please focus only on a referral activity that occurs with some regularity between your firm and the firms listed in the list. Referrals can be part of a joint program or a simple exchange of services, tasks or parts.

Please go through the list and indicate (with a √) which of the firms you have been involved with over the past six months or so for each of the types of relationships listed. If you had no involvement with a firm, please leave the space blank. An example of answering the question is given below.

Matrix
### Types of Links/Ties - past 6 months

(Check The Box If You Had This Link)

<table>
<thead>
<tr>
<th>FIRM</th>
<th>Service contracts</th>
<th>Shared Information</th>
<th>Referral sent</th>
<th>Referral received</th>
<th>Relationship Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Region</td>
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<tr>
<td>APMMHQ1</td>
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<td>✓</td>
<td></td>
<td>✓</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>MTUPJAYA2</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>1 2 3 4</td>
</tr>
</tbody>
</table>

6. Next, in the last column, we would like you to evaluate the *overall quality* of your firm’s working relationship with this other firm. Please circle the number that best reflects the relationship quality using the following scale:

1 = poor relationship  2 = fair relationship  3 = good relationship  4 = excellent relationship

Again, if you have no relationship with the firm, simply leave the cell blank. At the end, please indicate any firm that we may have missed and specify the type of links or ties you had with them. An example of answering the question is given below.

The following list of firms has been arranged according to their locality for your convenience.

### Matrix of inter-firms relations between firms

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<tr>
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<th>Service contracts</th>
<th>Shared Information</th>
<th>Referral sent</th>
<th>Referral received</th>
<th>Relationship Quality</th>
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</thead>
<tbody>
<tr>
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<tr>
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<td>✓</td>
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<td>1 2 3 4</td>
</tr>
</tbody>
</table>

The following list of firms has been arranged according to their locality for your convenience.
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<th>(Please circle)</th>
<th>Relationship Quality</th>
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<td>(Check The Box If You Had This Link)</td>
<td>1 = poor, 2 = fair, 3 = good, 4 = excellent</td>
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7. Now, please refer back to the answers that you have given for the question in section 3 (a), and indicate in each column which link/tie has been most critical to your firm. To do this simply circle the check marks you made for those links/ties that you believe are especially important. Please circle no more than five (5) check marks for each type of link/tie (i.e. the five (5) most important contracts, the five (5) most important information-sharing ties, the five (5) most important referrals sent and received).

8. Between October 2009 and September 2010, on average, how often did you have contact with the following firm with regard to the provision of materials and services for the production of RHIB? Contact can be via meetings, phone calls or emails.

**Instruction:** For frequency of contact questions, please check (✓) in the given space.

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| Sarawak Region        |                     |                     |                     |                     |
| WILSAR25              |                     |                     |                     |                     |
| DMKCHNG26             |                     |                     |                     |                     |
| DMBTULU27             |                     |                     |                     |                     |
| DMMIRI28              |                     |                     |                     |                     |
| PMTMANIS29            |                     |                     |                     |                     |
| MTUKCHG30             |                     |                     |                     |                     |

| Sabah Region          |                     |                     |                     |                     |
| WILSAB31              |                     |                     |                     |                     |
| DMLBUAN32             |                     |                     |                     |                     |
| DMKBALU33             |                     |                     |                     |                     |
| DMSDAKAN34            |                     |                     |                     |                     |
| DMTAWAU35             |                     |                     |                     |                     |
| PMLDATU36             |                     |                     |                     |                     |
| MTUKBALU37            |                     |                     |                     |                     |
9. The following is a list of potential reasons why your firm might normally choose to be involved with other firms for logistics services and tasks (with regard to the supply of ship’s spares). Please go through the list and rate each one as to the importance of the reason. **Circle** the number that corresponds most to your reason for using the following scale.

1 = almost never the reason  
2 = seldom the reason  
3 = sometimes the reason  
4 = often the reason  
5 = almost always the reason for involvement

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<th>Item</th>
<th>Reasons</th>
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<td>b</td>
<td>Reputation of the organization/unit</td>
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<td>c</td>
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<td>1 2 3 4 5</td>
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<td>Similar beliefs and method of services</td>
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<td>Location</td>
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<td>Service need</td>
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<td>j</td>
<td>To improve efficiency</td>
<td>1 2 3 4 5</td>
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<td>k</td>
<td>Other:</td>
<td>1 2 3 4 5</td>
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<tr>
<td>l</td>
<td>Other:</td>
<td>1 2 3 4 5</td>
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</table>
10. Because a firm is involved with other firms one way or another, consideration must be given to these other firms when making their decisions. Name up to five (5) other firms within the APMMHQ-1 supply network whose decisions, goals, needs and/or expectations are generally taken into consideration when your firm makes a major decision related to the logistics services and tasks (with regards to the supply of ship’s spares). If you feel your firm’s decision-making is influenced by fewer than 5 other organizations/units, please list only these firms.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

11. In dealing with logistics services and tasks (with regard to the supply of ship’s spares) which firms in the logistics network of the APMMHQ-1 have the same professional norms, value and method that are most similar to yours? These are firms that may have staff with similar training to yours, similar logistics management philosophies, etc. Please list up to five (5) other firms. Please refer to the list in question 9 to assist you with answering this question. If you feel your firm’s decision-making is influenced by fewer than 5 other firms, please list only these firms.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

12. In dealing with logistics services and tasks (with regard to the supply of ship’s spares), which firms in the logistics network of the APMMHQ-1 do you believe have the capacity to fulfil the promises made? Please list up to five (5) firms. Please refer to the list of 9 questions to help you answer this question. If you feel that there are less than 5 firms, please list only the relevant firms.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________
13. Next, we would like to know which firms other than your own you **most admire** for conducting especially good logistics services and tasks (with regard to the supply of ship’s spares). Again, please list five (5) firms. If you feel your firm’s decision-making is influenced by fewer than five (5) other firms, list only those firms.

a. ______________________
b. ______________________
c. ______________________
d. ______________________
e. ______________________

14. We would now like to obtain some information about how the system/network for provision of materials and services (with regard to the supply of ship’s spares and parts) in the logistics network of the APMMHQ-1 is managed and governed.

a. Do you or any of your staff or members of your firm participate in regular meetings with the APMMHQ-1 with regard to the provisions of spares and services?
   _____ Yes   _____ No

b. If you answered YES, how often is this meeting held?
   ______ times/month

c. Please list or describe other mechanisms that have been used by the APMMHQ-1 Logistics Department to manage and coordinate the supply of spares and parts for the fleet in the APMMHQ-1 supply network?
   ___________________________________________________________
   ___________________________________________________________
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-END-
APPENDIX B10: SURVEY INSTRUMENT IN MALAY

Kajian Impak Interaksi Sosial Dalam Rantaian Bekalan

BORANG KAJI SELIDIK

Nama dan Pangkat:____________________________________________
Jawatan:____________________________________________________
Organisasi/Unit Anda:________________________________________
Alamat Organisasi/Unit:_______________________________________
Bilangan Tahun Beroperasi Organisasi Anda:____________________

Bahagian 1: Maklumat Umum

Sebagai permulaan, sila nyatakan saiz organisasi/unit anda mengikut kategori berikut. Sila berikan anggaran jika tiada maklumat tepat.

1. Berapakah bilangan staf dalam organisasi/unit anda?
   Jawapan:____________________

2. Kira-kira berapa jamkah yang diperuntukkan pada hari biasa untuk perkhidmatan atau tugas logistik (dari segi pembekalan alat ganti kapal dan peralatan – peralatan lain) dalam organisasi anda?
   Jawapan:____________________

3. Berapa ramaikah pengguna yang mendapatkan perkhidmatan berkaitan pembekalan alat ganti dan peralatan kapal daripada anda?

389
Jawapan:____________________

4. Pada pendapat anda, setakat manakah pentingnya perkhidmatan atau tugas logistik (berkaitan pembekalan alat ganti dan peralatan kapal) terhadap keseluruhan misi organisasi/unit anda? Sila gunakan skala dari 1= tidak begitu penting hingga 7=amat penting.
Kepentingan: ________ (skala dari 1 hingga 7)

Bahagian 2 : Hubungan dengan organisasi logistik dalam rangkaian bekalan Agensi Penguatkuasaan Maritim Malaysia (APMM).

**Soalan 5 dan 6 untuk Bahagian 2 adalah berkaitan. Sila rujuk semula jawapan yang anda berikan di dalam matriks untuk soalan 5 bagi menjawab soalan 6.**

5. Berikut ialah senarai semua organisasi/unit dalam rangkaian bekalan APMM yang dipercayai terlibat dalam penyediaan perkhidmatan dan tugas logistik (berkaitan pembekalan alat ganti dan peralatan lain kapal). Walaupun terletak di kawasan dan tempat yang berlainan, organisasi/unit ini juga menyediakan perkhidmatan kepada banyak organisasi/unit lain dalam rangkaian bekalan APMM. Kami ingin tahu apa kaitan atau hubungan organisasi/unit anda dengan organisasi/unit lain dalam senarai ini ketika memberikan perkhidmatan dan melakukan tugas logistik (berkaitan pembekalan alat ganti dan bahagian kapal). Organisasi lain ini mungkin berada di dalam wilayah anda atau di luar wilayah anda.

Kami menyenaraikan empat penglibatan yang mungkin wujud antara organisasi/unit anda dengan organisasi/unit lain dalam menjalankan urusan perkhidmatan dan tugas logistik (berkaitan pembekalan alat ganti dan bahagian kapal). Ini termasuk 1) hubungan melalui kontrak perkhidmatan formal dengan organisasi/unit lain, 2) melalui pertukaran maklumat sahaja atau 3) melalui rujukan penghantaran dan juga 4) penerimaan rujukan tetapi tiada kontrak formal. Rujukan boleh merangkumi mana-mana penghantaran dan/atau penerimaan rutin bahan atau perkhidmatan dari satu organisasi/unit ke organisasi/unit yang lain. Namun demikian, sila tumpukan perhatian hanya kepada aktiviti rujukan yang berlaku agak kerap antara organisasi/unit anda dan organisasi/unit yang disenaraikan. Rujukan juga boleh jadi sebahagian daripada program bersama ataupun pertukaran mudah untuk perkhidmatan, tugas atau bahagian.

Sila teliti senarai dan nyatakan (dengan tanda semak ✓) organisasi/unit yang pernah berurusan dengan organisasi/unit anda dalam menyediakan perkhidmatan dan dalam tugas logistik sepanjang tempoh enam bulan yang lalu atau lebih untuk setiap jenis hubungan yang disenaraikan. Jika organisasi/unit anda tidak mempunyai sebarang penglibatan dengan mana-mana organisasi/unit berkaitan penyediaan perkhidmatan atau tugas logistik, sila kosongkan ruang tersebut. **Contoh kaedah menjawab bahagian ini adalah seperti di bawah.**
Di lajur terakhir matriks adalah seksyen yang bertajuk **Kualiti Hubungan. Lajur ini menilai kualiti hubungan** antara organisasi dalam rantai bekalan APMM. Kami ingin anda membuat penilaian tentang **kualiti keseluruhan** hubungan kerja organisasi/unit anda dengan organisasi/unit lain. Berpandukan skala berikut, sila bulatkan nombor yang paling tepat menggambarkan kualiti hubungan tersebut:

1 = hubungan yang lemah  
2 = hubungan yang agak baik  
3 = hubungan yang baik  
4 = hubungan yang sangat baik

Jika organisasi/unit anda tidak mempunyai sebarang hubungan dengan agensi penyediaan perkhidmatan atau tugas logistik (**berkaitan pembekalan alat ganti kapal**), kosongkan ruang tersebut. Di baris terakhir, sila nyatakan mana-mana organisasi/unit yang tidak ada dalam senarai dan nyatakan kaitan atau hubungan anda dengan organisasi/unit tersebut. **Contoh kaedah menjawab bahagian ini adalah seperti di bawah.**

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(Sila teliti dan nyatakan dengan tanda semak ✓)

Kualiti Hubungan
1 = Lemah, 2 = Agak Baik, 3 = Baik, 4 = Sangat Baik
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<th>Code</th>
<th>Sub-Region</th>
<th>Code</th>
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<td>Sabah Region</td>
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</tbody>
</table>

7. Kesinambungan dari soalan 5, anda diminta untuk menyatakan kaitan/hubungan yang paling penting bagi organisasi/unit anda di dalam setiap kotak jalur hubungan yang untuk soalan 5. Untuk melakukannya, hanya bulatkan tanda semak bagi setiap kaitan/hubungan yang anda fikirkan sangat penting di jalur yang berkaitan. Sila bulatkan tidak lebih daripada lima (5) tanda semak bagi setiap jenis hubungan (iaitu lima (5) kontrak yang paling penting, lima (5) perkongsian maklumat yang paling penting, lima (5) rujukan yang dibuat dan lima (5) rujukan yang diterima. Contoh kaedah menjawab soalan ini adalah seperti di bawah.

| WILSAB31 |   |   |   | 1 2 3 4 |
| DMLBUAN32 |   |   |   | 1 2 3 4 |
| DMKBALU33 |   |   |   | 1 2 3 4 |
| DMSDAKAN34 |   |   |   | 1 2 3 4 |
| DMTAWAU35 |   |   |   | 1 2 3 4 |
| PMLDATU36 |   |   |   | 1 2 3 4 |
| MTUKBALU37 |   |   |   | 1 2 3 4 |
**Matriks**

<table>
<thead>
<tr>
<th>SENARAI ORGANISASI</th>
<th>Bentuk Komunikasi/Hubungan – tempoh 6 bulan yang lepas (Sila teliti dan nyatakan dengan tanda semak ✓)</th>
<th>Kualiti Hubungan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 = Lemah, 2 = Agak Baik, 3 = Baik, 4 = Sangat Baik</td>
</tr>
<tr>
<td>Wilayah Utara (WILUTA)</td>
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<td>(Sila Bulatkan)</td>
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<tr>
<td>Ibu Pejabat Logistik APMM Wilayah Utara</td>
<td>Kontrak Perkhidmatan ✓  Perkongsian Maklumat ✓  Rujukan yang dibuat ✓  Rujukan yang diterima ✓</td>
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<td>1 2 3 4</td>
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</table>

***Hanya bulatkan 5 sahaja tanda semak untuk setiap lajur jenis hubungan/komunikasi***
7. **Kekerapan Komunikasi:**

Antara Oktober 2009 and September 2010, pada puratanya, berapa kerapkah anda berkomunikasi dengan organisasi di bawah yang berkaitan dengan perolehan alatganti di dalam rantai bekalan APMM. Komunikasi boleh didalam bentuk email, panggilan telefon, mesyuarat atau mel elektronik. Sila tanda (√) di ruang yang disediakan.

<table>
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<tr>
<th>Organisasi/Unit</th>
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<th>Setahun Sekali</th>
<th>Setiap 6 bulan</th>
<th>Setiap 4 bulan</th>
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</table>
Bahagian 3. Maklumat Tambahan Berkaitan Komunikasi


1 = hampir tidak pernah menjadi penyebabnya
2 = jarang menjadi penyebabnya
3 = kadang kala menjadi penyebabnya
4 = kerap menjadi penyebabnya
5 = hampir selalu menjadi penyebabnya

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</tr>
<tr>
<td>b</td>
<td>Reputasi organisasi/unit</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>c</td>
<td>Tabiat dan tradisi</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>d</td>
<td>Kepercayaan dan kaedah perkhidmatan yang serupa</td>
<td>1  2  3  4  5</td>
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<td>e</td>
<td>Lokasi</td>
<td>1  2  3  4  5</td>
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<tr>
<td>f</td>
<td>Keperluan perkhidmatan oleh pengguna akhir</td>
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<td>g</td>
<td>Ditentukan oleh mandat</td>
<td>1  2  3  4  5</td>
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<td>h</td>
<td>Keperluan kontrak</td>
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<tr>
<td>i</td>
<td>Tekanan pihak luar</td>
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<td>j</td>
<td>Untuk meningkatkan kecekapan</td>
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<td>k</td>
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<tr>
<td>l</td>
<td>Lain-lain:</td>
<td>1  2  3  4  5</td>
</tr>
</tbody>
</table>

10. Memandangkan sebahagian organisasi/unit itu sedikit sebanyak pasti mempunyai kaitan dengan organisasi/unit lain, maka organisasi/unit itu perlu menimbangkan organisasi/unit lain semasa membuat keputusan. Sila senaraikan sehingga lima (5) organisasi/unit dalam rangkaian bekalan APMM yang biasanya keputusan, matlamat, keperluan dan/atau jangkaan mereka diambil kira apabila organisasi/unit anda membuat keputusan penting berkaitan perkhidmatan dan tugas logistik (berkaitan pembekalan alat...
ganti kapal). Jika anda merasakan keputusan yang dibuat oleh organisasi/unit anda dipengaruhi oleh kurang daripada 5 organisasi/unit lain, sila senaraikan organisasi/unit itu sahaja.

a. ____________________
b. ____________________
c. ____________________
d. ____________________
e. ____________________

11. Dalam urusan perkhidmatan dan tugas logistik (berkaitan pembekalan alat ganti kapal), organisasi/unit dalam rangkaian logistik APMM manakah yang mempunyai norma, nilai dan kaedah yang paling serupa dengan norma, nilai dan kaedah anda? Organisasi/unit ini mungkin mempunyai kakitangan yang menerima latihan dan mempunyai falsafah pengurusan logistik yang sama, dan sebagainya. Sila senaraikan sehingga lima (5) organisasi/unit lain. Sila rujuk senarai di soalan 9 untuk membantu anda menjawab soalan ini. Jika anda merasakan bahawa tindakan membuat keputusan oleh organisasi/unit anda dipengaruhi oleh kurang daripada 5 organisasi/unit lain, sila senaraikan organisasi/unit itu sahaja.

a. ____________________
b. ____________________
c. ____________________
d. ____________________
e. ____________________

12. Dalam urusan perkhidmatan dan tugas logistik (berkaitan pembekalan alat ganti kapal), organisasi/unit dalam rangkaian logistik APMM manakah yang diyakini berkeupayaan menunaikan janji yang di buat. Sila senaraikan sehingga lima (5) organisasi/unit lain. Sila rujuk senarai di soalan 9 untuk membantu anda menjawab soalan ini. Jika anda merasakan bahawa tindakan membuat keputusan oleh organisasi/unit anda dipengaruhi oleh kurang daripada 5 organisasi/unit lain, sila senaraikan organisasi/unit itu sahaja.

a. ____________________
b. ____________________
c. ____________________
d. ____________________
e. ____________________
13. Seterusnya, kami ingin tahu organisasi/unit lain yang paling anda kagumi kerana melakukan tugas yang sangat baik dalam menyediakan perkhidmatan dan melakukan tugas logistik (berkaitan pembekalan alat ganti kapal). Sekali lagi, sila senaraikan lima (5) organisasi/unit. Jika anda merasakan bahawa tindakan membuat keputusan oleh organisasi/unit anda dipengaruhi oleh kurang daripada 5 organisasi/unit lain, sila senaraikan organisasi/unit itu sahaja.

a. ______________________
b. ______________________
c. ______________________
d. ______________________
e. ______________________

14. Sekarang kami ingin mendapatkan maklumat tentang pengurusan dan pentadbiran sistem/ rangkaian penyediaan bahan dan perkhidmatan (berkaitan pembekalan alat ganti dan peralatan kapal) dalam rangkaian logistik APMM.

a. Adakah anda atau mana-mana kakitangan atau ahli organisasi/unit anda menyertai mesyuarat biasa dengan Bahagian Logistik APMM (Putrajaya) berkaitan penyediaan alat ganti dan perkhidmatan untuk angkatan laut?
   _____ Ya  _____ Tidak

b. Jika YA, berapa kerapkah mesyuarat ini diadakan?
   _____ kali/bulan

c. Sila senaraikan atau jelaskan mekanisma lain yang digunakan oleh Bahagian Logistik APMM bagi menguruskan dan menyelaraskan bekalan alat ganti dan bahagian untuk angkatan laut dalam rangkaian bekalan APMM.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

-TAMAT-
-SILA KEMBALIKAN BORANG INI MENGGUNAKAN SAMPUL YANG TELAH DISEDIKAN-