UNDERSTANDING ATTITUDES TOWARDS PERFORMANCE IN KNOWLEDGE-INTENSIVE WORK: THE INFLUENCE OF SOCIAL NETWORKS AND ICT USE

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Let no man deceive himself. If any man among you seemeth to be wise in this world, let him become a fool, that he may be wise. For the wisdom of this world is foolishness with God. For it is written, 'He taketh the wise in their own craftiness'. And again, 'The Lord knoweth the thoughts of the wise, that they are vain' Therefore, let no man glory in men. For all things are yours; Whether Paul, or Apollos, or Cephas, or the world, or life, or death, or things present, or things to come; all are yours; And ye are Christ's; and Christ is God's.

-- 1 Corinthians 3:18-23 --

Abstract

Understanding factors that enhance or diminish performance levels of individuals is instrumental for achieving individual (low level) and organisational (high level) goals. In this study, the effect of social network structure, position, ties and information and communication technologies (ICT) use on performance attitudes of knowledge-intensive workers in dispersed occupational communities is investigated.

Based on social network theories of strength of weak ties and structural holes, and the social influence model of technology use, a theoretical framework is developed. In conjunction with qualitative interviews conducted with subject matter experts, the framework is used to further develop and refine a valid and reliable survey instrument. Secondly, network measures of degree centrality, density, structural holes (constraint and efficiency), tie strength and tie diversity are applied for exploring the association with ICT use and performance from a sample of 110 rural general practitioners.

Empirical results suggest that network structure, position and ties of knowledge workers play a crucial role in individual performance and ICT use. In particular, degree centrality and task-level ICT use was found to be positively associated with performance while ego-network constraint was found to be negatively correlated with performance. In terms of ICT use, functional diversity and degree centrality were positively associated with task-level ICT use whereas ego-network efficiency was found to be negatively correlated with ICT use at the communication-structure level. Among the variables that showed significance, degree centrality best explained overall variance for performance, and functional diversity best explained overall variance for task-level ICT use, although professional accreditations remains a potent indicator also.

The results from this study resonate with findings from past literature and extend traditional theory of social networks and performance within the micro level to include geographically dispersed individuals involved in knowledge-intensive work. For individuals in such non-competitive settings, traditional network theories such as structural holes theory

still apply. However, a key finding is that network structure is a much more potent predictor of performance although network position is important. The second key finding addresses a major gap in the literature concerning understanding social processes that influence ICT use. As the technology acceptance and the social influence models lack empirical evidence from a social networks perspective, this research shows that rather than the strength of ties which functions as a conduit of novel ideas and information, it is the functional tie diversity within individual professionals networks that increase ICT use at the task-level.

Methodologically, the study contributes towards a triangulation approach that utilises both qualitative and quantitative methods for operationalising the study. The quantitative method includes a non-traditional "networks" method of data collection and analysis to serve as a fine complement to traditional research methods in behavioural studies. The outcome is a valid and reliable survey instrument that allows collection of both individual attribute and social network data. The instrument is theoretically driven, practically feasible to implement, time-efficient and easily replicable for other similar studies.

At the domain level, key findings from this study contradict previous literature which suggests that professionals in occupational communities such as general practitioners decline in performance as they age. In fact, findings from this study suggest that age and experience do not affect for performance; rather, there is a negative relationship between experience and task-level ICT use, and that task-level ICT use is positively associated with performance in terms of attitudes to interpersonal care. Furthermore, degree centrality is also positively associated with professional accreditations, such as fellowship of the Royal Australian College of General Practitioners, which is conducive to performance in terms of attitudes to interpersonal and technical care. The contextual implication from the quantitative and qualitative evidence of this study is that while contemplating strategies for optimising ICT use or for improving attitudes to quality of care at the technical and interpersonal level, the importance of social structure, position and relations in the practitioner's professional network needs to be considered carefully as part of the overall individual and organisation-level goals.

List of Abbreviations

Abbreviation	Meaning
ABS	Australian Bureau of Statistics
CME	Continuing Medical Education
ERD	Entity Relationship Diagram
FRACGP	Fellowship of the Royal Australian College of General Practitioners
FRACMM	Fellowship of the Australian College of Rural and Remote Medicine
GP	General Practitioner(s)
GSS	General Social Survey
ICT	Information and Communication Technology
IS	Information Systems
IT	Information Technology
RACGP	Royal Australian College of General Practitioners
RDA	Rural Doctors' Association
RDN	Rural Doctor's Network
SN	Social Network
SQL	Structured Query Language

Preface

When I left Telstra & Protocom Technologies to return to graduate studies, I applied to one place, University of Sydney, to work with one person, Associate Prof. Liaquat Hossain, who motivated me to pursue research on the effects of social networks on individual outcome. I am truly grateful to him for his scholarly guidance, generous funding support and for being a friend. Liaquat has a flair for research supervision, a born-natural in idea generation and conceptualisation that laid the foundation for this work. I thank Associate Prof. Joseph Davis for his constructive feedback on my research and support as an associate supervisor. I am deeply grateful to Dr. Sue Page, Prof. Tim Usherwood and Dr. Michael Kidd for their helpful directions during the early phases of my research. To Prof. John Robinson, thank you for your time and generosity in helping me with statistical data analyses. To Dr. Simon Poon and members at the school and the Knowledge Management Research Group, the intellectual stimulus and objectivity of your input during my PhD candidature have not only helped me fine-tune this thesis but have also humbled me, so much so that I say if this work be of value to anyone, in any way, I consider the goal of my PhD journey accomplished.

On a personal note, I thank my grandparents for believing in me, to my sister, Frida, for your undivided care during our undergraduate years in uni (and even now!), to my bro Richard for your moral support. Vix and Vivian, your gourmet food kept us alive many a time when Yury & I were at our busiest! Kudos to you! To mum and dad, your continued patience, unspoken sacrifices, unconditional love, thoughts and concern for me remain unsurpassed - I love you for it. This journey has been extremely long. I fail you in many ways, but you embrace me. You guys are truly the best! To my parents-in-law, thank you for accepting me as a son; to Danny & Denise for supporting me as a brother to this very day.

To my wife, Yury, whose love and companionship have sustained me thus far, thank you for walking the ups and downs of life with me and for instilling the sanity and very meaning of life in me. You are adept in what I am inept, thus completing me. I'm so proud of you. To Pastor Song and Sydney Grace Church members, thank you for your prayers and for leading me to the way of the Lord. I've always thought wisdom came from men, and not from God. I was wrong. This entire journey in academia has been of the Lord and through Him, my only forte, this accomplishment, amongst many others, has been possible. If there is one truth I have learnt throughout this journey, it is this one that remains closely hidden within my heart; one simple, yet profound...

So then it is not of him who wills, nor of him who runs, but of God who shows mercy.

-- Romans 9:16 --

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Chapter 1

This chapter provides the introduction, objectives and justification for the research study. It first introduces the importance of performance issues in knowledge-intensive work and establishes the point that understanding the factors that affect it is crucial for enhanced performance. The introduction section concludes with an appraisal of how existing models and frameworks have understood performance along with a discussion of its limitations. From this, a need for a novel framework for studying performance is justified. The chapter then provides a background to understanding performance through a sociological and technological perspective. The arguments that formulate the construction of a conceptual model are presented in logical order, followed by an introduction to the domain of the study. Research questions, objectives and significance of the study are presented towards the end.

1. Introduction

Performance of individuals in knowledge-intensive work in any form of organisation remains critical to the success of both individual-level and organisation-level goals. Understanding factors that enhance and diminish performance levels of individuals is therefore, a necessity for managing performance. Accordingly, a growing body of research in management and organisational psychology have proposed understanding performance by decomposing its constructs based on task-level and contextual-levels. Theories from Information Systems (IS) research, for example, suggest understanding individual performance by examining the 'task-technology' fit within organisational human resources. Others have suggested understanding performance by evaluating impacts of information technology on performance at different levels, namely at the task-productivity and communication-structure levels. These models however do not account for the importance of social processes that weave together a rich fabric of human or ICT-enabled social and professional relationships that contribute largely towards performance. To this end, an emergent discipline of social networks theory and research takes as its central premise the embeddedness (Granovetter, 1985, p. 1065) of individuals in social networks. The novelty of this stream of research lies in how it draws on

structural properties of individuals in a social network to explain outcomes such as individual performance. With the pervasive growth of information and communication technologies (ICT), social network studies now encompass computer supported cooperative networks, online communities and virtual teams in its realm of explaining social outcomes. Aligning with the social network perspective of perceiving individual outcomes as the consequence of network structure (Borgatti et. al., 2003), this thesis constructs a theoretical framework for understanding individual performance in knowledge-intensive work by exploring its interplay between social network structure and ICT use.

1.1 Background to the Study

1.1.1 Social Networks and Performance

Network effects on individuals' ability to perform better have been documented in studies on communications, sociology and social psychology (Leavitt, 1951; Guetzkow et. al., 1955; Coleman, 1988). Previous studies further demonstrate that actors with a dense social network perform better (Reagans et. al., 2003; Oh et. al., 2004). Furthermore, actors who are rich in structural holes (connections to social clusters or groups who are themselves not well connected) are better situated in their social network to obtain, control and broker information (Burt, 1992). In the field of medical innovation, SNA proved useful for understanding the diffusion of innovation among physicians (Coleman et. al., 1957). It has also been fruitful for understanding the social processes which intervened during the initial trials of a drug called "gammanym" from the time when it was adopted by a few local innovators to the time when it was ultimately used by the entire medical community. In network epidemiology studies, traditional SNA has been widely used to understand mental illness (Perrucci et. al., 1982), social network and health status (Seeman et. al., 1985), and the spread of HIV disease (Morris, 1994). In the 1990s, SNA studies took a turn in domain application. With the advent of the internet in the early 1990s, the importance of contemporary information and communication technologies (ICTs) have become instrumental for the formation and sustenance of ties especially for individuals and groups across different geographical locations. With the

availability of Web 2.0 technologies today, the arena for social networking has changed dramatically with a great deal of social relations being conducted online.

1.1.2 ICT Use, Social Networks and Performance

According to Wellman (1996), where computer networks connect people, such networks are computer supported social networks. The use of information and communication technologies (ICT) refers to the utilisation of hardware or software for achieving task-oriented goals and includes computer mediated communication over text, graphics or computer networks. The effect of ICT use on individual work performance has been sufficiently well documented in Information Systems (IS) research (Kraemer et. al., 1988; Malone et. al., 1991; Goodhue et. al., 1995; Hinds et. al., 1995). Shifting the emphasis from productivity gains through ICT use, recent studies now focus on the communication structure effects in organisations and communities as a result ICT use (Hinds et. al., 1995; Pickering et. al., 1995; Haythornthwaite et. al., 1998; Nardi et. al., 2000; Katz et. al., 2002). This is because ICTs are replacing traditional resources for developing an actor's social network (Nardi et. al., 2000). Personal networks not only shape ICT for communication, but ICT means are also shaping personal networks and re-drawing social boundaries. This is particularly beneficial for occupational groups such as dispersed rural GPs who find maintenance of ties with peers and communities difficult and expensive (Pickering et. al., 1995). While most social network studies have assumed ties being conducted face-to-face, this study argues that such studies formally emphasise on one strand of tie – often work relations, therefore neglecting the multiplex character of personal networks, which tend precisely to intersect several social relations (Licoppe et. al., 2005). Furthermore, although the general argument from these studies remains that an individual's social ties are developed, facilitated and maintained through ICT, very few actually report on the interactions between ICT use and individual performance (Chung et. al., 2005b). Aligning with the social network perspective of perceiving individual outcomes as the consequence of network structure (Borgatti et. al., 2003), this research study constructs and operationalises a theoretical framework for understanding the relationship

between social network structure, ICT use and its impact on performance of individuals in knowledge-intensive work.

1.1.3 Problems Related to Geographically Distributed Knowledge-intensive Work

The quality of job performance in knowledge-intensive is affected by a variety of factors such as experience, education, keeping abreast of work-related and technological changes and so on. Holding such individual properties constant, performance to a large extent is a product of obtaining the right information to accomplish the task at hand or to solve complex problems. For example, finding information and finding expertise with the right information is crucial for job performance. While knowledge and expertise are critical resources, its mere presence is insufficient to produce high-quality work. As Faraj and Sproull (2000) argue, expertise must be managed and coordinated in order to leverage its potential. This entails knowing where expertise is located, where expertise is needed, and bringing needed expertise to bear. This problem is accentuated when geographical barriers are imposed. Grinter et. al. (1999) argue that irrespective of area of expertise, product structure, processes and customised steps in organisational work, one of the most pertinent problem is with location of expertise. Cross and Cummings (2004) claim that individuals who are not aware about the location of expertise elsewhere, and who have less ties spanning organisational and geographical boundaries are ones who suffer from obtaining useful information for work purposes. Furthermore, there is plenty of literature that emphasises the importance of social and professional network structure, position and tie diversity. For instance, individuals who tend to be in closed networks tend to have non-diverse ties and the interactions are usually with the same individuals. Such individuals are less successful in adapting to changing environment, receiving useful and novel information and their work is thus marked with low-quality performance (Ancona et. al., 1992; Podolny et. al., 1997; Reagans et. al., 2001; Cummings, 2004).

1.1.3.1 General Practice and Rural General Practice: An Overview

As an area of knowledge-intensive work, the domain of general practice faces the problem of declining performance as GPs age. Categorising performance into medical knowledge, adherence to standards of care of diagnosis, prevention, screening, and therapy, and health outcomes, Choudhry et. al.'s (2005) review of 59 empirical articles found that 52% found consistently negative results, 21% with partially negative results, 3% reported mixed results, 21% reported no effect, and those that reported partially positive and consistently positive results were 2% respectively. The following graph exhibits the results clearer.

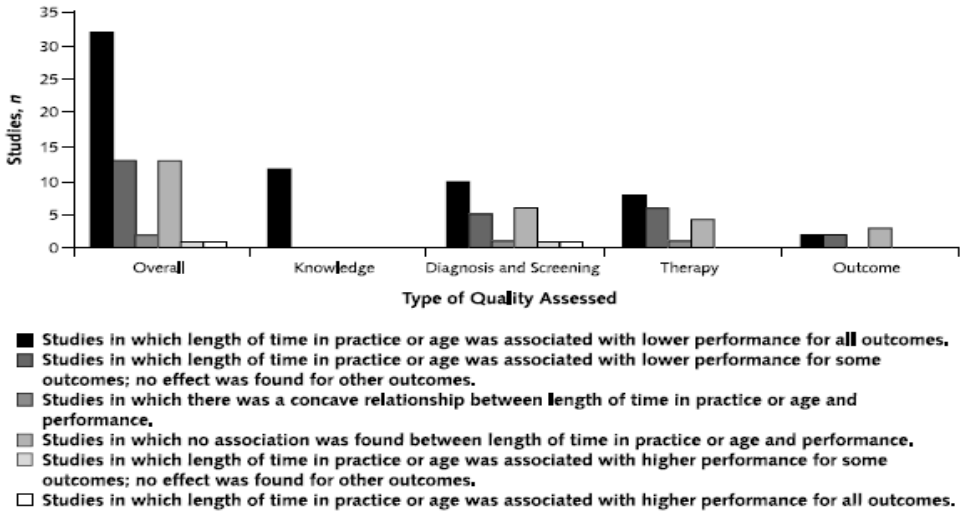


Figure 1.1: Distribution of Results Relating to Quality Assessed (Choudhry et. al., 2005)

The cause of the problem is attributed to obsolescence of technological and explicit medical knowledge and peer support (Choudhry et. al., 2005). The problem is further amplified in rural areas where general practice suffers from an ageing workforce (Strasser et. al., 2000), recruitment and retainment problems (Humphreys et. al., 1998), rapid technology obsolescence, and peer isolation (Joyce et. al., 2003). While general practice is regarded as "the provision of primary continuing comprehensive whole patient medical care to individuals, families and their communities" (RACGP, 2004), in Australia, the nature of a GP's work is knowledge-intensive in the sense that they deal with a number of complex problems rather than with established diseases in their provisioning of primary care (RACGP, 2004). Therefore, knowing where and whom to obtain information from is crucial for performance.

To put into perspective the numbers involved in this problem related to knowledge-intensive work and geographical isolation in Australia, there are about 59,023 registered medical practitioners, with 54,796 of them working in the medical labour force, out of which 53,991 are currently working in medicine. The total number of general practitioners (amongst those currently working in medicine) providing healthcare services to an estimated population of 19.6 million Australians is 21,815 (AIHWa, 2004)[1]. In rural New South Wales (NSW) alone, there are 1,518 GPs according to the Australian Divisions of General Practice (ADGP, 2005).

Australian GPs working in rural areas are geographically isolated from more populated practices. The nature of their work, isolation from the urban community and the numerous problems that plague their practice makes this study interesting. In rural areas, GPs often carry out procedures in situations with limited resources or personnel and are implicitly required to adapt to protocols and codes of conduct for rural settings (Mellow, 2005). Rural GPs are often expected to provide a wider range of healthcare services as compared to their urban peers (Weltmore et. al., 2001). As a result, they also work longer hours and face a greater chance of exhaustion because of shortage of colleagues (MacLellan, 1996). Factors attributed to such causes are failure to obtain technological updates (Scott, 1999) and obsolete medical knowledge. The onus is thus on the GP to acquire an extensive breadth of medical skills including in-depth medical knowledge while concurrently trying to keep abreast of new knowledge and latest technologies. Despite advance developments in information technology and the internet, there is no strong evidence to suggest that ICT use directly improves performance of GPs (Koppel et. al., 2005). Information architects and software designers still grapple with designing software that provides accurate medical information for GPs (Wears et. al., 2005). In Australia, although most of the general practices are computerised, the level of use and support remains suboptimal to date. In other words, there is much to capitalise on the task-based value and the social connectedness that can enable ICT especially for GPs in rural and isolated settings. It is widely accepted that it is crucial for GPs to maintain a sense of

[1] The figures from the AIHW report are based upon the 2002 census collated by the Australian Bureau of Statistics.

social connectedness amongst peers, health specialists, pathologists and other healthcare professionals in order to foster knowledge transfer and advice-seeking. The 'sense of social connectedness' is where the use of ICT remains instrumental for the establishing and maintaining of connections amongst a network of contacts, especially for GPs in rural settings.

1.2 Research Questions

This thesis investigates the interplay between social network structure, information and communication technology (ICT) use, and performance of knowledge-intensive workers. Studies on network structure and individual performance have been well document in previous studies (Sparrowe et. al., 2001; Ahuja et. al., 2003; Cross et. al., 2004). There is an obvious shift of importance in studies on technology use from impacts of ICT use on task level performance (Goodhue et. al., 1995) to impacts of ICT use on communication structure (Garton et. al., 1995; Hinds et. al., 1995; Goecks et. al., 2004). There is however, inadequate literature on the interaction effects between individual network structure, ICT use, and performance (Chung et. al., 2005b). The following questions motivate this research: (i) how does the interplay between individual social network properties and ICT use enhance and help us understand performance? (ii) to what extent does an individual's social network impact performance? (iii) to what extent does an individual's pattern and level of ICT use impact performance? (iv) to what extent is an individual's social and professional network properties associated with levels and patterns of ICT use for task and communication purposes (v) what are the most important factors of social network and ICT use to be considered in order to enhance individual performance in knowledge-intensive work?

1.3 Research Objectives

The following are the objectives of the research along with approaches to achieve them:

1. To introduce a social network perspective to understand performance of individuals involved in knowledge-intensive work.

2. To understand the relationship between social networks and ICT use, social networks and performance, and ICT use and performance.

3. To develop a conceptual model to capture theoretical constructs outlined in step 2 through an in-depth, iterative literature review and qualitative interviews.

4. To understand the interaction effects of the constructs in the conceptual model.

5. To extend traditional theory of social networks and performance by understanding the effect of ICT use on the inherent relationship between individual network structure and performance.

6. To demonstrate how the conceptual model developed can be operationalised in the context of rural GPs through a data collection survey instrument that achieves both data reliability and validity.

7. To contribute to the community of general practice and health by measuring GP's usage of ICT for clinical tasks as well as for professional network interaction along with suggested implications for professional practice.

1.4 Conceptual Framework

The following section briefly describes the conceptual framework for the study, followed by a brief review of theoretical constructs and research propositions. A diagram of the conceptual framework is depicted below.

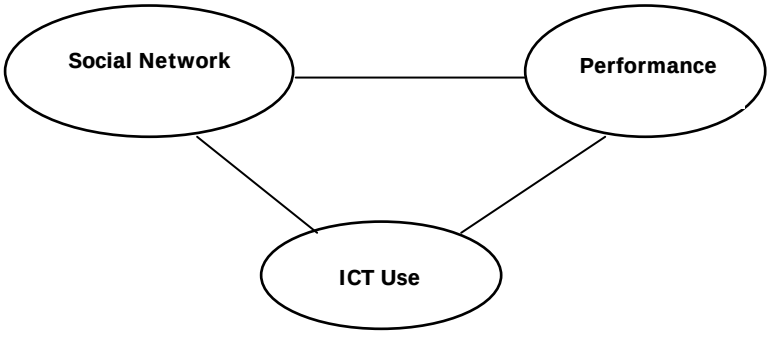


Figure 1.2: Conceptual Framework

1.4.1 Social Network and Performance

This thesis focuses on relational and structural properties of social networks because they bear significant impacts on an individual's outcome such as performance. Social ties in a relation form the basis of a network structure. Studies on weak ties have found that weak inter-unit ties sped up project completion times where the required information was simple, but slowed them down when knowledge to be transferred was complex (Hansen, 1999). Weak ties therefore foster search activities whereas strong ties facilitated the knowledge transfer process (Krackhardt, 1992) – the findings of which were confirmed by other studies (Levin et. al., 2004). These findings also demonstrate support for Granovetter's (1973) theory on the strength of weak ties, which argues that as strong ties tend to bond similar people, information that originates and circulates at a high velocity amongst strongly tied clusters tends to become redundant quickly. Such network-clusters are therefore are not conducive to channels of innovation or new information. The influx of new and novel information must hence come from weak ties.

The weak tie argument may cursorily suggest that individuals should focus on maintaining a huge number of weak ties in order to capitalise on information benefits. Previous studies have shown that denser ties in an individual's social network is conducive to diffusion of innovation (Coleman et. al., 1966), intellectual performance (Coleman, 1988), job performance (Shaw, 1964; Hansen, 1999; Sparrowe et. al., 2001; Cross et. al., 2004) and knowledge-sharing (Cross et. al., 2004). Burt (1992) however, takes on a structural perspective by suggesting that dense networks are far more inefficient than sparse networks because (1) they are costly to maintain, and (2) they provide redundant information.

Burt (1992) proposes the theory of 'structural holes' which is based on the idea that actors are in a better position to benefit from their interactions and transactions with others if actors are connected to others who are not connected themselves or well organised. The bridging of connection to others provides opportunities; the lack of connections among those others is the structural holes. Burt (1992) argues that an individual should be able to obtain unique and

resourceful information by connecting oneself to those belonging to non-redundant clusters in order to achieve diversity, brokerage and control advantages. Therefore, individuals who are surrounded by many structural holes with the potential to bridge those holes are the ones who will perform better.

In the context of medical practice, social networks have been regarded as a promising concept for becoming a unifying framework since 1970s (Erickson, 1975). To date, social network concepts and techniques have been applied in clinical and hospital settings (Anderson, 2002), for doctors and nurses to deliver better quality care (Cott, 1997; West et. al., 1999) and physician utilisation of medical information systems (Anderson et. al., 1985). In general, social networks theory and practice is regarded useful for clinical practice in location of resources and serves as an interpreter of help-seeking behaviour and utilisation of services. Numerous studies have documented GPs' need for immediate access to information and the importance of the social network of peers and colleagues. As Dee and Blazek (1993, p. 263) maintain, "…colleagues are familiar, reliable, immediately available, and inexpensive; they give concise, organised answers that synthesise available information". The value of a social contact is hence much more profound than simply being easily accessible and dispensing accurate information because it allows GPs to socialise, to leave routine, to display personal knowledge, and to generate professional contacts (Curley et. al., 1990). Connecting the above arguments together, it can thus be postulated that network structure, ties, and position are associated with performance in knowledge-intensive work.

> ***Proposition:*** *Social network structure, position, and ties are associated with performance in knowledge-intensive work.*

1.4.2 ICT Use and Social Networks

Traditional information systems literature have documented the implementation and use of technology as being crucial for accomplishing organisational goals especially when there exists a good task-technology fit. With rapid developments in technology, there exists a secondary effect of technology use in that information can now traverse spatial, structural and

temporal boundaries thus redefining work structures and communication patterns (Sproull et. al., 1991). Consequently, information science and information systems researchers have sought to understand the social processes that influence the use of such *information* and *communication* technologies (ICT). While there are competing models and theories that explain technology use such as the technology acceptance model (Davis, 1989) and the social influence model (Fulk et. al., 1990), very few focus on the significance of social structure, social position and social ties that constitute the influence. A key tenet in this study is that understanding the relationship between social network properties and ICT use of individuals is fundamental to the design of an effective information based organisation. In this dissertation, the motivating questions relating to ICT use and social networks are: at the individual level, (1) what forms of network structure are conducive to ICT use at the task and sociological levels? (2) what network position influences ICT use for task and communication purposes? (3) does work experience shape ICT use more so than an individual's social network property in distributed work settings? (4) how does one account for social factors that are important for designing and implementing ICT for enhanced performance?

According to Sproull and Kiesler's (1991) categorisation of the effects of ICT use, social networks and ICT use fall into the category of secondary effects or the social system effects. It is in line with Orlikowski's (1992) conceptualisation of technology where the recursive process of dual change occurs at both the individual and technological level and affects each other over time. Change at the technological level can be grouped into two categories in terms of providing sources of information: *relational* and *non-relational*. As an example of the former, with developments in the Internet, individuals can now seek advice, information, collaborate and communicate overcoming temporal and spatial barriers as well as offer new modes of communication (synchronous and asynchronous) (Wellman et. al., 1996). Furthermore, they also cross hierarchical and departmental barriers, change standard operating procedures and reshape work norms (Sproull et. al., 1991; Rice, 1994). Abundant studies have reported on how communication technologies have extended information reach

and enabled acquisition of useful information for individuals (Constant et. al., 1994) and occupational communities (Pickering et. al., 1995) through weak ties, despite lack of personal connections with others (Constant et. al., 1996). Furthermore, individuals tap into online communities and portals where benefits of social support, influence and information advantages are plenty (Butler, 2001). Such online communities and other artefacts within the online space also serve as a *non-relational* source of information. Internet-based discussion groups and listservs providing summaries of communications to its members via email digests is one such example. Furthermore, company newsletters, online databases, journal repositories and online search engines (e.g. Google) also provide readily available information matching almost the same credibility and quality as from a relational source (Henry et. al., 2001; Zimmer et. al., 2007). Therefore, the following proposition can be made:

> ***Proposition:*** *Social network structure, position, and ties are associated with ICT use at the sociological level (communication-related) in knowledge-intensive work.*

1.4.3 ICT Use and Performance

Literature in Information Systems widely recognises that ICT allows for adding intellectual content to work (Zuboff, 1988) and synergistic goal achievement when used and aligned properly with the task at hand (Goodhue et. al., 1995). Most literature on ICT use are task-level studies of associations between ICT use and productivity (Mukhopadhyay et. al., 1997; Drury et. al., 1999). In the medical domain, research on ICT use by general practitioners has begun to extend beyond informatics in hospitals and specialty medicine to include computing in general practice settings (Fafchamps, 1991; Aydin et. al., 1997). In some healthcare settings across Australia, the use of ICT systems is relatively new. It is only in the last few years that computerised clinical/critical pathways, computerised medical records, patient acuity/dependency levels, and patient information systems have been implemented in general practices throughout Australia (Western et. al., 2001; Western et. al., 2003). ICT use contributes to process of care by providing benefits to GPs such as better storage and retrieval of information, greater efficiency in terms of time and space, more consistent and accurate

records, improved drug management, better legibility and presentation, more flexibility, tighter security, and integration of clinical and administrative functions (Nielsen, 1998). Thus, it appears that ICT is utilised, and is a good fit with the general practice tasks it supports (Goodhue et. al., 1995). Therefore, the following postulation based on theory and literature is derived:

> ***Proposition:*** *ICT use at the task-level is associated with performance in knowledge-intensive work.*

1.5 Performance

Performance, in any research, is a concept that is extremely difficult to capture and measure as it deals with multitude of factors making it difficult to establish internal validity. In knowledge-intensive work within the context of organisations, performance has been defined and measured in different ways. Performance at the individual level has been usually defined in terms of individual output with individual output being operationalised in a variety of measures. Ranging from task completion times to error rates (Bavelas, 1950) and project completion times (Hansen, 1999), Cross and Cummings (2004) measured individual performance in terms of managers' overall ratings in terms of quality of output, efficiency, innovativeness, and ability to work well with peers. Hinds and McGrath (2006) measured individual performance in terms of coordination-ease using respondent ratings. In the health domain, as indicated previously, Choudhry et. al. (2005) conceptualised performance in terms of four criteria, namely - medical knowledge, adherence to standards of care of diagnosis, prevention, screening, and therapy, and health outcomes.

Performance literature in the context of general practice focuses on clinical appropriateness, standards of medical care, health outcomes and so on. Donabedian's (1980) theoretical framework is widely cited for evaluating performance in terms of 'quality of care'. Quality of care is further classified as structure, process and outcome. Campbell, Roland, and Buetow (2000) extend Donabedian's model by defining quality of care as "whether individuals can

access the health structures and processes of care which they need and whether the care received is effective".

Table 1.1 below refers to the dimensions of quality and care. However, because the scope of this research is limited to the "provision of primary continuing comprehensive whole patient medical care" (as per the RACGP (2004) definition of general practice in Australia), the *'process of care'* dimension of quality of care between GP and patient is regarded as relevant for the study. In particular, the *effectiveness* of the GP in delivering clinical and interpersonal care is what the study is concerned with.

	Care		
	Health Care System (Structure)	**Patient-centred Care (Process)**	**Consequences of Care (Outcomes)**
Quality			
Accessibility	- Geographic access - Affordability - Availability	- Affordability - Availability	- Health Status - User Evaluation
Effectiveness		- Effectiveness of Clinical Care - Effectiveness of Inter-personal Care	- Health Status - User Evaluation

Table 1.1: Dimensions of Quality of Care (Campbell et. al., 2000)

As such, comprehensively measuring the GP's attitude towards these dimensions of care comes closest to measuring their actual behaviour. Research in social psychology suggests that a person's attitude towards an object may be related to the overall pattern of a person's response to that object (Ajzen et. al., 1980). For example, it follows that GPs who strongly believe that behaviours such as smoking should be eliminated because of the risk of health, might be more likely to find out whether their patients smoke, and to offer pamphlets, advice or medication to help them give up (Cockburn et. al., 1987). It is therefore safe to argue that the perceptions the GPs hold are likely to influence their behaviour in the consultation and it is the attitude towards delivering effective quality care or the *perceived effectiveness* that is of interest in the study. As Salancik and Conway (1978) note, inferences about attitude are based not on one's actual behaviour, but rather upon what someone actually knows or remembers

about his or her behaviour. Perceived effectiveness is thus denoted as "performance attitudes" in this study and serves as a proxy or a surrogate measure for performance.

1.6 Significance of the Study

The purpose of this research is not to explain, in theory or in fact, the entire dimensions of individual performance and what factors affect it. Rather, it provides one mechanism for explaining one of the many effects in individual performance from a social networks and ICT use perspective. To do this, a conceptual model is developed to explore the effect of social network structure and ICT use on performance delivered by GPs in rural Australia. In the following section, the significance of the study is outlined at the theoretical, methodology and domain levels.

1.6.1 Theoretical Significance

At the theoretical level, the novel contributions of this research is that it extends traditional theory of social networks and performance to include geographically dispersed groups and individuals involved in knowledge-intensive work by examining the effect of ICT use to explain the relationship between social network properties and individual performance. It also extends theory on technological innovation diffusion and the technology acceptance model by showing how network structure, position, and ties can be used to empirically measure and validate major constructs of the social influence model. More importantly, it adds further empirical weight to the social influence model by explaining with quantitative evidence how network properties such as tie diversity is associated with ICT use. In doing so, it demonstrates how the research model can be operationalised in the context of rural GPs in NSW, Australia. It is also effectively the first study in Australia to measure GPs' usage of ICT for social network communication.

1.6.2 Methodological Significance

Methodologically, this research provides a developed, validated and reliable survey tool which can be easily administered to individuals in knowledge-intensive work. The cost of

filling up the survey is lesser than 15 minutes per individual. Therefore, to administer it at a large scale (e.g. nation-wide) at various domains (e.g. other professions such as consultants, real estate agents) is quite feasible as well. Obviously in the case of a different domain, the survey items pertaining to network, ICT use and performance will have to be contextually adjusted. The notion behind the analysis however remains the same. More importantly, a key benefit offered by the survey is its ego-centric nature such that it is able to obtain both relational data as well as attribute data for a richer analysis of individual patterns and outcomes in a simple and feasible manner. Furthermore, it is definitely possible to build up a sociocentric (entire) network from the collection of the ego-centric network data obtained from all the respondents, given that the respondents belong to the same domain or occupation. As such, the methodology offers a unique theoretically-motivated method for collection of social network data.

1.6.3 Significance for Knowledge-Intensive Workers in Occupational Communities

At the domain level, the main contribution stemming from this research is the appraisal of the relationship between ego-network structure, ego-network position, ego-network ties, ICT use and performance attitudes within the context of individuals working in occupational communities. Such individuals are physically geographically isolated or working in areas where the community population is low. In this context, when comparing network structure against network position and ties and its influence on performance, the study (as evidenced in chapter 4 and 5) suggests that network structure is the best predictor for performance. In particular, the number of social and professional connections is more crucial than how the individual is strategically positioned in his or her network, or how close or diverse his connections are. The other significance that stems from this study is that close attention needs to be devoted to the functional diversity of one's ties with others in one's professional network when accounting for implementation and usage of ICT for task-related purposes. These two findings are crucial because it emphasises the role of network structure and

network ties, rather than individual personality traits, in improving performance and ICT use of knowledge-intensive workers in occupational communities.

1.6.4 Significance in the Context of Rural General Practitioners

For rural general practitioners, this study is significant in that provides an insight into their advice-seeking and professional network in order to explore what dimensions of structure, position and relation, affect their attitudes to general medical care. Furthermore, while a plethora of studies in the medical and health informatics literature exists, very few have sought to understand the social processes that influence the uptake and use of ICT in general practice. For example, computerisation in rural general practices in Australia have attracted nation-wide governmental financial support, however, the sociological effects of ICT use has not been properly understood. In this study, not only task level and communication level use of ICT by general practitioners are sought, but through a social networks perspective, one can now understand the implications of social influence in an empirical way. In addition to this, the study also offers insights about how ICT and social networks play a significant role in the forming the attitudes of GPs towards better medical practice. As detailed in chapter 5, recommendations about socio-technical issues to consider when designing an effective ICT enabled organisation/practice for enhanced performance are also provided.

1.7 Forthcoming Chapters

The forthcoming chapters are structured as such:

In chapter 2, a review of the literature is presented for exploring the inherent relationship between social network, information and communication technology (ICT) use, and its impact on individual performance in knowledge-intensive work. It first provides an overview of social networks. Second, in order to develop a model for understanding the relationship between social networks, ICT use and individual performance, traditional theories of the strength of weak ties and structural holes along with their underlying assumptions are explored. The model is discussed within the context of an occupational community where

individuals are geographically distributed and non-competitive in nature. Following on, an appraisal of existing literature on social networks and individual performance is presented along with the introduction of ICT use as network catalyst for bridging and fostering social ties. The task level effects of ICT use is discussed with particular emphasis on the social system effects of ICT on individual performance. The chapter concludes by proposing a theoretical model together with hypotheses for understanding the relationship between network structure, position, ICT use and individual performance in knowledge-intensive work.

Chapter 3 provides an overview of the design of the study. It explains the triangulation research methodologies it takes and the process of development of the survey instrument based on theoretical perspectives that inform the conceptual model. The research framework consists of the in-depth interviews and the survey questionnaire that are conducted with a random sample of rural GPs from NSW, Australia. Finally, the chapter concludes with an overview of the design of the network data collection methods, the phases of survey administration, the sampling strategy and the techniques that are used to collect, store, extract and analyse the data.

In Chapter 4, the findings from the qualitative and the quantitative components of the research are reported. A brief summary about the results, followed by descriptive statistics about the data including tests of normality and a brief discussion on the distribution of each data variable is provided. Preliminary results of the relationships between the variables are also provided. Following on, results inferred from hypothesis testing using parametric techniques such as t-tests and multivariate techniques such as multiple regression models are reported and discussed.

Chapter 5 reinstates the primary objective of this study which is to understand the influence of social network and ICT use on individual performance in the context of geographically distributed knowledge-intensive work. By reiterating the motivating research questions in chapter 2, it comprehensively synthesises the literature review and the results from the study within the context of geographically distributed knowledge workers. In particular, the

discussion is structured by: (1) the *network position* hypotheses, which discusses the influence of ego-network efficiency and constraint on individual performance, (2) the *network structure and relational* hypotheses, which discusses the influence of degree centrality, tie strength and diversity on individual performance, (3) the *ICT use* hypotheses, which discusses the influence of ICT use at both the task-level and sociological-level on both network and individual performance. Following on, the validity of the theoretical model is discussed as a whole along with major findings.

Finally, in chapter 6, the limitations, and implications for future research and practice are presented. The critical findings and inferences of the research in chapter 5 translate into a set of implications and recommendations for theory, method, domain, and for rural GPs in NSW, Australia in particular. In conclusion, the drawbacks of the study are presented along with directions for future research.

Chapter 2

2. A Social Networks based Model for Exploring ICT Use and Individual Performance

This chapter provides a literature review of studies that explore the inherent relationship between social network, information and communication technology (ICT) use, and its impact on individual performance in knowledge-intensive work. The chapter first provides an overview of social networks. Second, traditional theories of the strength of weak ties and structural holes along with their underlying assumptions are explored in order to support the development of a model for understanding the relationship between social networks, ICT use and individual performance. In particular, the validity of the assumption that bridges are significant because it span weak ties is discussed. The brokerage advantage assumption offered by actors occupying structural holes in the network is also discussed. Conventionally, these theories have been applied in organisational and competitive contexts. However, in this research, the model is applied in an occupational community context where individuals are geographically distributed and non-competitive in nature. In the third section, an appraisal of existing literature on social networks and individual performance is presented. In the fourth section, ICT use is introduced as network catalyst for bridging and fostering social ties and relationships. In particular, task level effects of ICT use is discussed with particular emphasis on the social system effects of ICT use on individual performance. Clarification on what is meant by ICT use, including its types, and justifications to measures of individual performance are also provided. In conclusion, a theoretical model is proposed together with hypotheses for understanding the relationship between network structure, position, ICT use and individual performance in knowledge-intensive work.

2.1 Social Networks - Overview and Brief History

A social network is basically a set of actors and relations that hold the actors together. Actors can be individuals or aggregate units such as departments, organisations, or families. Actors form social networks by exchanging one or many resources with each other. Such resources

can be information, goods, services, social or financial support. These kinds of resource exchanges are considered a social network *relation*, where individuals who maintain the relation are said to maintain a *tie* (Emirbayer, 1997). The strength of a tie may range from weak to strong, depending on the number and types of resources they exchange, and frequency and intimacy of the exchange (Marsden et. al., 1984). Furthermore, social ties consist of multiple relations (as in the case of doctors who have a professional and family relationship with colleagues) and are called "multiplex ties" (Haythornthwaite, 2002).

Scott (2000), Hummon et. al. (1993) and Freeman (2004) provide a good overview of the historical developments of social networks as well as how social networks can be studied as a normal science. A brief chart showing the pioneers of social networks from several groups working independently in traditional fields of sociology and anthropology is provided in Figure 2.1.

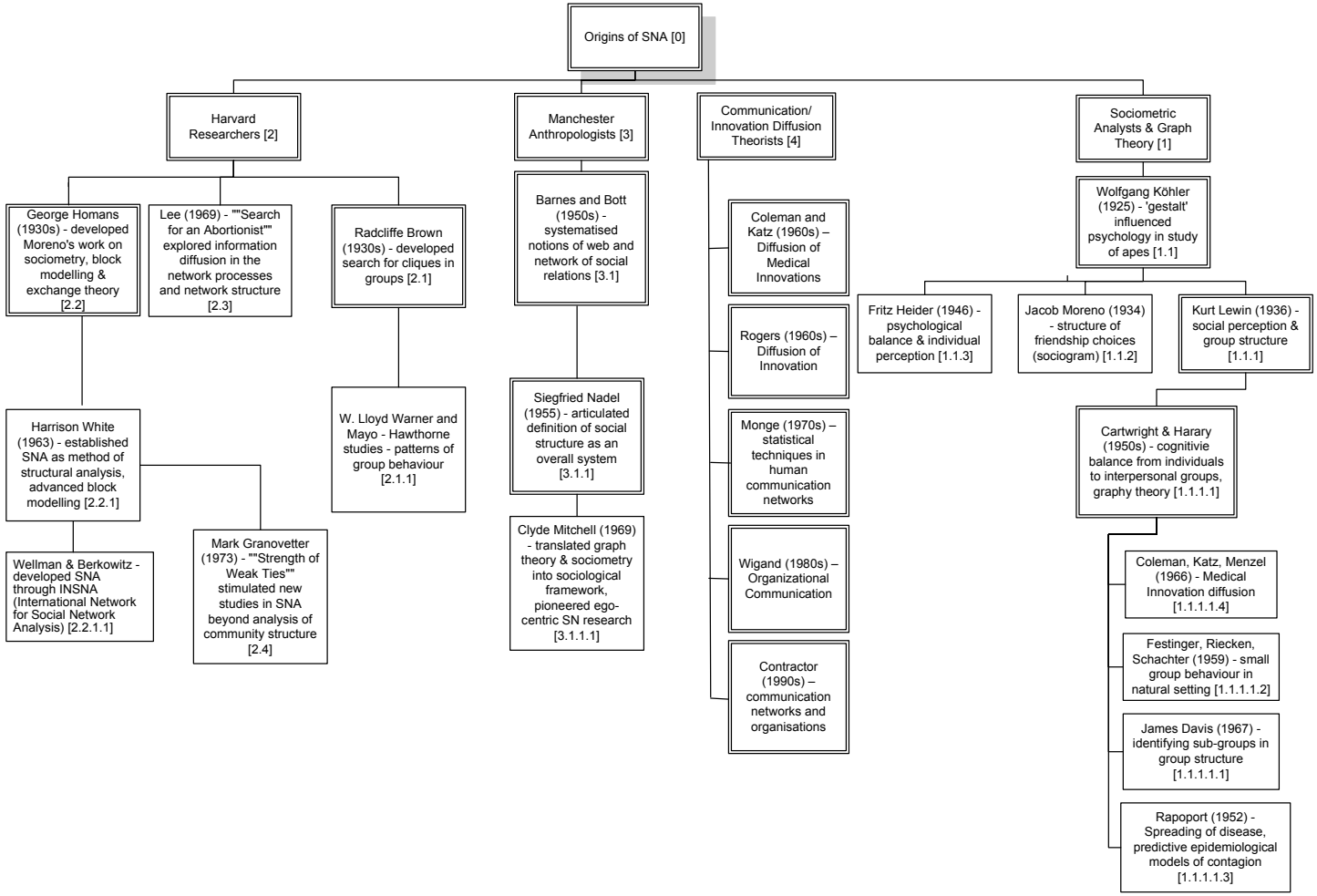


Figure 2.1: Chart depicting the influences of the work of key pioneers and its development towards the field of Social Network Analysis

Recently, social network[2] studies have gained significant recognition in terms of both theory and method and have greatly impacted research areas such as social capital, knowledge management, and organisation behaviour (Freeman, 2004). In fact, Borgatti et. al. (2003) note that "the boom in network research is part of a general shift in, beginning in the second half of the 20th century, away from individualist, essentialist, and atomistic explanations towards more relational, contextual and systemic understandings". Figure 2.2 demonstrates this exponential growth in the networks literature.

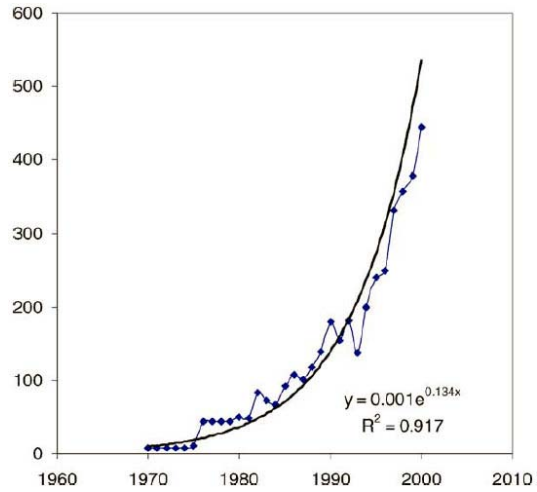


Figure 2.2: Exponential growth of publications indexed by Sociological Abstracts containing "social network" in the Abstract or Title (Borgatti et. al., 2003)

The fact that SNA techniques and methods have been used in different disciplines and context demonstrates the growing importance of SNA (Otte et. al., 2002). Figure 2.3 shows the growth of social network related publications while Figure 2.4 depicts the increasing diversity of domains in which SNA methods have been applied. The line of best fit shows the number of academic journals which deploy the use of SNA increasing cumulatively in a span of fifteen years. An interesting observation made by Otte and Rousseau (2002) is that "in the early 1990s most articles dealt with family and socialisation, while at the end of this period the SNA articles mostly dealt with the sociology of health and medicine. Indeed, social network analysis is now often applied in AIDS and drug abuse studies."

[2] The term 'social network' and 'network' may be used interchangeably from this point on, unless otherwise specified.

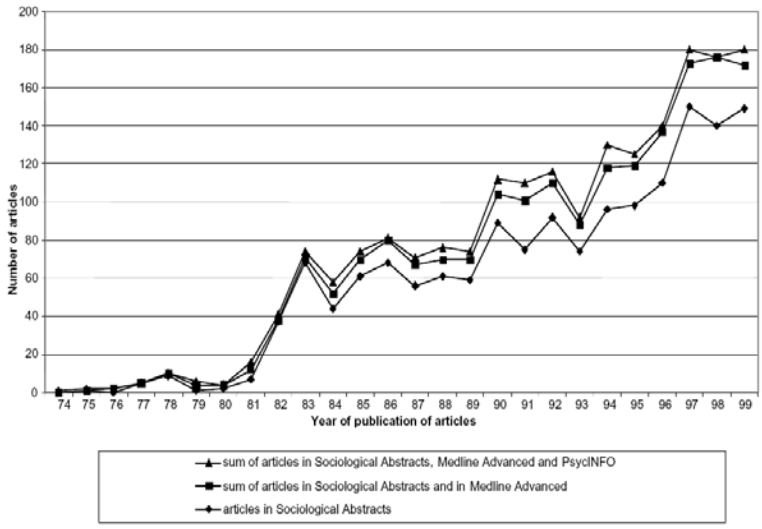


Figure 2.3: Sum of SNA articles in Sociological Abstracts, Medline Advanced and PsycINFO (Otte et. al., 2002)

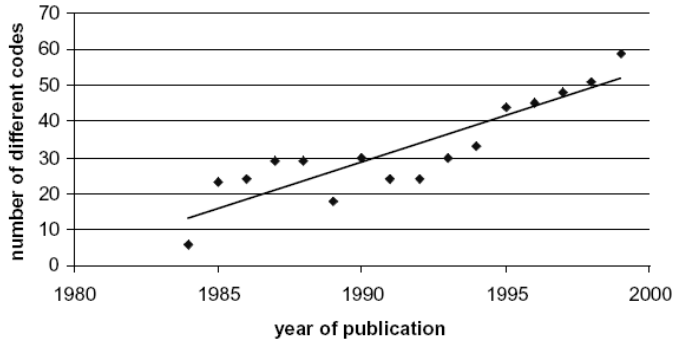


Figure 2.4: Number of different published journal articles which deals with SNA over the years (Otte et. al., 2002)

Evidently, theoretical foundations of social network studies have matured to a stage where the extent of its application spans several disciplines. Furthermore, the development of computers and the internet have provided not only tools for massive and rapid computational prowess but also a digital bridge for the creation, facilitation and sustenance of new and existing social ties. The questions that currently challenge philosophical notions of the relationship between social network, information and communication technologies and its impact on individual performance are thus:

1. How can individual performance be understood through the emergent patterns of social processes that constitute performance? How can it be evaluated?

2. What is the role of social influence and social networks (that create such influence) in understanding individual performance? Why is understanding social network structure and position important for understanding individual performance?
3. Is there a relationship between the configuration of social network structures and the patterns and frequency of use of communication technologies as well as individual performance?
4. How does one account for social factors, apart from personal and demographic factors, that are important for designing and implementing ICT for enhanced performance for individuals?

In order to shed light on the above philosophical questions, one needs to explore possible answers by reviewing the literature in the area of social networks, ICT use and performance. While there is currently a lack of literature that ties these three constructs together in a coherent form, it is important that these constructs are explored individually, jointly and holistically in a sequential manner. The following section begins by exploring some of the earliest works in the domain of network structure and performance.

2.2 Classical Works of Network Structure and Performance

2.2.1 Bavelas-Leavitt Experiment

One of the earliest studies that related sociometric aspects of human communication patterns to performance was that of the 'Bavelas-Leavitt Experiment' (Leavitt, 1949; Bavelas, 1950), also known as the MIT experiments. Drawing from the assumption that (i) success of any classes of tasks depends upon an effective flow of communication (holding the nature and content of the communication constant), and (ii) that fixed communication pattern affects task performance and individual outcome, the motivating question in the study asked – "under what principles may a pattern of communication be determined that will in fact be a fit one for effective and efficient human effort?" The question sought to answer how social network

structure measured in terms of patterns of communication affects work and life of individuals within groups through a laboratory controlled experiment.

The experiment consisted of five people who had to communicate with each other through enclosed cubicles in order to solve a puzzle. Each subject was given five symbols from a set six. All had unique symbols but there was a common one in all five. The puzzle was solved when each group reached consensus as to what the common symbol was. The experiment was trialled fifteen times. None of the subjects knew each other, nor did they know the number of subjects in the study, or the configuration of the communication structure. The channels and flow of communication was controlled by the experimenter. The subjects could pass as many messages they wanted through the cubicle lines depending on the structure of the communication channels, illustrated in Figure 2.5.

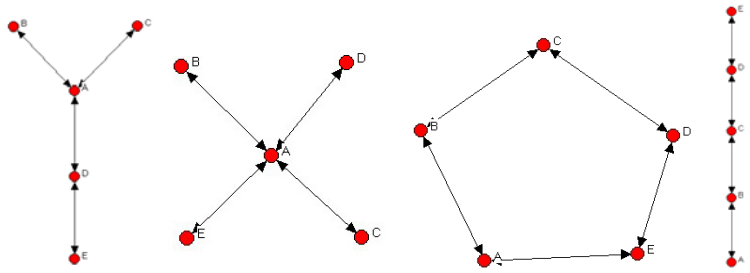


Figure 2.5: The Y, Star, Circle and Line Structure

The performance of network structures was evaluated on the basis of pattern comparison and node-level analysis. Performance of the task-oriented groups was measured in terms of time required to complete the puzzle and number of errors made in the process of "guessing" the right answer. When patterns of various structures were compared, the star and Y structures were on average relatively faster than the other structures (circle and line) in completion time. The explanation offered by Leavitt (1951) was that centralisation was key to influencing performance. Using centralisation (measured as the sum of internal distances of nodes *x* to *y*) as an operational construct, it was found that patterns which demonstrated higher centralisation performed better. When the subjects channelled all information through a central actor, the information was better coordinated and shared. Thus, the star and the Y structures also used the least amount of messages compared to the other structures and also

made the fewest errors. When node-level analysis was conducted, it was discovered that structures that have higher centralisation also tended to have a leader emerge during the task-processes. The leaders emerged at positions of highest centrality (measured by the degrees of communication activity). Thus, the Y and star structures had nodes with extremely high degree centrality compared to other nodes within the structure which led to better performance.

Inevitably, a thought-provoking finding that emerged from this study back then was that centralised structures, such as the star (or hub-spokes or wheel) network, were far more conducive to performance (solving the puzzle faster) in contrast to decentralised or flatter structures, such as the circle network. The crux of the argument is that information flow is inefficient in decentralised networks and therefore less conducive to performance. However, later research by Guetzkow and Simon (1955) revealed that decentralised structures actually worked better than centralised structures when tasks become more complex. Complexity of tasks results in problems and sub-tasks which cannot be handled by an individual alone. The analogy is same where central nodes are overwhelmed with communications. In this context, the circle structure worked much better than the star structure. The performance of the structures was dependant on how well the channels of communication were used as opposed to the structure per se. In contrast to the star structure, the all-channels structure in Figure 2.6 (assuming that there are no "ties-overload" caused by having excessive ties per node) provides a reconfigurable capacity for task-relevant communication. For the actors, this allows an opportunity to negotiate about directions of communication, details about what the task type is, and whether specific nodes are to be brokers of the communication. The resulting communication patterns tend to be potentially more efficient than if the network structure and flow of information were rigid in form.

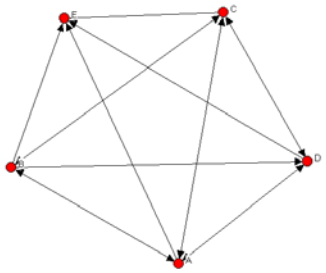


Figure 2.6: The "all channels" Structure

As Guetzkow and Simon (1955) and Guetzkow and Dill (1957) stipulate, the actors must solve two problems: (1) that of developing an organisation scheme suitable for finding the common symbol within the constraints of their particular network structures and (2) that of actually finding the common symbol. Ultimately, they would seek and find an organisational structure that works and then play with variations on it both to maintain interest and to seek a 'better' form. The following table (Table 2.1) shows the optimal match between task complexity and structure centralisation:

Variable	Simple Task	Complex Task
Least Messages	Centralised	Centralised
Least Time	Centralised	Decentralised
Least Errors	Centralised	Decentralised
Most Satisfactory	Decentralised	Decentralised

Table 2.1: Conditions under which Centralisation/Decentralisation Structures are Best Adapted from Borgatti (1996)

The Bavelas and Leavitt experiment during the early 1950s was a crucial milestone as it injected rejuvenated vigour in the space of network structure-performance research. Their key finding was that centralisation leads to enhanced performance in simple tasks and that decentralisation leads to efficient performance in complex tasks. Their conceptualisation of the effect of communication pattern in terms of social structure and social position on task performance opened up new research avenues. Consequently, it begged new ideas and questions on understanding performance using a social networks perspective.

2.2.2 Freeman's concept on Centrality

As described in the above section, the idea of centrality was applied to human communication in the early 1950s. Although the 'structural centrality and influence in group processes'

hypothesis was proposed by Bavelas (1950) and reported in depth by Leavitt (1951), modifications and extension to the original experiments provided contradictory and confusing results (Burgess, 1968). In the late 1970s, Freeman (1978) wrote a seminal article that clarified the conceptual foundations of centrality, which soon became a core concept in social network studies. His work laid the foundation for social network scholars to apply and extend the notion of structural centrality at both the node and network level, conceptually and empirically.

Freeman (1978) reviewed literature that utilised the notion of centrality and showed that the concept was applied beyond 'experimental groups task-related' research such as in understanding urban development, organisation of populated nations such as India, transportation and communication networks in Russia, and in explaining patterns of diffusion of technological innovation in the steel industry. Freeman (1978) then reviewed the various measures and overlapping concepts of centrality by unifying the measures while clarifying its range and limits of potential for application.

In particular, he defined centrality in terms of point, betweenness and closeness centrality, with each having important implications on social outcome and processes. According to Freeman (1978), "these kinds of centrality imply three competing 'theories' of how centrality might affect group processes". Degree centrality can be measured in terms of degree (the number of ties to and from an actor). Structurally, centrality is measured in terms of closeness (the extent to which an actor is close to all others in the network), and betweenness (the extent to which an actor lies in the shortest path to all others in the network). Each centrality concept has been related to important social occurrences - degree centrality being viewed as an important indicator of an actor's *communication activity*; betweenness centrality as an indicator of the potential of an actor's *control of communication;* and closeness as an index of *minimum cost of time and efficiency* for communicating with other actors in the network.

In a subsequent study, Freeman et. al. (1979) reverted to the classic experiment by Bavelas (1950) to study the effects of structural centrality on human communication. Using 100

volunteers (university students) as subjects for the experiment, Freeman et. al. (1979) analysed the results and demonstrated that centrality is an important structural factor influencing leadership, satisfaction and efficiency. In particular, out of the three concepts of structural centrality, only two demonstrated interesting results and significance in its effect on performance; namely the control based measure of *betweenness* and the activity based measure of *degree*. The independence index based on closeness was "vaguely" related to experimental results. Interestingly, another structural factor, the overall *density* of communication paths in the structural form also turned out to be relevant in understanding performance. Back then, these results breathed new life into the MIT lab experiments at a time when the research avenues from the experiments seemed to have stagnated, as it raised new questions as to what kinds of structure (influenced by individuals or groups) influenced differing types of performance (task or contextual).

In another classical work on the effects of network structure on innovation diffusion, Coleman et. al. (1957) attempted to understand the underlying social processes that affected 125 doctors' rate of adoption of a new drug. Results suggested that doctors who were generally more integrated with their peers, that is, with denser networks, were faster in the adoption of the new drug as compared to those who were more isolated. The results from Coleman et. al.'s (1957) study suggests that the larger number of ties an individual has results in a higher likelihood to diffuse innovation faster. These individuals are quicker to capitalise on the novelty of the information and are thus in a position to enhance individual outcomes such as performance. These results resonated strongly with similar findings about the density concept by Freeman et. al. (1979) described above. Since then, the notion of centrality, density and centralisation were one of the key network measures used for studying effects on individual and group outcomes such as task efficiency, productivity, improved performance, project coordination as well as favourable attitudes towards task-related work (Salancik et. al., 1978; Pfeffer, 1980; Brass, 1981; Brass, 1985; Bonacich, 1991; Mullen et. al., 1991; Faust, 1997;

Sparrowe et. al., 2001; Ahuja et. al., 2003; Cummings et. al., 2003; Cross et. al., 2004; Hossain et. al., 2006).

The contribution of Freeman's (1978) work was so influential that the notion of centrality is now almost always attributed to him. By expounding on the intuitive notions of centrality – closeness, degree and betweenness, Freeman (1978) has not only unified these measures mathematically, but has also provided their respective theoretical and practical implications which are key contributions to the network structure and task-performance research. That is, betweenness centrality (the extent of communication controlled), and degree centrality (the extent of communication activity) have been shown to influence performance from a network structure perspective while closeness centrality (the extent of communication efficiency) is not.

2.3 Burt's Structural Holes Theory

A major caveat in previous studies of network structure such as the one of Coleman et. al.'s (1957) is that it assumes individuals are able to maintain ties within their personal network *consistently over time*. It also assumes that each tie is a channel-provider of unique information or communication. These drawbacks are the paradoxical reasons as to why an extremely dense network may paralyse an individual's ability to perform better.

In the early 1990s, Burt (1992) made an influential contribution to the network paradigm and phenomena of structural effects on individual outcome by shifting the focus from *network structure* and *network relations* to *network position*. Burt's (1992) theory on structural holes offers a novel and subtle but interesting perspective in explaining why some individuals perform better and others do not. For example, it takes Coleman et. al.'s (1957) study and its assumptions a step further by offering an explanation of why social processes such as innovation diffusion may occur faster from a structural positional point of view rather than from a relational perspective. The theory is linked to personality theory suggesting that personal attributes (such as locus of control, leadership skills, ability to perform well) of an

individual is associated with structural autonomy – an optimal situation where an individual benefits from non-redundant information benefits.

In contrast to network structure and relational ties, Burt (1992) argues that the structural configuration of an individual's social network which provides optimised "brokerage" position is what dictates structural advantages such as information novelty and control. The basis for this argument leverages on the fact that maximising the number of ties (weak or strong) in an individual's network does not necessarily provides such benefits. Instead, opportunity costs come into play and the maintenance of ties become expensive in terms of time and resource. Furthermore, as an individual's personal network grows over time, the extent of information coming from closely knit clusters tend to become redundant. Intuitively, an individual can maintain no more than 50 or more close ties on a frequent basis. This figure represents at best, an individual striving to maintain ties with his contacts. In particular, in a study by Gurevitch (1961) where a diary of acquaintances and friends was kept for 100 days by 15 study participants, the maximum number of acquaintances noted was 658; the average being 500. As one can imagine, to maintain ties with such numbers of contacts is socially expensive and time-consuming. To this end, Burt (1992) capitalises on his theory of structural holes by focusing on the importance of structural *position* rather than structural *properties* such as density or the size of the network.

The theory of structural holes is simple and intuitive yet empirically profound. 'Holes' in the network is the absence of ties which would otherwise connect unconnected clusters together. Individuals who bridge these holes attain an advantageous position that yields information and control benefits. Therefore, structural holes theory is based on the idea that actors are in a better position to benefit from interactions with others if actors are connected to others who are not well-connected themselves or well-organised. In other words, the bridging of connection to others provides opportunities; the lack of connections among those others is the holes in the structure (and therefore, structural holes). Individuals who attain structural autonomy are those who bridge all structural holes while the groups to whom the individual is

connected to are surrounded by structural holes. Closer examination on the crux of structural holes theory reveals that it is based on the assumption of betweenness centrality: that power and influence accrue to those who broker connections between unconnected groups of people. It is this concept of betweenness centrality that Burt (1992) capitalises on and extends to explain the role of "brokerage" as a form of obtaining structural autonomy which leads to improved performance, getting ahead and obtaining good ideas. This theoretical contribution offers a more insightful perspective on individual performance given that Guetzkow and Simon (1955) note that centrality in itself is not always a key predictor of individual performance. Instead, the theory offers insightful explanation beyond the concept of centrality and centralisation in that an individual's benefit accrues from the extent that individual's network is efficient, effective and constrained. The following section discusses network efficiency and constraint in greater detail.

2.3.1 Network Efficiency and Effectiveness

In order to optimise a network by capitalizing on structural holes, Burt (1992) claims that increasing network size (number of direct contacts) without considering the diversity reached by the contacts makes the network inefficient in many ways. Therefore, the number of non-redundant contacts is important to the extent that redundant contacts would lead to the same people and hence provide the same information benefits. The term "effectiveness" is used to denote the *average* number of people reached *per* primary contact; while the term "efficiency" concerns the *total* number of people of people reached with *all* primary contacts. Hence, effectiveness is about the *yield per primary contact* while efficiency is about the *yield of the entire network.* To illustrate, the network diagrams in Figure 2.7 contrasts an inefficient network (A) to an efficient network (B).

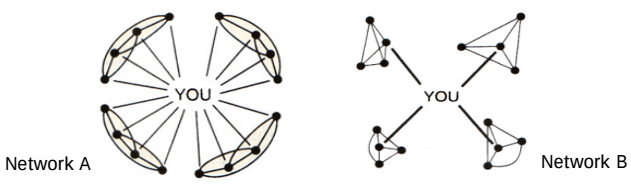


Figure 2.7. Inefficient (A) and Efficient (B) Networks (Adapted from Burt (1992))

In network A, the ego (you) maintains sixteen ties with every contact in the network. This represents a significant strain on the ego in terms of time and opportunity cost that could be invested in other contacts. Network B is far more efficient because you only need to maintain ties with four primary contacts thereby achieving efficiency at a fourth of the cost compared to network A. Network B is far more effective because the primary contacts in this network are non-redundant in that they are connected to clusters that are not connected to each other. An effective network therefore regards the primary contacts as ports of access to diverse clusters (because of non-redundancy), and therefore achieving yield of the entire network.

The term that Burt (1992) uses to denote effectiveness in networks is effective size. In network A, the network size is 16. The *effective* size however, is 4, because in effect, the ego is only able to obtain *novel information* and *benefits* from the four clusters, which is not connected to each other except through 'you'. The other three ties to each of the cluster are redundant because they provide the same information that is available through the fourth. Efficiency in network A is therefore 0.25 (measured as effective size (4)/network size (16)). In network B, the network size is 4, and effective size is 4, resulting in perfect efficiency of 1 (4/4). The relationship between network size, effective size and efficiency is shown in the graph below:

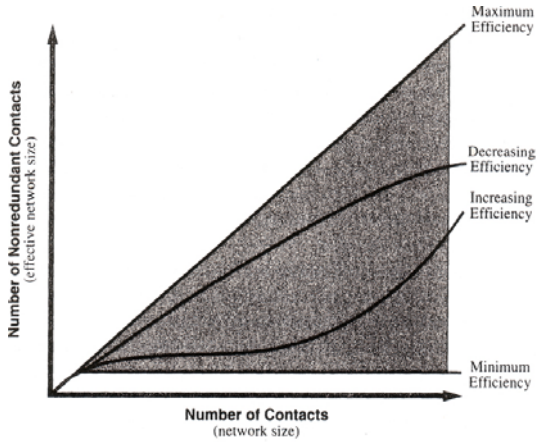


Figure 2.8. Relationship between Network Size and Effective Network Size (Burt, 1992)

In Figure 2.8, networks can be anywhere within the shaded area. Ideally, the number of non-redundant contacts should increase with the number of contacts to achieve optimal efficiency (i.e. 1). As one increases one's number of contacts and gradually start to have a smaller

number of non-redundant contacts, the individual's network efficiency decreases. Conversely, as the number of non-redundant contacts increases relative to the lower number of contacts, the individual's network efficiency increases.

2.3.2 Network Constraint

Constraint dictates the extent to which an individual's opportunities are limited by investing the bulk of his or her network time and energy in relationships that lead back to the single contact (Burt, 1992, p. 55). In other words, constraint measures the degree to which an individual's contacts are connected to each other and is therefore a proxy for redundancy of contacts. According to Hanneman (2001), constraint also measures the extent to which an ego is connected to others who are connected to one another. So if the ego has many connections to others who in turn has many connections to more others, the ego is quite constrained. At organisational levels, individuals with high constraint indices are unable to conceive novel ideas because of the redundant nature of information that is sourced from a densely connected group of individuals. Previous research has consistently demonstrated that high efficiency and low constraint indices are useful indicators of an individual's ability to produce good ideas (Burt, 2004), "getting ahead" in terms of job performance and promotion (Burt, 1992; Burt, 2005) and enjoy greater career mobility (Podolny et. al., 1997). In line with these arguments, it is expected that individuals in knowledge-intensive work thrive on useful knowledge and information from peers. An individual in knowledge-intensive work with an efficient and low constrained network structure is thus more likely to obtained useful knowledge from diverse and non-redundant contacts, which has been linked to improved performance. Therefore, the following hypotheses are formally derived as:

H1a: Efficiency of an individual's network position is positively associated with performance in knowledge-intensive work

H1b: Constraint of an individual's network position is negatively associated with performance in knowledge-intensive work

2.4 Social Network Ties and Performance

Obvious at this point, for social network scholars, the raison d'être is that the structure of relations among actors and the location of individual actors in the network have important behavioural, perceptual and attitudinal consequences both for the individual units and for the system as a whole (Knoke et. al., 1992). In this context, individual or system level outcomes are treated as a function of network structure and position (Gabbay et. al., 2001). However, at the individual level, the debate not only concentrates on how *structural position* impacts individual performance but also on *relational components* of an individual's network. Evidence in the literature demonstrate that just as structural position plays a vital role in the effect of individual performance, tie strength has significant effects as well (Borgatti et. al., 1998; Mehra et. al., 2001; Sparrowe et. al., 2001; Reagans et. al., 2003; Hossain et. al., 2006).

2.4.1 Granovetter's Theory on the Strength of Weak Ties

The most seminal work in social networks with regards to the relational component of an individual's social network almost always begins with Granovetter's (1973) theory on the strength of weak ties. Granovetter (1973) argues that individuals obtain new and novel information from *weak* ties rather than *strong* ties within the individual's group structure. The argument rests on the assumption concerning the homophilous nature of actors in a social system, where strong ties tend to bond similar people to each other, and that these similar people tend to cluster together such that they all become mutually connected. As such, information that originate and circulate at a high velocity amongst strongly tied cliques or clusters tend to become obsolete or redundant in a short amount of time. Such network-clusters or cliques of people bound together by strong ties are therefore are not conducive to channels of innovation. That is, such networks are closed networks and are not well receptive of new information. Granovetter (1973, p. 1373) suggests that the influx of new and novel information must therefore come from weak ties (hence, the theory of the strength of weak ties), which serves as a *bridge* to a different cluster of people from where the new information originates.

Although the theory of strength of weak ties theory has wide appeal, it suffers from the same drawback in its implication that maximising the number of weak ties in one's personal network would yield novel information benefits which in turn, allows one to perform better. Furthermore, according to Burt (1992, p. 28), a weak tie is "the chasm spanned and the span itself. By title and subsequent application, the weak tie argument is about the strength of relationships that span the chasm between two social clusters" and therefore not about information benefits. By definition then, it cannot produce novel information benefits per se. Unlike structural holes which provide information benefits, it also obscures the control benefits that come along with information benefits.

2.4.2 Strength of Strong Ties

Subsequent to the seminal study on the strength of weak ties, several researchers have examined the dichotomy on the strength of ties and associated it with individuals and group outcomes. Krackhardt (1992), for instance, notes that the "affect" level of strong ties is important and cannot be ignored. In his study (Krackhardt, 1992) of a Silicon Valley firm where advice and friendships networks of 36 employees were compared, he concluded that strong ties were particularly important especially in the generation of trust within propagators of major organisational change. In another study of 127 knowledge-intensive workers from a pharmaceutical company, a bank, and an oil and gas company, Levin and Cross (2004) reported that the relationship between strong ties and receipt of useful knowledge was mediated by benevolence-based trust and competence-based trust. They also found evidence that strong ties, more so than weaker ties, led to the receipt of useful knowledge for improving performance in knowledge-intensive work. However, when their research model controlled for the two dimensions of trust, the structural benefit of weak ties emerged, suggesting that it was the weaker ties which provided access to non-redundant information. In this context, the results are consistent with prior research by Hansen (1999) who investigated the association between tie strength, transfer of complex knowledge and performance in terms of project

completion times by 41 different subunits within an organisation. The conceptual model postulated by Hansen (1999) is depicted in Table 2.2 below:

	Tie Strength	
	Strong	**Weak**
Knowledge		
Noncodified, Dependent	Low search benefits, moderate transfer problems	Search benefits, severe transfer problems
Codified, Independent	Low search benefits, few transfer problems	Search benefits, few transfer problems

Table 2.2. Search and Transfer Effects associated with Four Combinations of Knowledge Complexity and Tie Strength (Hansen, 1999)

According to Hansen (1999), weak ties facilitate faster project completion times when the task is simple and enables faster search for useful knowledge amongst other organisational subunits. However, strong ties foster complex knowledge transfer, rather than weak ties as it slows down the transfer process when knowledge is highly complex, where the complexity of knowledge is determined by its tacitness and whether an individual is dependent on another for transfer and acquisition. Similar findings were also echoed in Reagans and McEvily's (2003) study of a sociocentric network of 104 highly skilled employees within a contract R&D firm where they found significant support for the positive association between tie strength and the ease of knowledge transfer in performing knowledge-intensive task activities. Furthermore, they also found that diversity of ties (in terms of network range or ties to different knowledge pools) was positively associated with ease of knowledge transfer. Therefore, where knowledge-intensive work is involved and where knowledge transfer and receipt of useful information is crucial for the performance, strong ties rather than weak ties facilitates complex knowledge transfer especially to heterogeneous audiences (Reagans et. al., 2001). In other words, for an individual in knowledge-intensive work to perform well, the importance of strong ties of an individual cannot be discounted. Stated formally:

H2a: Strong ties will be positively associated with individual performance in knowledge-intensive work

2.4.3 Degree and Diversity of Ties

Apart from observing tie strength, various studies also examined the number of ties as a significant predictor of individual performance. In this context, an individual's number of direct ties to other individuals in his or her network is also termed network size (Burt, 1992, p. 16) or degree centrality (Freeman, 1978). In a study that examined tie correlates of individual performance of 101 engineers and 125 consultants, Cross and Cummings (2004) found significant support for the positive association between an individual's number of ties (from and to departments outside his or her department) and individual performance. Furthermore, they also found that an individual's number of ties to higher hierarchy levels and those that spanned physical (geographical) barriers was positively related to performance. These findings suggest that ties that span departmental boundaries and geographical barriers, including those that reach senior personnel, enhance the diversity of information flow especially where complex work with high integration of specialised knowledge is involved. According to Cummings (2004), individuals in work groups are more likely to perform better if they exchange knowledge externally with members in their professional network who are structurally diverse. Structural diversity here refers to individual differences in geographic locations, functional assignments, reporting managers and business units. For example, past research has shown that geographical location influence what individuals experience, who they interact with and therefore generate novel task-related information and knowledge-sharing opportunities (Monge et. al., 1985). In particular, although internal and external knowledge sharing has direct implications on performance, the latter is more valuable when individuals in the work group are more structurally diverse. Therefore, individuals with higher *reach* and *diversity* of information are more likely to be exposed to unique and relevant knowledge that are helpful in solving complex problems. More formally:

H2b: Degree centrality is positively associated with individual performance in knowledge-intensive work

H2c: Geographical tie diversity is positively associated with individual performance in knowledge-intensive work

H2d: Functional tie diversity is positively associated with individual performance in knowledge-intensive work

To surmise, the previous sections of this chapter up to this point have critically analysed key literature concerning the relationship between social network and task-related performance. In terms of social network structure, Bavelas (1950) and Leavitt (1951) demonstrated that hierarchical or centralised structures perform better when tasks are simple, but decentralised structures are more conducive towards lesser errors, satisfaction and speed of task completion in complex tasks. Freeman (1978) later expanded on the notion of centralisation to show that performance was related to the individual's property of centrality attributed by the structure of the network. In particular, he identified that degree centrality connotes intensity of communication flow, betweenness centrality indicated communication power and influence, and closeness centrality indicated efficiency of information flow. Burt's (1992) notion of structural holes built further upon the assumption of betweenness centrality that advocated the idea of a brokerage position as providing information and control benefits. In fact, this shift from the focus on network structure to network position was instrumental and paved way for further research in delineating the relationship of communication patterns and performance at the individual level. At the relational level of network structure, the main theory reviewed was the strength of weak ties (Granovetter, 1973) which stipulates that weak ties provide novel and useful information as opposed to strong ties within a densely knit cluster of people. However, later research in the dichotomy of the strength of ties have also led to claims that strong and diverse ties are equally and respectively important for performance. This research therefore amalgamates these concepts together to propose that network structure, position and relations individually and jointly impact individual performance. In the next section, the implications of ICT use and its relevance to the network-performance model is introduced and incorporated.

2.5 Effects of ICT Use on Social Networks and Task-level Performance

A fundamental assumption of most social networks research described earlier is that performance is influenced by the interplay of both network structure and tie correlates, autonomous of the medium that conduct the relations. Most studies pertaining to social networks and performance have either focused on the impact of network structure or on the effect of differing tie strengths within organisational contexts (Feld, 1981; Burt, 1992; Krackhardt, 1992; Mehra et. al., 2001; Sparrowe et. al., 2001; Cummings et. al., 2003; Cross et. al., 2004; Oh et. al., 2004). However, most of these network studies have been conducted isolating the fact that contemporary ICT media play no significant role in the creation and maintenance of social ties – the fundamental relations that connect individuals spanning geographical distances today. While most studies have assumed relations being conducted face-to-face, another criticism is that the studies formally emphasise the focus of one strand of tie – often work relations, therefore neglecting the multiplex character of personal networks, which tend to intersect several social relations (Licoppe et. al., 2005). Furthermore, individuals often work within a network of informal links that fits into a larger social structure. Such ties are generally geographically dispersed, specialised and connected by ICTs that facilitate communication and information transfer.

The revolution of technology and internet means that the entire communication environment has taken on a virtual dimension. ICTs are replacing traditional resources for developing an actor's social network (Nardi et. al., 2000). Therefore, personal relations are no longer conducted face-to-face only. Besides the telephone, various forms of ICT (e.g. emails, wikis, blogs) are currently available for various purposes. Thus, personal networks not only shape the ICT for communication, but the patterns and frequency of ICT use are also shaping personal networks and re-drawing social boundaries.

In light of the above discussion, there have been several theories and models proposed to conceptualise ICT use. Drawing on structuration theory as an analytic perspective to view the use of ICT, Orlikowski (1992) presented a model (see Figure 2.9) of interaction among

institutional properties, technology, and human action. Her argument is that technology is an outcome of human action, sustained by ICT use, which in turn mediates human action by facilitating or constraining performance. Furthermore, human action, in using technology acts upon the institutional properties of an organisation such as structure, which can, for example, be described in terms of professional ties that link information workers together. In sum, human actions in ICT use shape and are shaped by such structural properties.

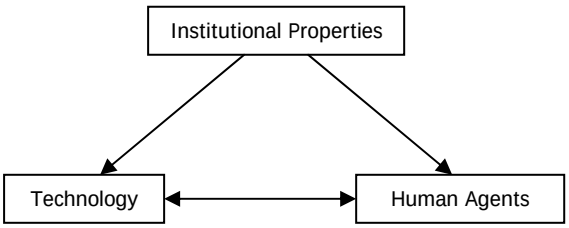


Figure 2.9: Orlikowski's (1992) model of Duality of Technology

Other scholars attempted to conceptualise ICT use based on the factors contributing to individual usage of ICT such as the technology acceptance model (Davis, 1989), the social information processing model (Salancik et. al., 1978) and the social influence model (Fulk et. al., 1990). There is also a long tradition of research in the Information Systems (IS) community on impacts of ICT which examines how individuals experience information systems and technologies (Anderson et. al., 1990; Kraemer et. al., 1990; Igbaria et. al., 1997; Mukhopadhyay et. al., 1997; Montano et. al., 2005). As this study is concerned with the effects of ICT use at the individual level, Sproull and Kiesler's (1991) categorisation of the effects of ICT use as efficiency (task-level) and social (communication-structure) effects is most relevant. Their work captures the two forms of effect of ICT use at both the task level and at the communication structural level. Therefore, in this study, by ICT use, the focus is on the *use* of *information* and *communication* technologies in a professional context for achieving a certain set of tasks as well as for the purpose of communication to obtain information for accomplishing the task(s). The following section documents the sociological effects of ICT use first.

2.5.1 Social System Effects – Communication Structure & Sociology

As indicated earlier, the use of ICT does not impact individuals at the task level only but has also revolutionalised ways in which individuals communicate, acquire, share and utilise information (Nardi et. al., 2000; Nardi, 2005). Sproull and Kiesler (1991) have documented such secondary effects or impacts of ICT use as *sociological effects* because it affects the ways people communicate. Their categorisation is in line with Orlikowski's (1992) conceptualisation of technology in that the recursive process of dual change occurs at both the individual and technological level and affects each other over time. Change at the technological level can be grouped into two categories in terms of providing sources of information: *relational* and *non-relational*. As an example of the former, with developments in the Internet, individuals can now seek advice, information, collaborate and communicate overcoming temporal and spatial barriers as well as offer new modes of communication (synchronous and asynchronous) (Wellman et. al., 1996). Furthermore, they also cross hierarchical and departmental barriers, change standard operating procedures and reshape work norms (Sproull et. al., 1991; Rice, 1994). Abundant studies have reported on how communication technologies have extended information reach and enabled acquisition of useful information for individuals (Constant et. al., 1994) and occupational communities through weak ties (Pickering et. al., 1995), despite lack of personal connections with others (Constant et. al., 1996). Furthermore, individuals tap into online communities and portals where benefits of social support, influence and information advantages are plenty (Butler, 2001). However, such online communities and other artefacts within the online space also serve as a *non-relational* source of information. For instance, most Internet-based discussion groups provide summaries of communications to its members via email digests, irrespective of whether members participate or lurk. Furthermore, professional associations, company newsletters, online databases, journal repositories and online search engines such as Google provide readily available information matching almost the same credibility and quality as from a relational source (Henry et. al., 2001; Zimmer et. al., 2007). Subsequently, knowledge-intensive workers, who need to rely on updated and correct information to provide the highest

quality of work, are those who should perform better. In light of these arguments, we state the following hypothesis:

H3a: Use of ICT for professional communication activities is positively associated with individual performance

While the study anticipates that those who use both relational and non-relational sources of information will be better positioned to perform better, it is equally important to understand the factors that are conducive or contradictory to the relationship between ICT use and social structure. In other words, the question to ask is - what forms of network structure at the individual level are conducive to ICT use at the task and sociological levels? Alternatively, does the uptake and use of ICT foster change in network structures at both task and sociological levels? To this end, there are various theories that have been postulated. For instance, the rational choice model explains that individuals choose to use technology based on the best match between the kind of technology available and the task at hand along with a whole set of factors such as media accessibility, usage experience, personal preference, time and cost advantages (Culnan et. al., 1987). In particular, media use theory, a proponent of the rational choice model, argues that individuals choose media through a matching process. This matching involves assessing the requirements of the particular communication task at hand and selecting a medium with communication capabilities that match the requirements (Williams, 1979). Along the same lines of the rational choice model, social presence theorists argue that individuals choose media based on social presence, which is the degree to which the medium facilitates awareness of the other person and interpersonal relationships during the interaction (for example, on a scale from high to low social presence, face-to-face is highest and print media has lowest social presence) (Short et. al., 1976). Yet another alternative view of the rational choice model is the information richness theory whereby communication media are arrayed along a continuum of "information richness" based on four factors: the degree to which the source is personal enough, speed of feedback, types of channels used for communication and the richness of the communication (Daft et. al., 1981).

However, the social influence model is a more comprehensive model that encapsulates and accounts for the dynamics of social influence in explaining ICT use. While the rational choice model argues that choice of ICT use is objectively rational and that behaviour is efficiency-motivated, it fails to explain why certain individuals choose to use ICT although their motivations may not be efficiency-motivated. For example, when various forms of ICT are introduced, there is consistently growing literature that demonstrates social influence as potent predictors of use (Fulk et. al., 1990). In case of introducing new ICT in organisations, strong ties are useful predictors for its use (Haythornthwaite, 2002). The phenomena of social processes and human action in such cases are beyond explanations of the rational choice model therefore paving way for a model that captures these phenomena.

The social influence model (Fulk et. al., 1990) starts with the basic assumption that individuals cognitively process stimuli. It argues that perceptions of ICT are subjective and socially constructed and can be determined to a substantial degree by the attitudes, statements, and behaviours of colleagues. Colleagues exert social influence through overt statements about characteristics of the media or tasks that individuals absorb mentally within their perceptions. The influence may also take place through vicarious learning from observing the experiences of others. Thus, if an individual observes effective behaviour by another, the observational learning produces similar behaviour by that individual. In sum, the social influence model postulates that for any application, an individual's ICT use is "a function of: (a) media evaluations (perceptions and attitudes); (b) experience and skills; (c) social influence in the form of direct statements by co-workers regarding the application, vicarious learning, group behavioural norms, and social definitions of rationality; (d) tasks evaluations; and (e) situational factors such as individual differences, facilitating factors, and constraints" (Fulk et. al., 1990, p. 127). The shaded box in Figure 2.10 highlights the *social influence* model for ICT use:

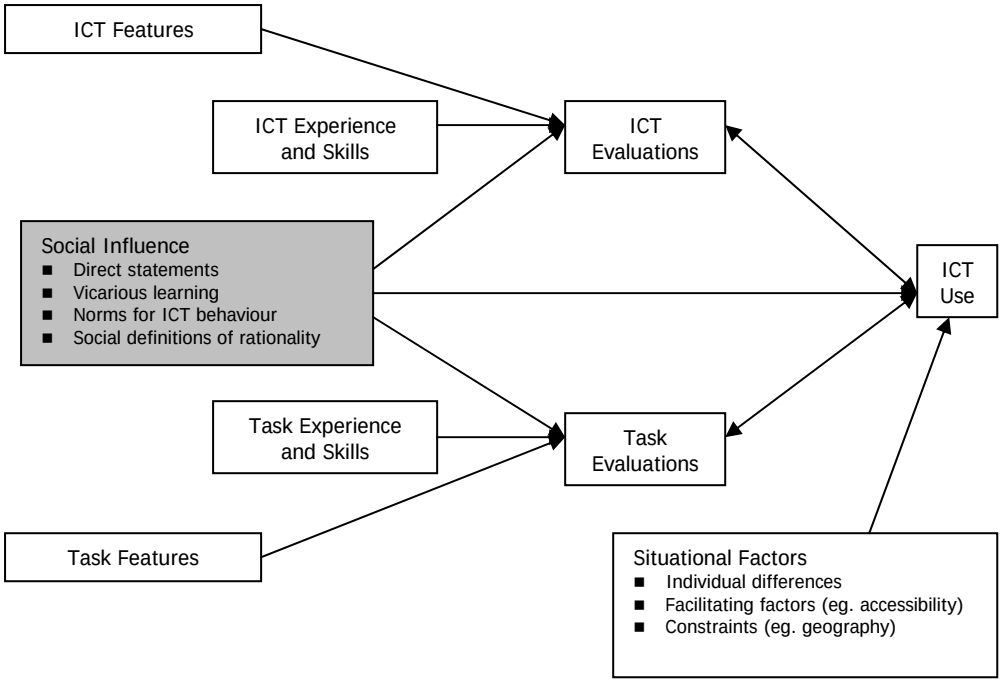


Figure 2.10: Social Influence Model of ICT Use
Adapted from Fulk et. al. (1990)

Given these postulations from the social influence model, it helps to explain why a study in a large insurance firm found similar patterns of usage of voicemail among colleagues occupying the same structural network position (Shook, 1988; Shook, 1990). Similarly, Rice et. al. (1990) found similar patterns of email adoption among colleagues who were closely connected. In a subsequent study, Rice (1994) found that the amount and network measures of email usage were significantly associated with work and work familiarity networks. Furthermore, as ICT such as email, networked databases, and group decision support systems vastly increase interaction opportunities, potential for information sharing and diversity amongst individuals such as knowledge-intensive workers also increases. Information seeking in social contexts is thus a function of social influence in terms of network structure (Cross et. al., 2001). Therefore, for individuals in knowledge-intensive work, we hypothesise the following:

H3b: Use of ICT for professional communication activities is positively associated with efficiency of an individual's network in knowledge-intensive work

H3c: Use of ICT for task-level activities is positively associated with degree centrality of individuals in knowledge-intensive work

H3d: Use of ICT for task-level activities is positively associated with functional diversity of an individual's professional network

2.5.2 Task Level Effects – Efficiency of Productivity Gains

While literature in Information Systems widely recognises that ICT allows for adding intellectual content to work (Zuboff, 1988) and synergistic goal achievement when used and aligned properly with the task at hand (Goodhue et. al., 1995), such effects are captured under primary or *task-level efficiency* effects according to Sproull and Kiesler (1991). Most common in the literature are task-level studies of associations between ICT use and productivity at the industry, firm, group and individual levels (Mukhopadhyay et. al., 1997; Drury et. al., 1999). Theoretically, the main arguments that contend information should enable efficiency or productivity gains (Bulkley et. al., 2005) are through *reductions in uncertainty* (resulting in better decision making and resource allocation) and *sharing of simple task level information* (resulting in better search and quicker access to information). It is important to recognise that the mere existence of ICT per se does not impact any of the levels aforementioned. What is important is its use and that at the core of all industry, firm or group levels, it is the individuals who use the ICT, and in turn through their actions, change the conduct of their work in response to the availability of ICTs. Reverting to Orlikowski's (1992) model, this change coupled with innovations in the development of ICT have allowed individuals to overcome mundane and routine tasks, multi-task, and achieve higher productivity (Goodhue et. al., 1995). A critique however, is that the mechanisms by which ICT affect performance in the aforementioned studies remains poorly modelled and understood (Aral et. al., 2006). Furthermore, as documented in the previous section, these studies tend to undermine the significance of ICT in enabling new forms of communication and work organisation that overcome synchronous-asynchronous, temporal and spatial

barriers (Hinds et. al., 1995). Therefore, it is important to understand how ICT affects information work at the individual level and at the detailed task level for any domain of study.

Generally, the term *ICT use* connotes technology acceptance and is a primary variable which affects individual performance. The technology acceptance model postulated by Davis et. al. (1989) argues that the degree of user acceptance of technology positively affects the *usage* of technology, which in turn affects performance. Users therefore do not use technology if it constrains them or does not satisfy the accomplishment of their task or communication purpose (Drury et. al., 1999). Conversely, the *patterns* and *frequency of usage* of certain ICT by an individual for certain tasks indicate one's willingness, comfort and ease of use, and therefore, acceptance of the technology. According to DeLone and McLean (1992), patterns and frequency of usage of ICT are influential factors of individual impact such as quality, productivity and performance. In Igbaria et. al.'s (1997) study of 625 employees in a large organisation, it was found that user satisfaction on individual performance was actually mediated by ICT use, therefore suggesting the ICT use variable as an indicator of performance.

ICT use has been primarily ascertained by measuring the attitudes of individual users in terms of tasks for which it is used, the frequency of use, and perceived ease and comfort of use. Such attitudes of individual users towards ICT are quite important, mainly because a positive attitude is usually indicative of technology acceptance (Mahmood et. al., 2000), which in turn allows the user to believe that using the ICT would enhance his or her performance (Davis et. al., 1989). The premise of measuring attitudes stems from the theory of reasoned action which describes an attitude as a "predisposition to respond favourably or unfavourably to an object, person, event, institution, or another discriminable aspect of the individual's world" (Ajzen, 1988). Therefore, this study argues that attitude towards behaviour is a direct determinant of the behavioural intention to perform the behaviour.

Measures of ICT use for task-level activities in knowledge-intensive work include indicators of patterns and frequency of use. In organisational settings, some example indicators of ICT

use were (1) the number of computerised applications used by employees, and (2) the number of business tasks for which ICT is used (Igbaria et. al., 1997). Similarly, in studies of technology use by medical professionals, *frequency of use* of computers for *clinical functions* such as prescribing, electronic health record functions, generation of computerised patient lists and so on are generally asked (Western et. al., 2003; McInnes et. al., 2006). Therefore, for measuring ICT use, it is useful to ask about context-specific use of ICT for task-level activities relevant to that particular domain. Formally stated:

H3e: Use of ICT for task-level activities is positively associated with individual performance

2.6 Network Structure, ICT Use and Individual Performance

From diagram in Figure 2.11 below, it is clear that compared to past studies which have only examined impacts on performance using either constructs of network structure or ICT use without examining in detail its interplay, there have been relatively few efforts designed to increase current understanding of how network structure and patterns and use of ICT influences individual performance. Below, two of them are discussed.

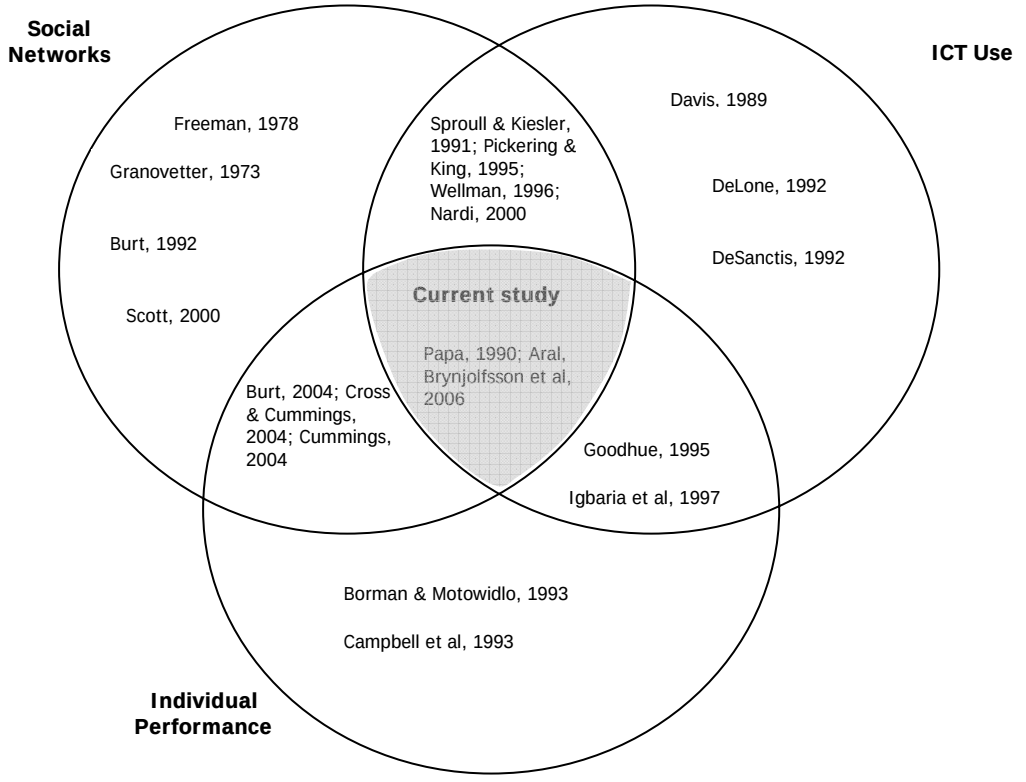


Figure 2.11. Venn diagram showing key literature relevant to the study

In Papa's (1990) study of the relationship between employee performance with new technology and employee communication network variables (activity, size, diversity and integrativeness) in two corporate offices consisting of 301 employees, it was found that network structure was a significant predictor of the speed with which employees increased their productivity ratings. Network diversity, network integrativeness and size were also significant predictors of how quickly employees implemented an innovation in ICT use.

Aral et. al.'s (2006) more recent study of the detailed relationship between information worker output, information flow (measured using betweenness and structural hole measures), information technology, multitasking and project duration (as performance measures) showed that network position was highly correlated with performance. The domain of the study was a mid-sized recruitment firm with team-level and individual-level data available. Two significant contributions from the study were: (1) demonstration of detailed task-level evidence of information worker output, and (2) objective measures of information flows through social networks, thereby allowing a higher resolution microscopic view to study organisational phenomena.

In summary of the previous sections and in addition to the above arguments, it can be postulated that those who are in an advantageous network position and who use ICT for both task-level and non-relational and relational forms of obtaining information are those who perform better. In other words, individuals who are structurally autonomous and who capitalise on ICT use for both task-level and communication-level purposes are those who can perform better. The argument is based on three reasons: (1) those who are using ICT for communication purposes are those who have *accepted use* of the technology and are using it for both relational and non-relational information acquisition, (2) such individuals are more 'tech-savvy' (ICT literate) and are continuously influenced by non-redundant social peers about novel information and new developments in technology and professional know-how work through vicarious learning, and (3) at the task-level, their literacy and knowledge about new task and technology know-how continuously feeds and assimilates into the individual's

professional state of mind and attitude towards work allowing them to capitalise on information and control benefits to perform better. In the following section, the importance of personal attributes and the link to professional networks, ICT use and performance concepts are highlighted. Finally, the domain is described within which the theoretical model for the study is applied and operationalised.

2.7 Personal Attributes, Professional Network, ICT use and Performance

Although it has been ascertained that structure of relations among actors and their network positions have important behavioural, perceptual and attitudinal consequences for individuals, one cannot discount the importance of personal attributes that affect and individual's network structure, relational aspects and network position. In this section, the importance of personal demographic attributes such as organisational affiliation, qualification, experience and gender and its effects on social network attributes is highlighted.

Firstly, gender has long been recognised as an important factor that is linked to individual outcomes in the social sciences. Men and women often differ in the nature of their interpersonal exchanges and in their opportunities for social interaction (Dykstra, 1990). The differences in the interpersonal style of women compared with men have stimulated a good deal of interest as a possible source of variation in the interpersonal aspects of a variety of domains, including areas of knowledge-intensive and geographically distributed work (Eagly et. al., 1990; Aries, 1996). For example, women tend to reveal more information about themselves in conversations (Dindia et. al., 1992), are better facilitators and moderators in communication than their male counterparts, and are more intimate, warmer, and more engaged in non-verbal communication than men (Hall, 1984). In the medical practice domain for example, it is no different. Female physicians facilitate a more open and equal interaction with patients as well as colleagues, and a unique therapeutic milieu from that of male physicians (Verbrugge et. al., 1981; Weisman et. al., 1989). More recently, a meta-analytic review of 26 articles in the MEDLINE, AIDSLINE, PsycINFO and Bioethics databases from 1967 to 2001 accounted for physician gender effects in medical communication. It was

concluded that female physicians engage in significantly more active partnership behaviours, positive talk, psychosocial counselling, psychosocial question asking and emotionally focused talk than male physicians (Roter et. al., 2002). In light of these arguments, it is anticipated that the network structure, position and ties will be influenced by such attributes in the process of professional socialisation. Therefore, the following hypotheses can be postulated:

H4a: There is a significant difference in degree centrality between gender-based ego-networks in knowledge-intensive work

H4b: There is a significant difference in constraint indices between gender-based ego-networks in knowledge-intensive work

H4c: There is a significant difference in professional tie diversity (geographically and functionally) between gender-based ego-networks in knowledge-intensive work.

With regards to ICT use, a review of past gender-technology literature shows that there is evidence that women's continued discomfort with technology remains at the centre of the social construct of gender and technology (Bray, 2007). However, it is not anticipated that gender difference would influence ICT use at both the task or communication levels. This conjecture stems from abundant literature which finds no significant difference in the adoption and use of technology. For example, quantitative data show that in the US and Australia, men and women use the internet in nearly equal proportions and there is no significant difference (Singh, 2001). Similarly, in knowledge-intensive work such as primary care, it was reported that there is no gender difference in views about adoption or ease of use of ICTs by male and female general practitioners as they think that computers are equally easy to use at the task level (Western et. al., 2001). Therefore, in knowledge intensive work, the following hypothesis is stated:

H4d: There is no significant difference in the frequency and pattern of ICT use for task-level and communication-related activities between genders in knowledge-intensive work.

Another valid demographic attribute irrespective of gender that is speculated to influence network structure, ICT Use and performance is education and professional qualifications of individuals in knowledge-intensive work. Inferring from previously discussed theories about work structural diversity, ties and performance (Cummings et. al., 2003; Cross et. al., 2004), and technological effects on performance (Aral et. al., 2006), it is anticipated that individuals who are accredited or affiliated with professional memberships related to their work or who take on the responsibility of additional functional tasks (such as hospital appointments in primary care) will enjoy the advantage of greater diversity in professional network ties, higher degree of interaction, higher usage of ICT for task and communication purposes and a higher level of performance as well. Therefore, the following hypotheses are postulated:

H4e: There is a significant difference in ego-network density between holders and non-holders of professional appointments in knowledge-intensive work

H4f: There is a significant difference in ego-network efficiency between holders and non-holders of professional appointments in knowledge-intensive work

H4g: There is a significant difference in degree centrality between holders and non-holders of professional accreditations and memberships

H4h: There is a significant difference in functional tie diversity between holders and non-holders of professional accreditations and memberships

H4i: There is a significant difference in ICT use for task-level and communication related purposes between holders and non-holders of professional accreditations and memberships

H4j: There is a significant difference in performance attitude between holders and non-holders of professional accreditations and memberships

2.8 Context of the Study – Rural General Practitioners of NSW, Australia

In order to validate the above hypotheses that form the conceptual and theoretical model for the study at an operational level, the chosen context of the study is the rural general practitioners (GPs) of New South Wales, Australia. The Royal Australian College of General

Practitioners (RACGP) defines "general practice" as "the provision of primary continuing comprehensive whole – patient medical care to individuals, families and their communities" (RACGP, 2004). Rural GPs are considered knowledge-intensive workers because of the nature of their work – extensive medical expertise, high patient to GP ratio, long work hours, usage of advance medical technologies, provision of diverse healthcare services and so on (Humphreys et. al., 1998). GPs working in rural areas are geographically more isolated from populated practices. Furthermore, rural GPs often carry out procedures in situations with limited resources or personnel and are implicitly required to adapt to protocols and codes of conduct of rural settings (Mellow, 2005). In knowledge-intensive work, knowing where and whom to obtain information from is crucial. Although most of the general practices in Australia are computerised (Western et. al., 2003; McInnes et. al., 2006), the level of use and support remains suboptimal to date. In particular, there have been no studies known of conducted in Australia about the rural GPs' use of ICT for professional communication or obtaining useful information. Furthermore, studies that consider the effect of ICT on task-level activities within the context of GPs in rural Australia are lacking. Thus, there is much to capitalise on the task-based value and the social connectedness that ICT enables especially for GPs in rural and isolated areas. Such problems and others such as decreasing performance as GPs age, lack of association with professional peers, obsolescence with modern technology, and isolation from community not only hinder performance but makes this study potentially interesting and practically useful (Choudhry et. al., 2005; Chung et. al., 2005b). It also provides justification for the GPs as knowledge-intensive work subjects for this study.

2.9 Towards a Social Networks-based Model for ICT use and Performance

2.9.1 A note on Organisation

A commonality of Papa's (1990) and Aral et. al.'s (2006) study described earlier is that both focused on knowledge-intensive individuals working within the boundaries of an organisation defined by corporate structure and hierarchy. In this research, the focus is on individuals within organisations which defy such structure and who are rather dispersed across

geographical areas, yet having the same common values and organisational goals. Although most of the research evidence discussed above pertains to organisational settings in terms of formal bureaucratic structures, this study adopts the view of an organisation postulated by Arrow (1974, p. 26), who contends that there are many other organisations besides the firm. Companies, universities, or government institutions are not the only forms of organisations. Ethical codes and systems that guide individual norms (e.g. market system of demand and supply) can also be interpreted as organisations (Arrow, 1974, p. 33). Firms typically comprise of individuals who on the basis of collective understanding perform tasks to achieve organisational goals. Van Maanen and Barley (1984, p. 38) note that organisations consists of many individuals therefore comprising a unique social world because of the rich interactions between one another and the common norms and practices that they share. These individuals need not be functioning under the same physical organisation, but may also be in dispersed locations such as in the case of occupational communities, such as doctors (Pickering et. al., 1995).

2.9.2 Performance

Performance is essentially a multi-dimensional construct that varies in different contexts of work. Borman and Motowidlo (1993) conceptualised performance in terms of task-based performance and contextual-based performance. They defined task-based performance as "the proficiency with which job incumbents perform activities that are formally recognised as part of their jobs, activities that contribute to the organisation's technical core either directly by implementing a part of its technological process, or indirectly by providing it with needed materials or services" (Borman et. al., 1993, p. 75). On the contrary, contextual performance is defined as behaviour that support the broad organisational, social, and psychological environment of the organisation in contrast to behaviours that support the organisation's technical core. In this study, 'performance' is about *task-based activities* that are core to a GP's practice, such as the process of diagnosis and prescription. In particular, it relates to "the

provision of primary continuing comprehensive whole patient medical care" as per the definition of general practice.

Although the notion of performance is a complex concept to encapsulate, its measurement poses an equally difficult challenge. In the general practice domain, for example, a systematic review of 59 empirical articles from the MEDLINE database found that as doctors age, the quality of medical care delivered by them declines dramatically (Choudhry et. al., 2005). Age was defined in terms of the number of years since graduation from medical school, or years since certification, or the practitioner's age as the explanatory variable. 59 empirical articles were found and systematically reviewed, and data on 62 groups of relevant outcome were reported. 'Appropriate care' was categorised into four groups based on whether the studies evaluated *(1) knowledge, (2) adherence to standards of care for diagnosis, screening or prevention, (3) adherence to standards of care for therapy, and (4) health outcomes.*

A major drawback in the study by Choudhry et. al. (2005) is that performance definition takes on a broad term of 'appropriate care', which is fairly loose and subjective. There is no fine line between what constitutes contextual and what constitutes task-based form of care. It can be argued however that their grouping criteria reflect elements of 'quality of care'. Several studies in primary health care have attempted to define and measure quality of care (Donabedian, 1980; Lawrence et. al., 1997; IOM, 2001). Most of these definitions give rise to concepts and indicators that pertain to clinical measurements of quality of care (QoC). There have also been alternative methods proposed to measure a general practitioner's ability to deliver quality of care such as peer reviews, observations and patient surveys (Franco et. al., 2002; Epstein et. al., 2005). However, there is no specific quality of care standard or a generic form of physician performance index that is available within the context of the general practice consultation (doctor-patient consultation) (Epstein et. al., 2002). Given this predicament, a preliminarily step is to develop an understanding of quality of care that can contribute to GP performance measurement within the context of the study.

Donabedian's (1980) theoretical framework is widely cited for evaluating medical performance in terms of quality of care. He describes three methods to assess quality of care. The first approach is to assess 'structure' – the physical infrastructure, organisation and instrumentalities of care. These include facilities, equipment, human resources and financing. The second method is to assess the 'process of care' – the quality of the way in which care is given. This involves assessment of the care itself and evaluation of the activities of the GPs, namely the GP-patient interaction process (consultation). The third aspect of evaluating quality of care focuses on the 'outcome' of patient care. This refers to the assessment of the end results of care, usually specified in terms of health, welfare, patient satisfaction, patient stress, and so on. Assessment of "structure" and "outcome" is beyond the scope of this study, clearly because data is not readily available for the assessment of structure and assessing health outcomes would mean tracking of health progress of patients which could take years. Therefore, the 'process of care' dimension is relevant for this study. Furthermore, because the scope of the research is limited to the "provision of primary continuing comprehensive whole patient medical care" (as per the definition of general practice), the *'process of care'* dimension between the GP and patient is regarded as relevant for the study. In particular, the *effectiveness* of the GP in delivering "comprehensive-whole" medical care is of interest.

2.9.2.1 Attitudes to Process of Care

Given that there is currently no generic performance index of GPs, a proxy to measure the effectiveness of GPs in delivering medical care is to account for their behaviour in actual practice. Ideally, this would entail ethnographic accounts of what was actually observed in the consultation process and whether the practice equates to components of 'good quality' patient care. However, this would most likely be an obtrusive and expensive exercise time-wise and resource-wise. Therefore, an alternate method to study behaviour is to find out and empirically evaluate the self-perceived attitudes the GP hold towards the processes of medical care as research in social psychology suggests a strong association between attitude and behaviour.

Most commonly defined, "attitudes are predispositions to respond to some class of stimuli with certain classes of responses and designate the three major types of response as cognitive, affective, and behavioural" (Rosenberg et. al., 1960, p. 3). This definition has wide appeal in social psychology because of its breadth and ancient philosophical roots. In particular, the cognitive component represents the knowledge and perceptions that an individual develops through experience or information related to the attitude object. The affective component is the individual's intuition that captures an individual's global assessment of the attitude object, and the behavioural component represents the extent to which the individual will act upon certain attitude objects. Attitudes are also "enduring systems of positive or negative evaluations, emotional feelings, and pro or con action tendencies with respect to social objects" (Kretch et. al., 1962, p. 139). Research in the area of social psychology suggests that the attitude a person holds towards any object is very likely to be related to the overall pattern of a person's response to that object (Ajzen et. al., 1980). Although there have been previous studies showing only weak correlations between measures of attitudes and measures of behaviour toward their objects (Wicker, 1969; Breckler et. al., 1989), Fishbein et. al. (1974) demonstrated that attitude and behaviour are correlated given the following conditions: (1) when the observed behaviour is judged to be relevant to the attitude, (2) when the attitude and behaviour are observed at comparable levels of specificity, and (3) when mediation of the attitude-behaviour relation by behavioural intentions is taken into account. Their findings were largely influential in the development of the theory of reasoned action or planned behaviour (see Figure 2.12), which claims that behaviour is mediated by behavioural intention, which is influenced by attitude and social norms. Furthermore, Fazio (1986) demonstrated that attitude and behaviour are correlated (1) when the attitude is based on direct experience with the attitude object, and (2) to the extent that the attitude is cognitively accessible.

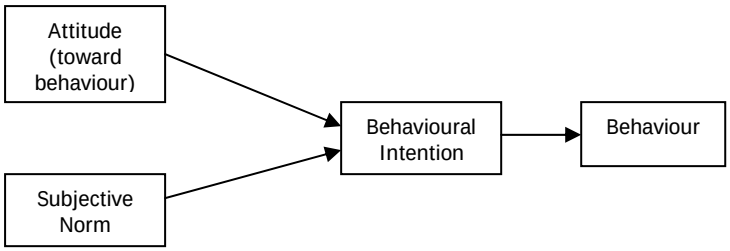


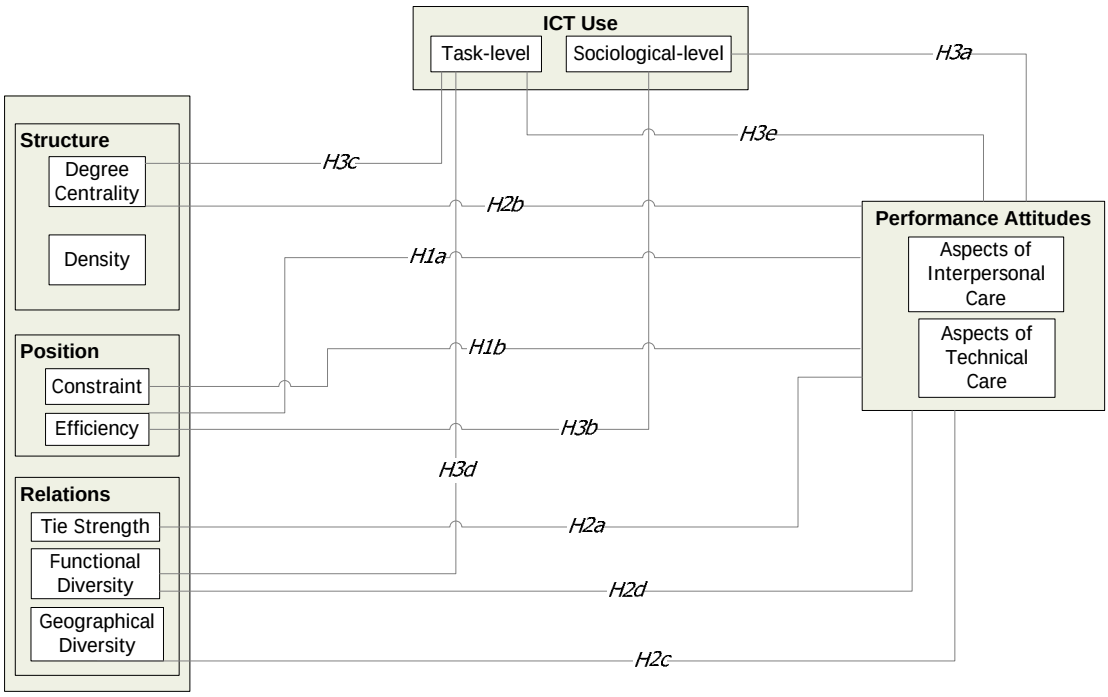
Figure 2.12: Theory of Reasoned Action

According to self-perception theory, behaviour also serves as a source of information for constructing attitude statements (Bem, 1972). Therefore, in work settings, attitudes about work practices is determined by an individual's past behaviour and how these behaviours come to be attributed to the environment or person. Using a social information processing approach to work attitudes and task design, Salancik et. al. (1978, p. 230) argues that "the process of attributing attitudes from action is itself affected by (1) the individual's commitment to the behaviour, (2) the information about past behaviour that is salient at the time the attitude is generated, and (3) social norms and expectations that affect what can be considered legitimate or rational explanations for past behaviour." Plenty of evidence suggests that when individuals are committed to a situation, they tend to develop attitudes consistent with their commitment and their committing behaviour (Kiesler, 1971; Igbaria et. al., 1997). For example, Breer and Locke (1965) present extensive laboratory evidence in support of their theory that the beliefs, values, and attitudes of individuals are determined by their task experiences. More specifically, in Svenning's (1982) research in a large petrochemical firm, it was found that a significant predictor of attitudes toward videoconferencing was an individual's perceptions of the opinions and supervisors about videoconferencing and its use.

In the case of general practice, as stated previously, GPs are guided by physician charters, medical standards and norms of practice. They are subject to norms of diagnosis and prescription which are fairly standard in the consultation process. Moreover, the nature of their tasks is also fairly specific to the extent that their behaviour affects the attitude attribution process. The attitude formulated in turn is charged with emotion which predisposes a class of medical actions towards consultation during medical practice. Therefore, although

behaviour changes attitudes, attitudes are developed from justifying past behaviour. Given the above arguments, it is important to find out how GPs see their role in terms of the processes of care during the consultation process because firstly, their perceptions are very likely to influence their behaviour in the consultation, and secondly, they allow for comparison with views held by other GPs (and patients as well). Therefore, the argument acknowledges that although the attitude of the GPs is not a *sole or sufficient cause* of behaviour, it is a *contributing cause*.

2.9.3 Research Model



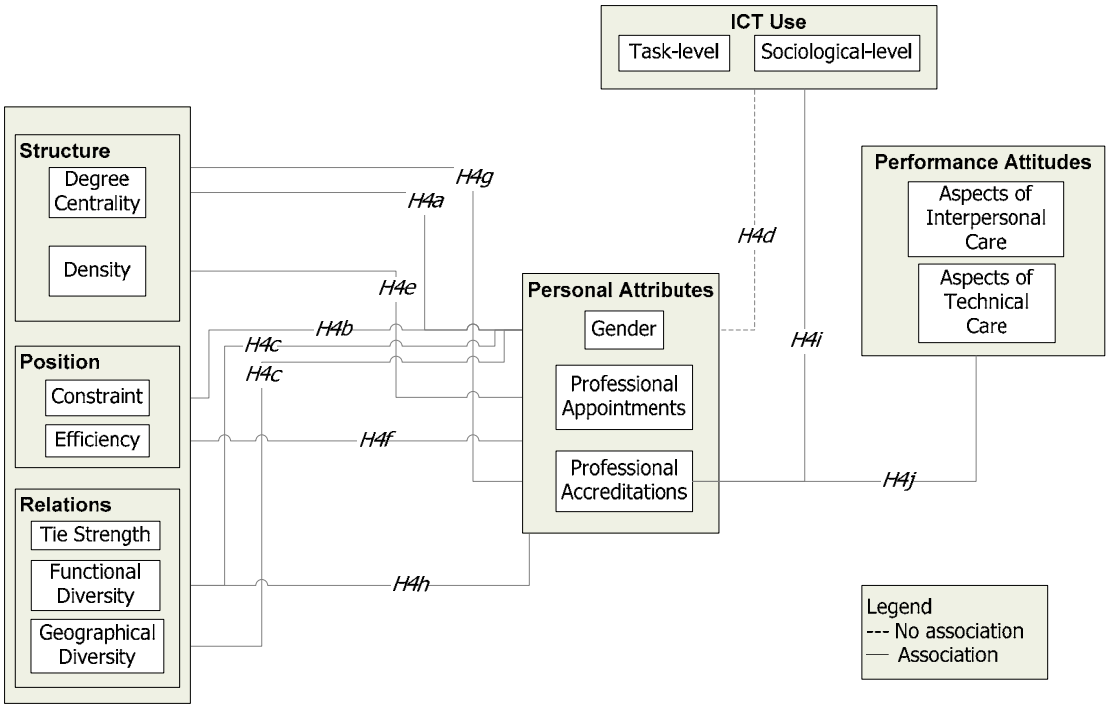


Figure 2.13. Theoretical Model for the Study (with and without personal attributes)

So far, the discussions mentioned above have drawn on theories from sociology, social network studies and information systems which relate to individual performance. Having established that performance is also influenced by attitude, the research model is different from past studies that have studied performance through a social networks and technology use perspective. While both Papa's (1990) and Aral et. al.'s (2006) research utilised the sociocentric network approach of gathering data from individuals, the novelty of this egocentric study lies in the fact that it is able to highlight a feasible approach for conceptualising and measuring an individual's (1) *personal professional* network for seeking advice (2) extent of *ICT use*, and (3) *performance* in rural and geographically dispersed settings. Furthermore, each knowledge worker's case is quite unique or disparate to some extent depending on the demographics (e.g. education, gender, hospital appointment) characterising the area they work in. The theoretical model is depicted in Figure 2.13 (above: without personal attributes; below: without network and ICT attributes).

The model can be described in the context of a GP's workflow during the consultation process along with the hypotheses developed from the literature. As GPs in rural areas work

progressively, it is assumed that they build their own professional network of contacts. They would have to know where to refer patients to in case specialised services (e.g. gynaecology) are required. They would need to know where x-rays need to be taken or where specialised help is available. Although it is not impossible to practice in isolation, it is anticipated that GPs who are structurally well positioned in their professional network are progressively fed with novel or useful information that would assist in their work, for example, prescription of a new drug, accuracy of diagnosis of symptoms and so on. Conversely, GPs who are unable to tap into such professional networks that provide information benefits are anticipated to be relatively poorer in performance. These arguments pertain to *H1 – the network position hypotheses*.

It is inevitable that there are GPs who have practiced within the same practice or in a different one within the rural community for a long period of time. Such GPs are bound to establish close ties not only with patients and the community, but would have also developed close relationships with other health professionals and fellow GPs. In such cases, it is anticipated that discussion of medical problems ranging from the minor ones to the most complicated ones would be facilitated by the strong ties. Through these same ties, technical knowledge, or information about advances in technology can flow through the social exchange easily. Furthermore, along the lines of structural holes theory, those GPs who tap into a diverse group of people, for instance, through attending an annual conference where health professionals gather, are also able to obtain useful or novel information through such diverse ties. It is anticipated that GPs with ties that are much more diverse than those whose ties are relatively not perform better. These arguments relate to *H2* – the *network structure and relational hypotheses*.

The other major construct concerns the nature of ICT use – that is, the types, patterns and frequency of use of various technologies that assists GPs with their medical tasks as well as professional communication and information seeking tasks. Most Australian rural general practices have at least a computer that is generally used for medical administration and

prescription tasks. For example, the most commonly used software, "Medical Director" is capable of not only storing patient diagnosis details and maintaining prescriptions but also drug interaction checking, which is useful in the prescription process. Some practices however, harness the full utility of the technology not only for task-related purposes, but also for GPs, specialists, nurses and even patients to be connected online through local networks and online portals via the Internet. For example, Medisphere (www.medisphere.com.au) is an online portal where rural GPs can connect online, interact with other GPs, post comments, email and exchange a wealth of useful information through the portal. It also allows other medical professionals (e.g. pathologists) to check on status of reports as well as health status of patients. It is therefore anticipated that GPs who capitalise on the use of such ICTs on a regular basis will perform better. It is also anticipated that as GPs use ICTs within a practice for both tasks and communication purposes, the size of their professional network increases. These *ICT Use* hypotheses are reflected in the model as *H3*. Accounting for the professional social networks and the ICT use pattern and frequency together, it is expected that GPs who have achieved structural autonomy and use ICT for task-level and communication and/or online information seeking purposes regularly will perform better than those on the contrary. Such GPs are highly informed as they are central and efficient in tapping into new and required information which are required for delivery of high quality care.

Finally, the theoretical model also depicts the importance of personal attributes such as professional accreditations, professional appointments and gender, that influence individual outcomes such as performance attitudes and ICT use. This is in accordance with personality theory which is linked to Burt's (1992) structural holes theory for understanding the nature of social competition and social outcomes. In the context of rural GPs, it is anticipated that features of an individual such as gender, education, professional practice experience, affiliations with various fellowships of the medical profession, and hospital appointments will have significant associations with their individual network properties, including ICT use and performance attitudes. For instance, it is anticipated that female GP will have a more diverse

network of professional ties as well as higher degree centrality than male GPs. Another example is that GPs who have links with professional fellowships and associations such as the RACGP or the ACRRM would rank higher in performance attitudes given the professional networking opportunities and the professional benefits offered by these organisations. The personality attributes-related hypotheses are classed as *H4* in the model.

2.10 Conclusion

This chapter began with an overview of social networks and the association between analysis of social networks and individual outcomes were presented. For social network scholars, the raison d'être is that the structure of relations among actors and the location of individual actors in the network have important behavioural, perceptual and attitudinal consequences both for the individual units and for the system as a whole (Knoke et. al., 1992). In this context, individual or system level outcomes are treated as a function of network structure and position (Gabbay et. al., 2001). At the individual level, the debate concentrates on how the *structural position* and *relational components* (size and strength) of an individual in the network impacts outcome, such as performance or coordination capabilities, of that person (Borgatti et. al., 1998; Mehra et. al., 2001; Sparrowe et. al., 2001; Reagans et. al., 2003; Hossain et. al., 2006). The chapter reviewed the theoretical foundations of network structure and its implications on performance starting with Bavelas' (1950) and Leavitt's (1951) MIT experiments. It then reviewed Freeman's (1978) notion of centrality as a social network concept that has been widely operationalised at both the social structural and relational level. Centrality indicates the extent to which a person has power, influence, and direct access to resources (information, emotional or instrumental support, and so on) and has been claimed to have an impact on job satisfaction and performance (Sparrowe et. al., 2001). The notion of betweenness centrality as a concept of brokerage control provided foundation for Burt (1992) to argue that individuals who bridges structural holes – the absence of ties among unconnected groups of people are the ones who stand from job promotions, good ideas and better performance. The chapter also discussed the assumptions of structural holes theory and

contrasted it against the assumptions of the strength of weak ties theory. Subsequent hypotheses were provided. It then discussed the implications and important secondary effects of ICT use as it revolutionalised the way individuals create and maintain social ties. The use of ICT is significant to the extent that it affects individual production efficiency at the task level and individual communication structure at the sociological level. The chapter also reviewed the social influence model and adopted aspects of structuration theory as a theoretical motivation to understand the social influences of ICT use and also as an analytic perspective to understand the relationship between ICT use and social networks. Hypotheses relating to network structure, position, ties, ICT use, demographic attributes and individual performance were postulated. In the end, the chapter concludes with a theoretical model for the research, providing discussions on the notion of organisation and performance – how it is defined and operationalised. In the following chapter, the research framework, domain of the study, and study design, including instrument design, validation and administration is discussed.

Chapter 3

3. Research Methodology: Instrument Design, Data Collection & Analysis

In the preceding chapter, a thorough review of the literature on network structure, relevance of ICT use in social networks, and its effects on individual performance was provided. Chapter 2 concluded with a proposed theoretical model for examining in detail the relationship between social network, ICT use and individual performance within the context of an occupational community in dispersed knowledge-intensive settings. This chapter discusses the design and framework for the research. The research design begins with a methodological overview of social network analysis, including a discussion of network data collection approaches and how data is collected from the domain of rural general practitioners in NSW, Australia by using network-centric survey methodology. The design of the survey instrument along with measures and operationalised items for demographic, social network, ICT use and performance components are outlined and discussed. In order to ascertain whether the instrument item sets measure what they intend to measure and whether they are internally consistent, validity and reliability tests are carried out respectively. Sampling strategies, data collection and collation, and various phases of the survey administration process are also discussed. The chapter concludes with a justification for the techniques used for data analysis.

3.1 Social Network Analysis – A Methodology Overview

The collection of data from a social network is similar to the collection of data from a sample of individuals in any general social survey (GSS). However, one key difference is that in designing a social network survey, relational data is collected along with attribute data. Burt (1984) makes a strong argument as to why relational data should be collected in the administration of a general social survey. First, any national GSS (as in the US) is sociology's premiere database of national survey data that can be used for theoretically informed empirical research. This is the same as with the Australian Bureau of Statistics (ABS). Second,

the costs are 5 to 11 minutes of interview time in addition to data processing time. Third, and more importantly, the inclusion of relational data allows for describing and understanding significant aspects of an individual's interpersonal and social environment, social participation, and exposure to normative pressures. Fourth, the analysis of both attribute and relational data (e.g. ethnic background and number of social ties in a workforce) offer richer insights to explain social outcomes. For example, in a study of directors of nursing and clinical directors by West et. al. (1999), the socio-demographic characteristics were correlated with relational characteristics to understand differences in their interaction patterns. The combination of both relational and attribute data therefore offers a very useful way to understand individual outcomes in a given social setting. However, the collection of relational data is quite different from traditional surveys and is laden with operational difficulties and issues which need considerable attention.

3.2 Network Data Collection

The section below highlights and describes the two main approaches to social network data collection – whole network and egocentric network approach.

3.2.1 Whole or Sociocentric Network Approach

The focus of a whole network analysis is on measuring the structural patterns of those interactions and how those patterns explain outcomes, like the concentration of power or other resources, within a group. The underlying assumption is that members of a group interact more than would a randomly selected group of similar size. Sociocentric network analysts are interested in identifying structural patterns in cases that can be generalised (Wellman, 1926; Garton et. al., 1997).

In a whole network study, the actors of the network are usually known or easily determined. This is because a sociocentric network study usually focuses on "closed" networks implying that the boundaries of a whole network are a priori defined. In many cases, this approach remains the gold standard because of its ability to gather data for the entire network. The

network represents the saturation sample of interest and the analysis allows for the results to be generalised to the population. Data collection using a whole network approach usually involves listing the names of the actors in the form of an adjacency matrix. When respondents are administered the network survey consisting of a roster of names, they usually check off the names of people whom they know depending on the name generator question asked. For example, in a general practice that consists of 15 workers including the GP and administration staff, a whole network study may be conducted in order to understand the communication network of the practice. A roster of the names of all the workers (excluding the respondent's) in the practice will be presented to each of the worker. A simple name generation question such as "In the past two months, who have you communicated with more than twice in a week within the practice in order to carry out your daily task?" Obviously, a definition of what constitutes a daily task will need to be provided to the respondent.

An example of a well-applied whole network approach was used by Hirdes and Scott (1998) who undertook the study in a chronic care hospital where random samples of patients, family members and employees were asked to report on relationships with people from each of the constituent groups. The setting in which the whole network study was conducted is interesting because the patients included those suffering from dementia. Given that some patients suffered a high degree of dementia, it was impossible to elicit any form of attribute or relational data from them. The advantage with the whole network approach towards data collection in this sensitive setting is that it allowed investigators to include them in the study.

There are challenges for conducting network data collection using a whole network approach in the context of rural GPs. In the study by Hirdes and Scott (1998), the boundaries were defined in terms of the patients, families and employees who stayed, visited and worked in the hospital. To conduct a whole network study of the GPs in rural NSW would mean that all names of the GPs would need to be known, which would generate a huge list of names (roster) for recall by the respondent. Previous studies suggest that scrutinising through long lists of names and identifying the multiple types of ties with each person on the roster causes

fatigue and recall problems (Bernard et. al., 1982a). Given these difficulties, an alternative strategy for network data collection that trades off respondent numbers with information richness and practicality is the egocentric network approach.

3.2.2 Egocentric Network Approach

In the social network parlance, the person we are interested in is referred to as the "ego" and the people referred to by the "ego" as his affiliate, advisor, friend, or relative, are known as "alters". Coleman, Katz et. al. (1957), in an attempt to understand the underlying social processes of doctors that affect their rate of adoption of a drug called "gammanym", used egocentric SNA to understand the social structure that linked the doctors together. They explained the drug adoption process empirically by using both relational and attribute data. They included all local doctors in the sample in whose specialties gammanym was of potential significance. This ensured that alters named by the doctors were also included in the sample as a result of which social ties amongst the doctors could be determined. 125 general practitioners, internists, and pediatricians were interviewed and this constituted 85 per cent of the doctors practicing in the four cities of interest. Regarding relational data, three questions were asked to each doctor: (1) to whom did he turn for advice and information? (2) with whom did he most often discuss his cases in the course of an ordinary week? (3) who were the friends, among his colleagues, whom he saw most often socially? While the first two questions are name generator and name interpreter items respectively, the third is a significant one because it elicits firstly, the ties and relations between the doctor's contacts themselves, and secondly, the strength of the relationship between the doctor interviewed and the doctor's close social contacts. With this information available, the construction of the social network of the doctors becomes complete. Attribute data of doctors such as age, number of medical journals subscribed to, attachment to medical institutions outside of the community and certain attitudes of the doctors were also collected. The attribute data (about doctors' attitudes) collected allowed for the categorisation of whether a doctor was more "patient-oriented" or more "profession-oriented". It was found that doctors who were generally more

profession-oriented were quicker to prescribe the drug as compared to those who were patient-oriented. More importantly, the relational data suggested that doctors who were generally more integrated with their peers were faster in the adoption of the new drug as compared to those who were more isolated.

A later study explored the professional affiliation and occupational status of 50 clinical directors of medicine and 50 directors of nursing in the UK and claimed that these individual attributes affected the characteristics of their social networks to a certain extent (West et. al., 1999). The two professional groups were chosen because of their probability to have well developed networks and because they were the two most important groups in the medical community in terms of number and power. The authors stratified their sample according to the Binley's Directory of NHS Management and randomly selected the Directors for their study. Similar to Coleman, Katz et. al.'s (Coleman et. al., 1957) study, they asked the following name generator question:

"From time to time, people discuss important professional matters with other people. In the last twelve months, who are the people with whom you have discussed important professional matters?"

Important professional matters included both clinical and managerial issues and were explained to the respondents accordingly. From each of the respondents, five alters were elicited, and socio-demographic data about alters, including the nature of the relationship between the alters were also collected. The research question that motivated the paper was whether network features (density, centralisation and centrality) were related to structural location in the organisational hierarchy or whether they were simply a function of individual characteristics.

West et. al. (1999) utilised descriptive statistical measures of cross-classifications of the different groups to compare the means and the results (from the Pearson's Chi-square tests) of the socio-demographic attributes such as sex, marital status and education across the two groups. Secondly, they compared the means of the variables across the occupational groups

and these variables included age, professional associations, social associations, journals read, network density, degree centralisation and information centrality. A statistical-significance test of the hypothesis that the means were not equal was also conducted (t-statistic). Thirdly, they cross-classified alter's relative rank and ego-alter tie strength against the occupational group to show (using Pearson's Chi-Square test) the statistical significances between the two groups.

3.3 Context and Domain of the Study

Earlier in chapter 1, it was noted that this study is theoretically and methodologically motivated. As noted in chapter 2, section 2.8, the context for exploring the interplay between social network, ICT use and individual performance in this study is the domain of the rural general practitioners in NSW, Australia. To recap, the choice of domain of rural GPs in Australia is important for three reasons:

1. Current studies have linked age and experience of GPs as a contributing factor for decline in performance but have not highlighted the role of social structure and relations that influence performance (Choudhry et. al., 2005).

2. A few studies have measured the computerisation and use of technology in general practices in rural Australia. None, however, have measured ICT use for communication/advice-seeking at relational (e.g. interaction with peers) and non-relational (accessing medical journals) levels for association with performance (Western et. al., 2003).

3. Although the Australian government supports computerisation and connectivity of rural general practices through various financial programmes such as the practice-incentive program[3], little is known about the social influence of peers and colleagues

[3] The introduction of the "Information Technology" component of the Practice Incentives Program (PIP) includes financial incentives (eg. up to $10,000 AUD per doctor per practice in the first year) to general practices using computers for electronic prescribing and those with the capacity for electronic communications.

around GPs that is critical for the adoption and systematic use of ICTs (Humphreys et. al., 1998).

This research builds on the tradition established by Coleman et. al. (1957) and the methodology utilised by West et. al. (1999). Burt's (1984) proposal to General Social Survey (GSS) motivates the methodology for this study. The survey instrument used in this study is based on questions provided by the GSS, with a few modifications to suit the focus on the social (professional) networks of rural GPs. To understand social network effects on performance, both relational and attribute data need to be collected and linked to facilitate analysis. Attribute data includes performance, ICT use, and personal attributes such as age, education, access to journals and medical databases, and memberships of professional and social associations of the GPs. Relational data includes elicitation of maximum 15 alters with whom the GP (ego) discuss important professional matters within a certain time-frame (e.g. past six months), detailed information about each alters, nature of relationship between the ego and alter, as well as the nature of relationship between alters. Details of these data types are described in the following section.

3.4 Toward a Social-networks based Design for Understanding ICT use and Performance

This section is the heart of the chapter as it delves into the details of the survey instrument design and development process, the qualitative and quantitative data collection process and choice of data analysis techniques for understanding the relationship between social networks, ICT use and individual performance in knowledge-intensive work.

3.4.1 Survey Instrument Design and Development

The survey for this study is essentially designed to cover three broad constructs – social networks, ICT use and performance. The following sections discuss the measurement concepts that operationalise each of these constructs. Firstly, the social networks construct is decomposed into three categories of network structure, position and relations. Secondly, the ICT use construct is decomposed further into task-level ICT use and communication-level

ICT use. Thirdly, performance is broken down into aspects of technical care and aspects of interpersonal care. The survey instrument can be found in Appendix E.

3.4.1.1 Egocentric Network Design and Items

As highlighted earlier, it is relatively expensive and non-feasible to conduct a sociocentric network study for the scope of this research because (1) it involves the entire GP population in rural NSW; (2) it requires forming a roster of all GPs and colleagues (alters) whom the ego GP would know and then asking the ego GP to elicit the relationship between all the alters. For this reason, the egocentric network approach is more practical, less expensive and hence adapted for the study. Furthermore, it also allows the ego GP to freely recall alters and may include alters not conceived of by the researcher. In contrast, this would not have been possible with the sociocentric network approach.

In this research, the following name generator to elicit names from a GP's professional network[4] is used:

> *"By 'professional network', we mean professional people whom you associate, interact or work with for the provision of care to patients (e.g. nurses, admin staff, specialists, pathologists, doctors etc.) Looking back over the last six months, please identify people (up to 15 maximum) who are important in providing you with information or advice for providing care to patients."*

Name interpreter questions are also commonly asked to elicit some attribute data about the alters and ties. In this study, GPs were also asked to provide their occupational roles and proximity of work with their alters. The justification for including these items originate from literature which suggests that occupational hierarchy of health professionals affects the nature of clinical practice (West et. al., 1999; , 2005a) and that work proximity and tie diversity affects work performance (Kiesler et. al., 2002; Cummings et. al., 2003; Cross et. al., 2004; Cummings, 2004). Other name interpreter items solicited were strength of each tie, measured

[4] Although the term 'social network' has been used through chapters 1, 2 and 3, for the purpose of this study, it refers to the 'professional network' of the ego GP.

by “time known the person”, “frequency of interaction”, “type of relationship”, and “degree of closeness” (Granovetter, 1973; Marsden et. al., 1984; Marsden, 1990). Attribute data about the frequency of interaction via email, telephone (including mobile), and video conferencing were also included in the instrument to segregate face-to-face and ICT media interactions.

A significant question in the egocentric approach concerns asking the ego about the relationship between elicited alters in order to complete the network structure. In this research, GPs were asked to determine how the members of their professional network relate to each other based on a five point degree of closeness scale ranging from ‘especially close’ to ‘do not know each other’. In other words, for each alter nominated, the GP would determine a closeness scale for every other alter. Although this approach has been criticised in the past for its recall reliability and accuracy (Bernard et. al., 1982a; Bernard et. al., 1982b; Bernard et. al., 1985), later studies confirmed that people also remembered long-term or typical patterns of interaction with other people rather well (Freeman et. al., 1987; Corman et. al., 1993). Furthermore, and as discussed earlier, the free recall method (in egocentric approach) elicits a richer data on the social networks of people whereas the fixed choice method (in sociocentric approach) influences people to elicit accurate information on the most important relationships (i.e. strong ties) (Hammer, 1984).

3.4.1.1.1 Measures of Network Structure – Density and Degree Centrality

Generally, the first measure of network structure is usually described by how cohesive the ego network is. For example, in order to ascertain network position (measured by efficiency and constraint) of an individual within a network, the results should be interpreted in light of the cohesiveness of the network. *Density* is a measure of network cohesiveness and is the ratio of existing number ties to the maximum possible ties possible. For an undirected graph with *n* nodes, density D is defined as:

$$D = \frac{\sum_{i,j=1}^{n} x_{ij}}{n(n-1)/2}$$

where x_{ij} is the value of the connection from i to j.

Degree centrality (C_D) is measured as the count of the ties (a) to the ego (p_k) (Freeman, 1978). In graph theoretical terms:

$$C_D(p_k) = \sum_{i=1}^{n} a(p_i, p_k)$$

where $a(p_i, p_k) = 1$ if and only if and are connected by a line, 0 otherwise.

3.4.1.1.2 Measures of Network Position – Efficiency and Constraint

In order to measure efficiency, it is first necessary to compute the effectiveness or effective size of the ego network. Effective size is the number of non-redundant contacts within an ego network. It is measured as the number of alters minus the average degree of alters within the ego network, not counting ties to the ego. Effective size of an actor's (ego) network is defined as:

$$\sum_j \left[1 - \sum_q p_{iq} m_{jq} \right], \qquad q \neq i, j$$

where i is the ego, actor j is a primary contact, and actor q is also a primary contact who has strong ties with the ego i (represented by p_{iq}) and actor j (represented by m_{jq}).

Efficiency is measured by dividing the effectiveness by the number of alters in the ego's network.

Finally, ego c*onstraint* measures the opportunities held back by the extent to which the ego has invested time and energy in relations with alters that lead back to a single contact (Burt, 1992, p. 55). In other words, it measures the extent to which the ego's connections are to others who are connected to one another. Constraint on an actor's network is defined as:

$$\left(p_{ij} + \sum_q p_{iq} p_{qj} \right)^2, \qquad q \neq i, j$$

where i is the ego, actor j is a primary contact, and actor q is also a primary contact who has strong ties with the ego i (represented by p_{iq}) and actor j (represented by p_{qj}).

3.4.1.1.3 Relational Measures of Tie Strength and Diversity

Marsden and Campbell's (1984) work on measuring tie strength is frequently cited wherever there is mention of measures of tie strength. Extending Granovetter's theoretical notion on tie strength, they found that 'emotional closeness' was the most valid indicator of tie strength over the other indicators of 'frequency of contact', 'reciprocity of services' and 'intimacy' (mutual confiding). Besides emotional closeness, 'frequency of contact' is widely used as a proxy for tie strength (Lin et. al., 1978; Granovetter, 1995). The other indicators are highly subjective and have not been widely adopted by studies to date. In this study, emotional closeness and interaction frequency is used to compute tie strength. The justification for this is that both the variables represent the same dimension of interaction intensity because it uses a work-related definition of closeness (Hansen, 1999) rather than an affective definition, as in most studies (Burt, 1992; Reagans et. al., 2003). These studies have also demonstrated that the correlation between frequency and closeness is very high and confirms that the two measures represent the same underlying construct. For the purpose of this study, tie strength of a GP is thus measured as the average of all its tie strength (frequency and closeness) to all other GPs within the network. Frequency of contact is measured on a five point Likert scale of "daily" to "less often". Similarly, degree of closeness is measured on a four point Likert scale of "especially close" to "distant".

As discussed earlier, attribute data about the ego GP's peers and colleagues such as occupational roles and proximity of work with them is also collected. This allows for the computation of the functional diversity and geographical diversity index. Both measures are computed using an entropy-based diversity index developed by Teachman (1980):

$$H = -\sum_{i=1}^{s} P_i (\ln P_i)$$

where if there are N possible states in which the system can be, P_i is the probability that the system will be found in state i, the only exception being when the a state is not represented in the case of which the value is 0 (Ancona et. al., 1992).

Therefore, if a GP has ties to professionals from diverse occupations, her functional diversity would be high. Similarly, if a GP has ties to professionals who are from differing cities and towns, her occupational diversity would be considered high.

3.4.1.2 Measures of ICT Use

In this study, ICT includes computers, technological software applications and systems such as Medical Director (a customised medical practice software popular among GPs), email, video conference and so on. Based on Sproull and Kiesler's (1991) categorisation of the effects of ICT use as efficiency (task-level) and social (communication-structure) effects, ICT use in this study is divided into *task-level ICT use* (for context specific tasks – e.g. clinical tasks) and *internet-related ICT use* (communication and task-level activites). Task-level measures were based on the reliable and valid item sets used by Western et. al. (2001). Internet-related ICT use items were adapted from the survey instrument developed the University of Kentucky's Department of Family Practice in a project supported by the Agency for Healthcare Research and Quality (AHRQ) in the US (Andrews et. al., 2004; Andrews et. al., 2005).

Table 3.1 lists the items measured on a 5 point Likert scale ranging from "daily use" to "never".

Task-level ICT Use (clinical tasks)	**Internet-related ICT use (tasks requiring internet access)**
Generating health summaries	Accessing medical journals (e.g. BMJ)
Recording progress notes	Accessing databases (e.g. PUBMED)
Using decision support functions to help you solve diagnostic problems or make decisions about dispensing or treatments	Accessing clinical guidelines
Writing prescriptions	Accessing evidence-based medicine related information (e.g. InfoPOEMS)
Accessing educational material for patients	Communicating with professional associations (including email)
Receiving or storing information electronically such as pathology results and reports	Access to continuing medical education (CME)
Preparing referral letters for patients	Professional development
Running a recall system to remind patients to return for routine tests	Finding information to help patients
	Email with colleagues
	Communicating with special interest groups

Table 3.1: ICT Use Items

Both the eight task-level ICT use (Cronbach's α = 0.942) and ten internet-level ICT use items (Cronbach's α = 0.900) items demonstrated high reliability.

3.4.1.3 Performance Measures

Since objective measures of performance are not available in the domain of rural general practice (see Appendix F for qualitative interview results), a validated and reliable questionnaire (Cockburn et. al., 1987) for assessing GPs' performance attitudes to medical care to ascertain their perceived effectiveness of clinical and interpersonal care was used as a surrogate measure in this study. Section G of the survey instrument in Appendix E lists the performance items and scales. In order to validate the item sets to see if they can be clustered into few dimensions, a factor analysis was conducted first performing the principal components analysis without rotation on the 17 items [5]. Principal components analysis revealed the presence of five factors with eigenvalues greater than one. These factors accounted for 60.6% of the variance, which is considered adequate in previous research (Hair, 1995). However, the first two factors captured much more of the variance (37.79%) than the other three factors. This was also clearly evidenced from the scree plot (Figure 3.1).

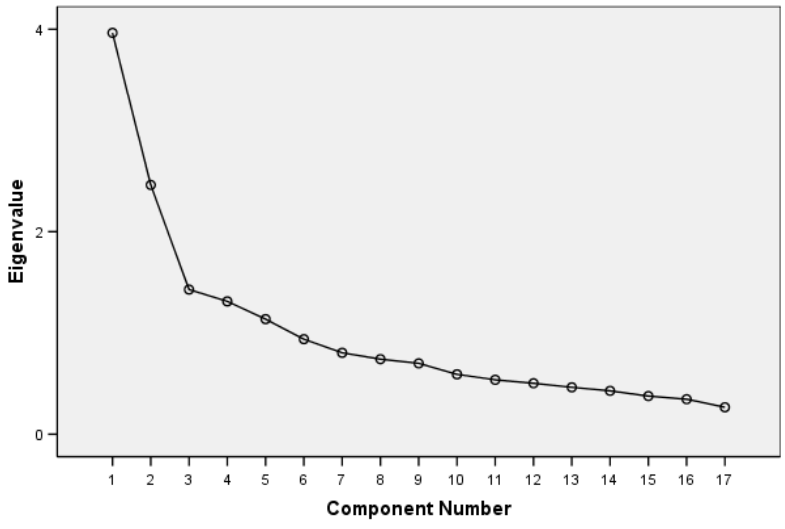


Figure 3.1: Scree Plot of Factor Eigenvalues for Performance Attitudes Items

[5] In order to verify that the data set was suitable for factor analysis, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and the Barlett's Test of Sphericity was conducted. The KMO test yielded a value of .745 (a minimal value of .6 is needed) and the Barlett's test of sphericity was significant *(approx. Chi-square = 482.98, df = 136, p=.000).* These results confirmed the validity of the factor analysis.

Using Catell's (1966) scree test, it was decided to retain two factors (note the clear break after the second component) for further investigation. The second step involved performing the exact same steps but rotating the two factors to simple orthogonal structure using direct oblimin with Kaiser normalisation. The two component solution explained a total of 37.8% of the variance, with the first factor contributing 23.3% and the second factor contributing 14.5%. Finally, items with a high factor loading of at least 0.40 on only one factor in the component matrix were retained (Table 3.2). One item (g15) that loaded relatively low on both factors (lesser than .4) was discarded. Factor 1 can be described as aspects of interpersonal care, and factor 2 as aspects of technical care and this is consistent with literature in quality of care in general practice (Brook et. al., 2000; Campbell et. al., 2000).

Item No.	Item Description	Component	
		1	2
g8	Partnership with patient	.813	
g4	Counselling patients personal problems helps them cope better	.674	
g9	Emotional support for patients	.643	
g6	Identifying modifiable risk factors is very important	.633	
g10	Be frank and open with patients	.621	
g3	Listening to patient worries is an important part of my role	.561	
g2	Ensuring prescribed treatment explanation is understood	.504	
g11	GPs are influential for lifestyle change	.465	
g16	Don't help with psychological problems		.723
g12	Treating physical disease is most important		.676
g14	Patient involvement in treatment decisions		.604
g13	Patients likely to follow GP advice		.598
g17	GP responsible for medical problems		.565
g5	Medical expertise wasted because I see many healthy patients		.486
g7	Patients make convenience of me		.444
g1	Waste of time persuading patients to give up smoking		.415

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalisation.
Rotation converged in 11 iterations.

Table 3.2: Rotated Pattern Matrix for Performance Attitudes

A reliability analysis demonstrated good internal validity and consistency for both factors 1 (interpersonal care) and 2 (technical care) with Cronbach's α=.771 & .720 respectively. The scores were summed up forming a composite score for technical and interpersonal care.

3.4.1.4 Demographic Items

Demographic details were also solicited from GPs. GPs were asked to state the number of years they have been practising as GPs and number of years they have practised in the current practice in order to ascertain their years of experience. This is an important variable as

research has shown that age and clinical experience is a covariate of performance. In particular, Choudhry et. al.'s (2005) systematic review of the literature on GP experience and performance show that quality of care delivered declines as GPs age. Other items that were asked in the survey were year of graduation, medical college and country from which the GP graduated, gender, number of GPs in the practice, whether they had hospital appointments, and if they were members of the 'Fellowship of the Australian College of Rural and Remote Medicine' (FACRMM) and 'Fellowship of the Royal Australian College of General Practitioners' (FRACGP). Inclusion of these items sets and others in the instrument were confirmed and validated with GPs from NSW, including those who held senior positions (e.g., president of the Rural Doctor's Network and president of the RACGP) in the field of general practice (see section 3.5 for details).

3.5 Data Collection: a Triangulation Approach

The data for the research was collected using a triangulation approach, split up into two phases – qualitative and quantitative (the survey component). Prior to instrument development and in order to validate preliminary ideas about the initial conceptual model in the context of rural GPs, it was decided that the ideas need to be confirmed from the field – that is, the rural GPs themselves. Therefore, in order to elicit a richer understanding of GP performance (from the GP's perspective) and its relevance to ICT use and social networks, semi-structured in-depth interviews were conducted by telephone with five experienced GPs out of which four practised in rural NSW regions such as Dubbo, Walgett, Bathurst, and Wellington and one practised in an urban setting in NSW. The interviews were held over the months of December 2005 and May 2006. Every GP was notified of the study and interview appointments were made at least a week in advance through email or through referrals from other GPs. The data collection approach undertaken is therefore a triangulation of qualitative and quantitative methods as discussed below.

3.5.1 Qualitative In-depth Interviews

3.5.1.1 Design and Structure of Interview Questions

The interview questions were designed and planned carefully so that when executed, a systematic flow to the data collection process was achieved (Sudman et. al., 1982; Miles et. al., 1994). Adopting a structured interview means having a set of strict procedures and a rigid interview structure. In general, structured interviews imply asking a set of fixed questions that are read out to the interviewee in a monotonous manner, while maintaining the style of the questioning, probing and promptings. Albeit interviewer bias is reduced to a total minimum, there is no indication of spontaneity and human interjection of interests in the subject matter and hence the scope for human interaction is reduced. On the other hand, an unstructured interview structure was not adopted simply because the data collected would not be theoretically conceivable. The advantage of having the interviews structured to a certain degree also meant that a template of the interview questions were in place so that it could be flexibly adapted to suit the other GP interviewees. Therefore, a semi-structured interview format was adopted. More importantly, the use of semi-structured interviews allows for the interviewer to ask questions in a more open-ended/close-ended manner, depending on the situation. In turn, a sense of freedom for GPs (interviewees) was also achieved in the quality and quantity of their responses. The dynamic and flexible nature of such an interviewing structure allows for a richer understanding of the set of data collected. In many ways, it provides for maximum communicability and also ensures the primacy of the respondent. As guided by Miles and Huberman (1994), the questions in the interview were given considerable thought and well formulated in order to avoid any kind of bias and sought to maintain control of the interview situation. The questions were constructed in such a way so as to avoid resistance, suspicion, prejudice and any sorts of negative forces within the interview environment. The interview questions are outlined in Appendix B.

3.5.1.2 Content of the Interview Questions

The content of the interview questions were primarily motivated by the questions posed by Fafchamps' (1991) ethnographic study of the workflow of physicians' practice and Gask and Usherwood's (2002) framework of medical consultation. In attempting to capture and model information-related behaviour of physicians during the medical consultation, Fafchamps found that physicians tend to ask the following recurring questions to the patients: (1) the reason for (patient's) visit (2) active problems of patient (3) status of health maintenance routine (4) current drugs/treatment undertaken (5) current lab results (if any), and (6) any others (e.g. GPs or specialists) who were seeing the patient. Gask and Usherwood (2002) however, claim that there are three functions in a medical consultation, namely, *Building the Relationship; Collecting Data; and Agreeing on a Management Plan.* The first stage entails the GP building rapport with the patient through warm greeting, active listening and detecting and responding to emotional issues. The second stage involves non-interruption in the process of eliciting the patient's explanatory model in order to develop a shared understanding of the problem. It is quite obvious that the *Collecting Data* stage would involve asking the 'recurring' questions posited above. The third stage involves functions where the GP reassures and advises the patient on medical plans or prescriptions.

While there are a plethora of books and papers on the nature of the medical consultation (see - Stott and Davis (1979)), there are very few that incorporate and emphasise the significance of social and professional networks and ICT use. Therefore, while the first few questions asked about the nature of general practice and the medical consultation in particular, the next set of questions was primarily aimed at exploring whether GPs seek help in professional matters from peers and colleagues when they experience work-related difficulties in the medical practice, and if so, from what kind of people. Such questions were intended to be open-ended and only prompted when the interviewees were in doubt (e.g. If in doubt, the interviewer would state, "Such people may be professional, such as other GPs, specialists, and so on"). While these questions elicited important social and professional networks, the next set of

questions targeted the importance and the kinds of ICT used by the GP, if ICT were used at all. Also, questions that related to the type of ICTs that were used for different types of tasks (e.g. Administrative or Internet-related) were also asked. The questions relating to ICT use were primarily aimed at establishing whether ICT use was seen as a critical component of social and professional connectivity and task performance for the GPs. Finally, the last set of questions was aimed at understanding the GP's notion of performance in the medical consultation. This question is important because the current medical literature is quite ambiguous on the concept of performance in general practice as the term "GP performance" connotes different meanings to different GPs and different medical organisations. Other parts of the questions were demographic questions which asked about the background of the GPs, such as the number of years practiced and year graduated from medical college.

3.5.1.3 Conducting the Interviews

The interviews conducted with each of the GP respondents were personal because it focussed on one individual at a time. All interviews were conducted through telephone and last an hour to an hour and a half. All the interviews were also unique in the sense that the interviews take place only once. This meant that the information was only collected once and the interview was concluded as soon as the session was over. The main reason why this had to be so was because the respondents (all of whom were in rural and remote practices of NSW) were quite pressed for time and had busy patient appointment schedules. In order to capture the all the information from the interview, notes were taken simultaneously as a minidisc recorder voice-recorded the entire interview session. The answers to the interview questions were unstandardised. This meant that the answers were not determined by a set of response categories. Since the tool for data collection was an in-depth interview, most of the questions were open-ended (with some close-ended ones), and did not leave room for the answers to be speculated nor standardised.

3.5.1.4 Qualitative Data Analysis

Following each interview, the taped session was transcribed into notes and contact summary sheets (Miles et. al., 1994) were generated and reviewed to identify emerging themes as well as existing ones suggested in the literature. Through identification of common themes and patterns in the responses of the GPs, the conceptual model could be validated. The interview findings (see Appendix F for contact summary sheets) and literature review led to the operationalisation of the conceptual model and development of the survey instrument for collecting attribute and relational data from rural GPs as described in the previous section.

3.5.2 Survey Method

Once the conceptual model was translated into an operationalised model, the survey instrument was developed and revised through several pre-tests and pilot study. This section discusses the sample frame, sampling unit, contact list generation, and phases and modes of administration of the survey instrument.

3.5.2.1 Sample Frame, Sampling Unit and Sampling Strategy

The general practice serves as the sampling unit and the general practitioners are the observation unit. There are 17 Divisions of General Practice within rural NSW, Australia totalling 1,518 GPs (ADGP, 2005). These divisions serve as a readily available mechanism for both the stratification and clustering of the sample of rural GPs. Therefore, the rural GPs within the NSW Division of rural general practice are considered the sample frame. Figure 3.2 and Table 3.3 shows the divisions of rural general practice in NSW, Australia.

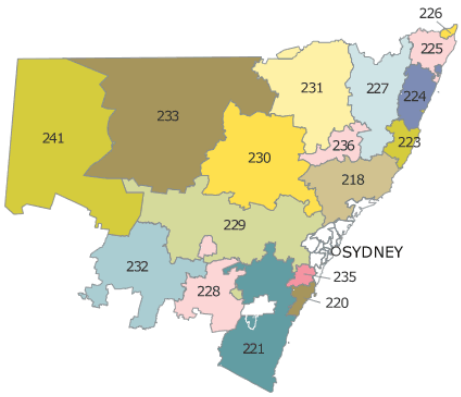


Figure 3.2: Divisions of Rural General Practice in NSW, Australia (ADGP, 2005)

Division Code	Division Name
218	Hunter Rural Division of General Practice
220	Shoalhaven Division of General Practice
221	Southern General Practice Network
223	Hastings Macleay General Practice Network
224	Mid North Coast (NSW) Division of General Practice
225	Northern Rivers General Practice Network
226	Tweed Valley Division of General Practice
227	New England Division of General Practice
228	Riverina Division of General Practice and Primary Health
229	NSW Central West Division of General Practice
230	Dubbo/Plains Division of General Practice
231	Barwon Division of General Practice
232	Murrumbidgee Division of General Practice
233	NSW Outback Division of General Practice
235	Southern Highlands Division of General Practice
236	North West Slopes (NSW) Division of General Practice
241	Barrier Division of General Practice

Table 3.3: Divisions of Rural General Practice in NSW, Australia and its Codes

The stratification sampling strategy presents two potential issues. Firstly, if the divisions are deemed to be the stratum, then one needs to consider what constitutes an appropriate sub-sample within each division given the confidence interval and confidence level. Secondly, a simple random sampling strategy of all the 17 divisions is expensive in terms of time and money because the researcher would have to travel to all the 17 divisions across NSW in order to collect data. The main advantage of conducting a stratified sampling approach is that the data would be more representative of the rural NSW GPs because the data would have been collected from a random sample of all the 17 divisions. Furthermore, recent research has shown that telephone interviews provide a more effective and valid measure to collect ego-centric network data because of the caller's anonymity especially in sensitive settings (Kogovšek et. al., 2005). Therefore, the use of telephone to collect network data from GPs in rural NSW is a feasible option that overcomes the predicament of personal travel for data collection.

Considering each division of general practice to be a cluster, one may choose a random sample of 7-10 divisions amongst the 17 and administer the survey to all the GPs of that division. The issue with this approach however, lies in the problem that cluster sampling

requires the participation of all sampling units within the cluster which inevitably is highly unlikely. This affects the reliability of the data collected as well as the extent to which it represents the population of rural NSW GPs. There is also a risk in that the divisions chosen as part of the random sample may be very low in the population of GPs as compared to the other divisions which have a relatively higher population. This biases the sample and overall generalisation of the data.

3.5.2.2 Sample Size

Many factors account for determining the sample size. These factors include (1) the confidence level selected, (2) variability of the population being sampled, (3) the population parameters to be estimated, (4) required precision from the population parameters to be estimated, (5) choice of sampling method and (6) the estimating procedure or statistical technique to be used (Hair, 1995). Large samples increase the power (the fraction of tests that one expects to yield a "statistically significant" p-value) of tests to detect effect of a specified size and involve smaller sampling errors. With given confidence levels, desired precision, population size, and known variability of a characteristic in the population, it is possible to calculate the minimum required sample size. For example, assuming that two means are compared using a t-test (or the non-parametric alternative – Mann Whitney U Test), given the desired effect size and power values, the sample size can be calculated. In Table 3.4, with a given power value of 95%, desired effect size of small to moderate (0.5), and an α value of 0.5, the GPower calculator (Erdfelder et. al., 1996) shows 176 subjects required as the sample size. However, most researchers in the social sciences choose a sample size to obtain 80% power (Murphy et. al., 2004).

t tests - Means: Difference between two independent means (two groups)			
Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	One
	Effect size d	=	.5
	α err prob	=	.05
	Power (1-β err prob)	=	.95
	Allocation ratio N2/N1	=	1
Output:	Noncentrality parameter δ	=	3.316625
	Critical t	=	1.653658
	Df	=	174
	Sample size group 1	=	88

Sample size group 2	=	88
Total sample size	=	176
Actual power	=	0.951425

Table 3.4: Sample Size calculation given Power, Effect Size and α

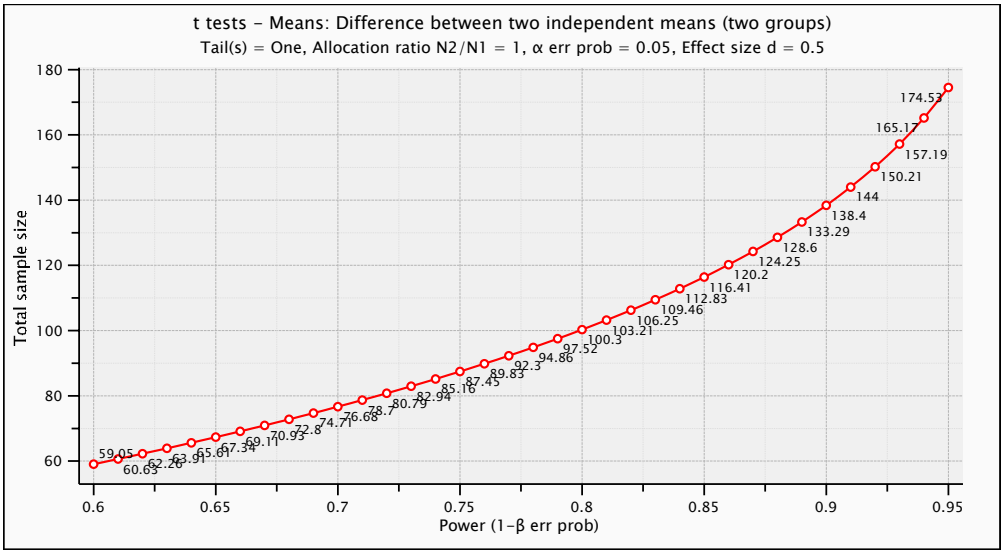


Figure 3.3: Plot for Sample Size versus Power value for an a priori Power Analysis

From the a priori power analysis plot in Figure 3.3, it is quite obvious that at 0.8 power value, the required sample size is 100 subjects. Furthermore, given the population of 1,518 rural GPs in NSW, at a confidence level of 95% with a confidence interval of 10%, the required sample size is 90 subjects (Tabachnick et. al., 2007). In light of these arguments, the study assumes that a sample size of at least 100 should be sufficient.

3.5.2.3 Modes and Phases of Survey Administration & Revision

Given the predicaments mainly relating to "lack of population representation" with the cluster sampling approach, the proposed solution was to stratify the rural general practices by their divisions. It was decided that achieving a more representative population was of highest importance and crucial for the study rather than sacrificing population representation for the sake of sampling convenience. Therefore, to achieve the highest representation of the population in the sample, a multi-method sampling strategy using post, telephone and personal administration of the survey was adopted across all divisions. Although claims that postal administration yield low response rates, recent research shows evidence that

respondents still prefer postal mode over other modes such as internet and telephone as choice of response mode in a longitudinal survey (Swann et. al., 2006). Therefore, surveys were posted out to 14 of the divisions of rural general practice in New South Wales, while in 3 divisions, the surveys were personal administered thereby guaranteeing highest reliability and rate of response. In a few cases, the GPs preferred survey administration over the telephone. The following table summarises the time period for the data collection with sample size and response rate.

	Qualitative Interviews	Pre-test	Simulation	Pilot	Final Survey
Date	Dec 2005 – May 2006	Sep 2006	Nov – Dec 2006	Dec 2006 – Feb 2007	Jun – Dec 2007
Sample Size	5	5 students + 10 rural GPs	500	136	1488
Invalid contacts	-	-	-	-	78
Response	5	8 (5 students + 3 rural GPs)	-	56	110
Response Rate	100%	53%	-	41%	7.80%

Table 3.5: Phases of Research Study with Sample Size and Response Rates

An initial survey was developed and pre-tested amongst a group of 5 students within the research laboratory. Ten copies of the survey were then sent out to rural GPs, with only three who responded. With low response rates, experts in the domain of general practice, including former president of the rural doctor's association (RDA) in Australia, professor and head of discipline of general practice in a renowned university, and rural GPs were consulted about the survey instrument. Consultations lasting at least an hour were conducted with these experts individually. Subsequently, the research design and theoretical constructs were further refined. The experts also vetted the instrument, which was then pre-tested for comprehension and ease-of-use. The general response from them was that the design of the network component in the survey was visually complex and confounding. As this not only deters response rates but also add cognitive load to survey completion, advice and suggestions from the experts were accepted and the survey was modified accordingly. In order to reduce non-response rates, an endorsement letter was also forwarded by the fellow rural GP and former president for the RDA (see Appendix I). The second version of the survey was designed to

cater for improved ease of comprehension and completion. Attribute items such as asking whether the GPs were trained overseas or locally were included. Other items to determine whether they were accredited with fellowships from the RACGP (Royal Australian College of General Practitioners) and ACRRM (Australian College of Rural and Remote Medicine) were also included in order to allow for cross demographic comparisons (although not shown in this study). The survey was piloted to 136 rural GPs practising in two different divisions of rural general practice. 56 agreed to fill out the survey thus achieving a response rate of about 41%. The survey was mostly personally administered in order to allow for capturing of survey duration, respondent reaction and errors in the survey. Only one was administered through telephone and five others through postal mail. The pilot test further allowed for detection and fixing of cosmetic errors such as grammar and spelling mistakes. It also picked up wrong ordering of a scale for the performance attitude component (that is, the order of the scale was "strongly agree, somewhat agree, agree…" instead of "strongly agree, agree, somewhat agree…"). After all errors were fixed, the final survey was posted out to 1,488 rural GPs, out of which 78 were either deceased, no longer practicing or had invalid postal addresses. Of the valid 1410 contacts, 110 responded achieving a response rate of 7.59%.

3.5.2.4 Contact List Generation

The generation of the list of GP contacts (name, address and telephone) involved various phases and was quite a systematic and time-consuming exercise. First, the Australian Divisions of Rural General Practice website provides comprehensive information about the divisions of rural general practices throughout Australia. For each division, there was a summary about the division, which includes details such as the rural areas and zip codes which were covered by the divisions, and the number of GPs within the division. Each and every zip code within a division was entered into the Medisearch International website, a free online doctor search facility for doctors and medical specialists in Australia only. A GP's first name, last name, address, and telephone details were obtained by inputting a postcode in the search facility provided by the website. This step was repeated for every postcode until the

postcodes covered by a division were exhausted. Eventually, a list of GP contacts for each and every division (17 in total) was obtained. A computer program (written in unix shell script – see Appendix A) was then used to parse through the contact details to convert the file to comma separated values (csv) format, which was then read in by Microsoft Excel and Word program to generate participant contact sheets and cover letters for the survey administration. The contact list aided telephoning each GP in a respective division of rural general practice two weeks in advance prior to receiving the survey letter. All GPs who did not respond were then contacted four weeks after the receipt of the survey. The following diagram (Figure 3.4) shows the process of contact list generation:

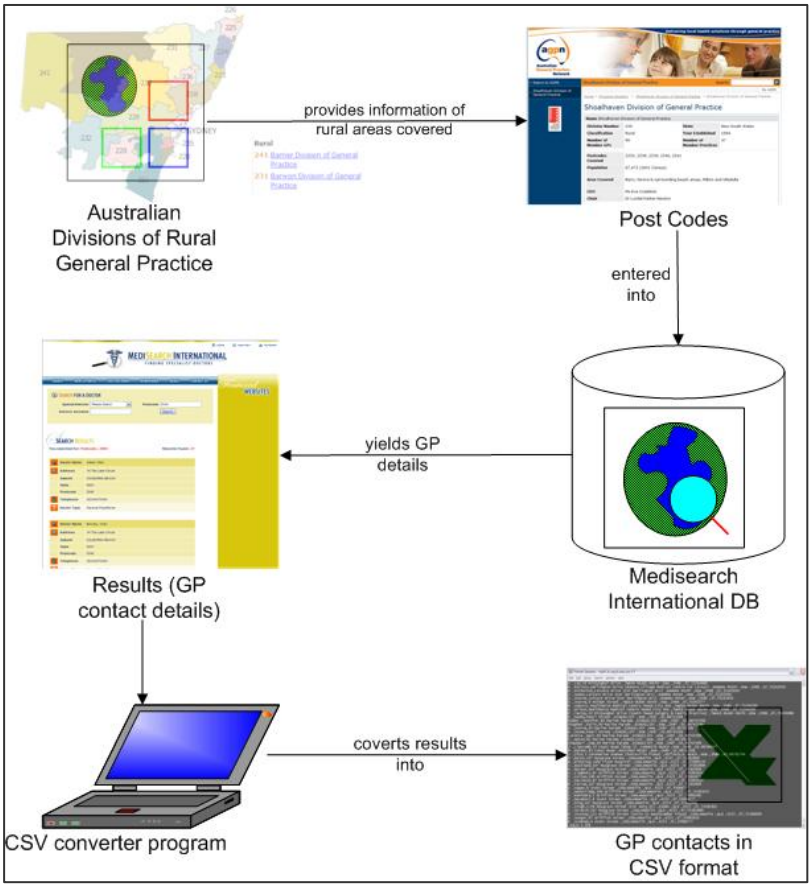


Figure 3.4: The GP Contact Details Collection Process

3.6 Data Storage

The mySQL (5.0.24-community-nt) server database was utilised for storing survey instrument data. The advantage of designing a database to store data for this study is not only flexible and efficient retrieval of network and attribute data based on the structured query language (SQL)

but it also allows for a simulation of data population prior to data collection. It was designed specifically so that data integrity can be preserved by ensuring that invalid codes in the survey instrument cannot be entered. Also referential integrity in the database ensures that if, for example, a GP's record is deleted from the database, then all his/her alters' information are also deleted. The database schema can be found in Appendix H. Furthermore, SQL query results were exported into a data file (comma separated values) which were then loaded into SPSS for further analysis. The following section describes the simulation of a data population-extraction exercise conducted prior to the pilot tests.

3.7 Data Population Simulation

While the realism of populating computer generated data into a social network survey instrument can be disputed and unmatched to real empirical data, this approach was utilised for several reasons during work in progress and while pilot testing of the survey was just about to commence. Firstly, early simulation of data population allows testing of the integral design and robustness of the data collection, extraction and analysis process. Essentially, it helped in fine-tuning various aspects of the design model at an early stage rather than at the final stage when real data is collected. Secondly, it allows for a rehearsal and experimentation of different sorts of data for the analysis, including outliers and missing values. The design of the data population process is described as follows.

3.7.1 Data Population Process

The essence of any simulation experiment begins with a random number generator. For this purpose, the random (`rand()`) function in Perl was utilised and modified to suit study's purpose such that it would produce a discrete random number between a minimum and a maximum given number. Every entry, except for generation of the GP ID (identity), in the database was populated based on this function. Several rules and constraints were incorporated in the data population program. For example, a GP's years in general practice has to be greater or equal to his years in current practice; the maximum connections of a GP's alter network cannot be greater than `n(n-1)/2` assuming symmetric interaction ties; and so

on. The motivation for the generation of simulated data was based on the work Tsvetovat and Carley (2005). While the entire simulation was coded using Perl (v5.8.8 ActiveState), the logic of the data population algorithm is as follows:

```
N=500;              // Number of GPs to simulate
Generate GP Profile;       // Creates GP & demographic items
FOR each GP until N DO
  Generate GP_ID // Creates GP, GP alters, & alter attributes
  Generate n alters // creates number 'n' no of alters
  FOR each of n alters DO
   Generate gp _network as gp_id, alter_id, alter names,
   work proximity code, occupation code, closeness, frequency,
   time known, and frequencies (of ICT communication)
  END FOR
END FOR

FOR each GP DO
 Get number of alters for each GP
  FOR given alter number of each GP DO
   Generate alter-alter ties & closeness code for each alter
   IF alter already has tie with alter then
     Do not generate tie again
   END IF
   Generate ICT use values
   Generate Attitudes to Process of Care values
 END FOR
END FOR
```

3.7.2 Data Extraction Process

Data extraction was a two phase process. The first phase involved extracting ego network data of the GP and the alters and converting the relational data into an input file (vna format) for analysis in Netdraw. Batch files (equivalent of scripts) were written in the DOS environment for analysing the vna files (500 files from the simulated output of 500 GPs). The batch command is as below:

```
rem Author: Kenneth Chung
rem Date:   22/10/2006
rem Description: This is a batch program that takes each vna filename
rem listed in the current directory as an argument and writes it in as
rem part of the loadvna argument in a file called batch.txt. The
rem batch.txt file is then read by netdraw and an output file is computed.
rem This output filename is described in the batch.txt file. The output
rem filename will be called "em_$inputfile.txt" where $inputfile is
rem the name of the input file. So an input vna file called "gp_1.vna"
rem will have a corresponding output file called "em_gp_1.txt" containing
rem the ego measures (em) for GP1. This file will later on be parsed by
rem Perl to extract the GP_id and the effectiveness and effsize into a
rem file containing the gp_id, density, effsize, effici.

for %%e in (*.vna) do ((echo loadvna %%e
echo runlayout
echo egomeasures
echo outputattr em_%%~ne.txt density degree indegree outdegree effsize
efficiency constraint hierarchy
echo close) > batch.txt
echo @echo off > netdraw.bat
echo "c:\Program Files\Ucinet 6\netdraw.exe" batch batch.txt >>
netdraw.bat
call netdraw.bat
)
```

The second phase of the data extraction process involved querying the database for the attribute data such as ICT use item values and attitudes to process of care item values. The extraction script was programmed in Perl. It also calculated density and collated the results from phase one (ego network relational values) and phase two (attribute values) into one comma separated values (csv) file for analysis in SPSS. In total, 500 records were simulated. The relational values were converted by the Perl program into 'vna' formats for network analysis using the UCINET 6.87 and Netdraw 2.4 program (Borgatti et. al., 2002). The Perl codes for the population and extraction of network data can be found in Appendix I.

3.8 Data Analysis

The choice of data analysis technique is dependent on a variety of factors ranging from research question to data distribution to sample size. Assuming that the distribution (at least the dependent variables) is relatively normal and that there are sufficient sample size numbers given the number of independent variables[6], a multiple regression model would be best suited for the purpose of investigating the relationship between variables of social networks, ICT use

[6] Tabachnick and Fidell (2007, p. 123) suggests using the following formula to calculate sample size *(N)* requirements, taking into account the number of independent variables: $N > 50 + 8m$ (where m = number of independent variables)

and individual performance and its potential interaction effects (Venter et. al., 2000). In this case, various assumptions of linearity, multicollinearity, normality and homoscedasticity need to be accounted for as multiple regression models are quite sensitive to violation of these assumptions. In any case, preliminary analysis of the data pertaining to its distribution and potential relationships amongst variables needs to be accounted for. This can be done using descriptive statistics, histograms, tests of normality and scatterplots. In the event that the data is normally distributed, statistical tests that investigate relationships amongst variables such as Pearson's correlations and multiple regression can be used. However, if the distribution is not normal, then non-parametric tests such as Spearman's rank order correlation and Mann-Whitney U tests need to be considered. Details of the justification and choice of data analysis techniques are found in Chapter 4 while the following table summarises the analytical techniques applicable for testing the hypotheses formulated in chapter 2.

Hypotheses	Variables Tested	Parametric Tests Applicable	Non-parametric Tests Applicable
H1a	Efficiency & Performance	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test
H1b	Constraint & Performance	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test
H2a	Tie Strength & Performance	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test
H2b	Degree Centrality & Performance	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test
H2c	Geographical Tie Diversity & Performance	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test
H2d	Functional Tie Diversity & Performance	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test

H3a	ICT use (Communication-related) & Performance	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test
H3b	Efficiency & ICT Use (Communication-related)	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test
H3c	Degree Centrality & ICT Use (Task-level)	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test
H3d	Functional Diversity & ICT Use (Task-level)	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test
H3e	ICT Use (Task-level) & Performance	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test
H4a – H4j	Demographic Items & Network, ICT Use & Performance	Pearson's Product Moment Correlation, Independent Samples t-test, Multiple Regression	Spearman's Rank Order Correlation, Mann-Whitney U Test

Table 3.6: Relevant Statistical Technique for Hypotheses Testing

3.9 Conclusion

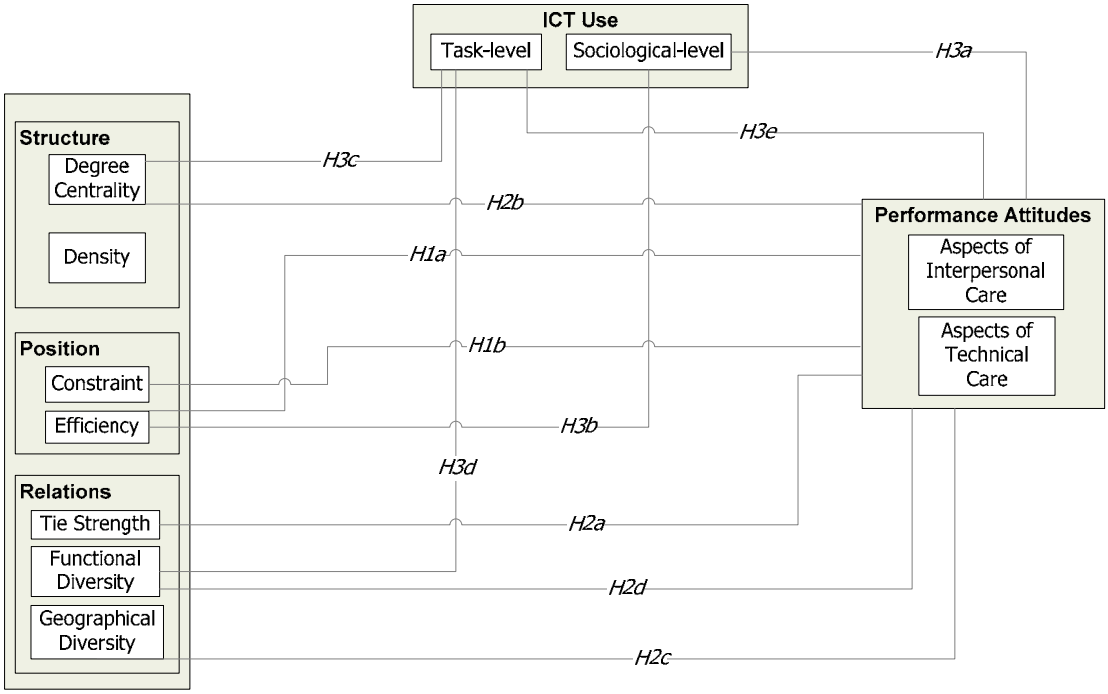
This chapter discussed the design and framework of the research. The chapter discussed in detail how the theoretical model can be made operational in the context of rural GPs in NSW, Australia. The chapter first provided an appraisal of social network approaches to collect social network data outlining the pros and cons of each approach. It then discussed the measures that constituted each theoretical construct of social network structure, position and relations, ICT use and performance. Demographic items that were included in the survey were also discussed. Furthermore, it discussed the triangulation of both qualitative and quantitative methods used in the research. It also described issues related to sampling strategy and sample selection. The instrument was tested through various phases that involved a computer simulation, pre-tests and pilot tests before it was finally sent out. In the next chapter, the analysis and results from the data collected are reported and chapter 5 provides a discussion of the results within the context of the theoretical model postulated in chapter 2.

Chapter 4

4. Results and Findings

This chapter reports results from the analysis of data for exploring the inherent relationship between social network, ICT use and individual performance. The data was collected from one hundred and ten GPs practicing in rural New South Wales, Australia. The chapter begins with a brief summary of the results, followed by descriptive statistics about the data including tests of normality and a brief discussion on the distribution of each data variable. Preliminary results of the relationships between the variables are also provided. Following on, results inferred from hypothesis testing using parametric techniques such as t-tests and multivariate techniques such as multiple regression models are reported and discussed.

It is useful at this stage to recall the operational model (Figure 2.13, page 60) which captures the links between the hypothesised associations of social network, ICT use and Performance variables.



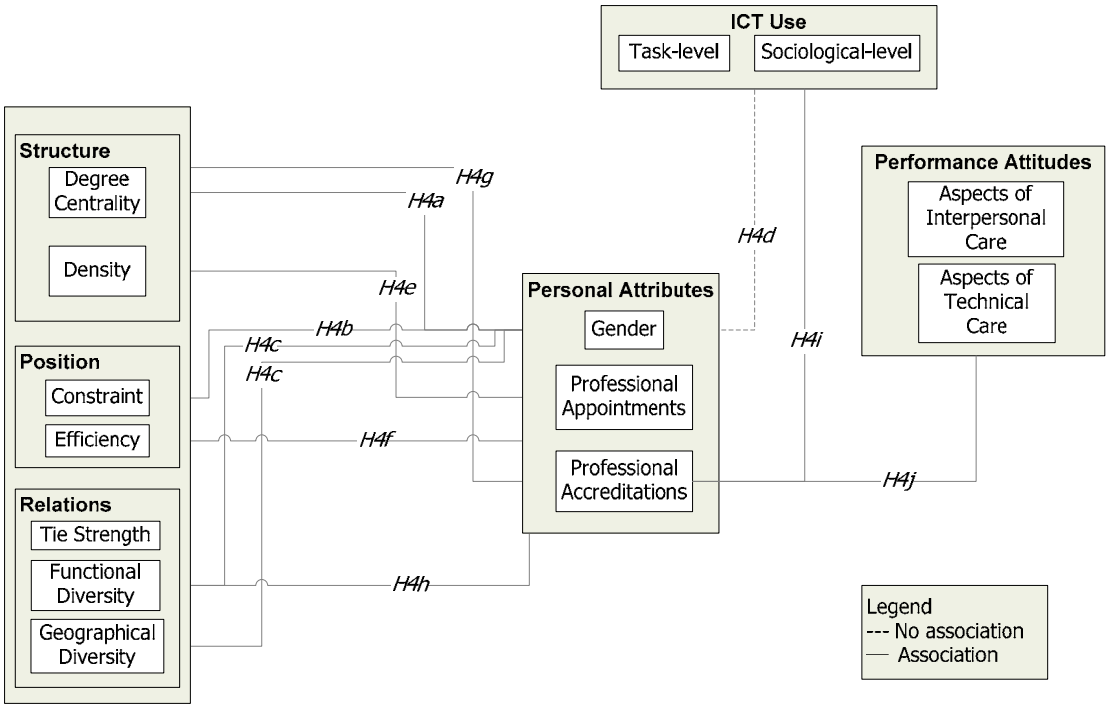


Figure 4.1: Towards a Social networks-ICT use Research model for exploring Performance

Recall that hypotheses 1 (*H1*) pertain to the *network position* hypothesis where efficiency is speculated to impact performance positively and constraint to impact performance negatively. Hypotheses *H2* relate to the *network relational* and the *network structure* hypotheses on individual performance. The network relational hypotheses focus on the positive impact of tie strength and tie diversity on individual performance while the network structure hypothesis claims that degree centrality would be positively associated with individual performance. Hypotheses *H3* relate to the *ICT use* hypotheses – that is, an examination of the social system effects (ICT use and network properties) and task-level effects (ICT use and performance). Recall also that hypotheses *H4* pertain to associations of demographic/personal attributes and the three constructs shown in the model. A brief summary of the results are as follows:

- Performance in terms of attitudes to interpersonal care was found to be significantly positively associated with degree centrality, task-level ICT use and FRACGP accreditation.
- Performance in terms of attitudes to interpersonal care was found to be significantly negatively correlated with ego-network constraint.

- Performance in terms of attitudes to technical care was found to be significantly positively associated with FRACGP accreditation.
- ICT use at the task-level was found to be significantly correlated with degree centrality, functional tie diversity and interpersonal care attitudes.
- Task-level ICT use was found to be negatively associated with experience in terms of years in rural practice and years in current practice.
- Communication-related ICT use, on the other hand, was positively correlated with task-level ICT use but negatively associated with ego-network efficiency.
- There were significant differences in network structure, position and relations of male and female individuals. Females experienced higher degree centrality and tie diversity (both functional and geographical) in their professional ego-networks, while males were more constrained in their professional ego-networks than females.
- Individuals with professional appointments (in terms of FRACGP and FACRRM accreditations) have higher frequency of task-level ICT use, higher scores in performance attitudes (technical and interpersonal) and higher degree centrality than those who do not.
- Post-hoc analysis conducted through a stepwise multiple regression model showed that for attitudes to interpersonal care, degree centrality and FRACGP were the most potent predictors while for task-level ICT use, the most potent predictors were functional tie diversity and FRACGP.

4.1 Descriptive Statistics

The following section provides descriptive statistics about the data collected from the GP respondents. The first section presents demographic data of GPs who responded to the survey. The second section presents descriptive statistics about the variables of interest in the research model – namely, ICT Use, social network variables and performance attitude variables.

4.1.1 Respondents' Demographic Data – GPs in rural NSW

The following statistics are provided to describe the respondents, namely, GPs in rural NSW, their personal and practice demographics and associations with various fellowships. Table 4.1 presents the demographics of the general practice of the respondents. Evidently, the typical rural GP has been in rural practice for 20.24 years, with 13.63 years in the current practice. Although there are solo-practices (a one doctor-only practice), the typical rural GP, as indicated by the results, works with at least 4 colleague GPs in the same practice. Interestingly, there were a few GPs who have for almost four to five decade dedicated themselves to rural practice. Figure 4.2 shows the histogram for years in rural practice.

	N		Mean	Std. Deviation	Minimum	Maximum
	Valid	Missing				
Years in Rural Practice	110	0	20.24	10.446	1	50
Years in Current Practice	110	0	13.63	10.373	1	43
No of GPs in Current Practice	110	0	4.54	4.117	0	25

Table 4.1: General Practice Demographics

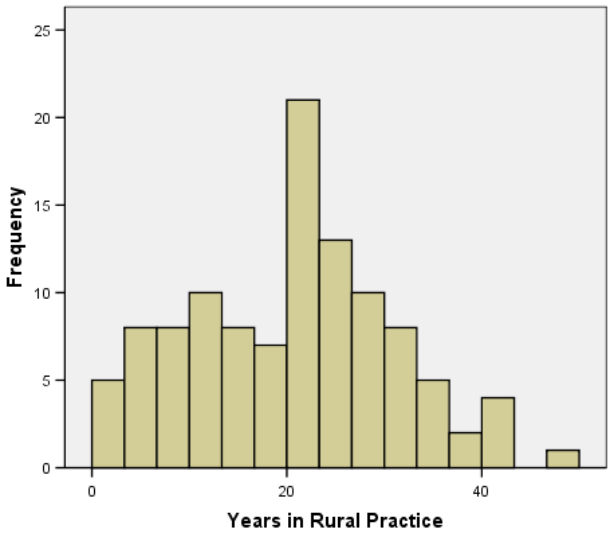


Figure 4.2: Histogram: Years in Rural Practice

Of the entire 110 GPs who responded, 90 (or 81.8%) are male and 20 (or 18.2%) are female, 85 (or 77.3%) have hospital appointments, only 30 (or 27.3%) are accredited with the Fellowship of the Australian College of Rural and Remote Medicine (FACRRM) and 44 (or 40%) have accreditations with the Fellowship of the Royal Australian College of General Practitioners. 77.3% of the respondents received their medical training from Australian

universities, with the remaining being from overseas. The following tables show the cross tabulations of these demographic data by gender of the respondents. Table 4.2 presents the number of GPs who have hospital appointments. Such appointments represent the GPs commitment to the community as well as an added significance to their role as medical professionals in the rural areas. Of the 77.3% who have appointments, about 69% are male and about 8% are females.

			Gender		Total
			Female	Male	
Hospital Appointment	No	Count	11	14	25
		% of Total	10.0%	12.7%	22.7%
	Yes	Count	9	76	85
		% of Total	8.2%	69.1%	77.3%
Total		Count	20	90	110
		% of Total	18.2%	81.8%	100.0%

Table 4.2: Cross Tabulation of Hospital Appointment by Gender

Table 4.3 shows that out of the rural GPs who responded to the survey, the majority 72.7% of the respondents do not have FACRRM accreditations. Out of the 27.3% who have, only 25.5% are males and 1.8% are females.

			Gender		Total
			Female	Male	
FACRRM	No	Count	18	62	80
		% of Total	16.4%	56.4%	72.7%
	Yes	Count	2	28	30
		% of Total	1.8%	25.5%	27.3%
Total		Count	20	90	110
		% of Total	18.2%	81.8%	100.0%

Table 4.3:Cross Tabulation of FACRRM accreditation by Gender

Table 4.4 displays the number of GPs who are members of the FRACGP. Only 40% are affiliated with the RACGP out of which about 29% are male and 11% female. The majority of the GPs are not affiliated with the RACGP, a premier association for GPs in Australia that provides governmental support as well as continued medical education programmes.

			Gender		Total
			Female	Male	
FRACGP	No	Count	8	58	66

		% of Total	7.3%	52.7%	60.0%
	Yes	Count	12	32	44
		% of Total	10.9%	29.1%	40.0%
Total		Count	20	90	110
		% of Total	18.2%	81.8%	100.0%

Table 4.4: Cross Tabulation of FRACGP accreditation by Gender

Table 4.5 displays the cross tabulation of countries from where GPs have graduated from their medical education. Inevitably, most respondents (77.3%) have graduated from universities within Australia (about 67% being male and 10% female). The next largest number of respondents who have graduated from overseas include medical institutions from India (4.5%), England (4.5%) and Egypt (2.7%).

			Gender		Total
			Female	Male	
Country Graduated	Australia	Count	11	74	85
		% of Total	10.0%	67.3%	77.3%
	Bangladesh	Count	0	1	1
		% of Total	.0%	.9%	.9%
	Canada	Count	0	1	1
		% of Total	.0%	.9%	.9%
	Egypt	Count	1	2	3
		% of Total	.9%	1.8%	2.7%
	England	Count	1	4	5
		% of Total	.9%	3.6%	4.5%
	Fiji	Count	1	0	1
		% of Total	.9%	.0%	.9%
	India	Count	3	2	5
		% of Total	2.7%	1.8%	4.5%
	Iraq	Count	0	1	1
		% of Total	.0%	.9%	.9%
	New Zealand	Count	0	2	2
		% of Total	.0%	1.8%	1.8%
	Scotland	Count	2	0	2
		% of Total	1.8%	.0%	1.8%
	South Africa	Count	1	0	1
		% of Total	.9%	.0%	.9%
	Sri Lanka	Count	0	2	2
		% of Total	.0%	1.8%	1.8%
	Tanzania	Count	0	1	1
		% of Total	.0%	.9%	.9%
Total		Count	20	90	110
		% of Total	18.2%	81.8%	100.0%

Table 4.5: Cross Tabulation of Country of Medical Training by Gender

4.1.2 Descriptives for Social Network, ICT Use and Performance Variables

Table 4.6 lists the descriptive statistics for the social network, ICT use and performance variables. These variables are measured on a continuous scale although categorical dummy

variables (for ICT use, network structure, network position, and network relations variables) were constructed (to cluster groups of data) for hypotheses testing. In most cases median values were used as cut-points clustering datasets for the tests. Histograms showing distribution of the variables are provided in Appendix C.

	N		Mean	Median	Std. Deviation	Minimum	Maximum
	Valid	Missing					
Network Structure							
Ego Density	109	1	.61255	.67900	.348204	.000	1.000
Degree	109	1	8.77064	8.00000	3.945539	1.000	15.000
Network Position							
Constraint	109	1	.40249	.35500	.197778	.078	1.000
Efficiency	109	1	.47560	.40600	.297494	.067	1.000
Relations (Ties)							
Average Tie Strength	110	0	2.2622	2.2500	.49040	1.00	4.50
Geographical Diversity	109	1	.70087	.67301	.367452	.000	1.714
Functional Diversity	109	1	.79958	.86756	.447394	.000	1.587
ICT Use							
Task level ICT Use	110	0	30.3727	35.0000	10.93589	8.00	40.00
Communication related ICT Use	109	1	26.5229	28.0000	8.45423	10.00	45.00
Performance (Attitudes)							
Interpersonal Care	110	0	47.4545	48.0000	6.25254	13.00	56.00
Technical Care	110	0	39.0727	40.0000	7.04990	19.00	53.00

Table 4.6: Descriptive Statistics for Social Network, ICT Use and Performance Variables

4.1.3 Normality in Data Distribution

Prior to any statistical analyses, it is necessary to explore the distribution of data through visualising graphs (e.g. histograms) and conducting statistical tests. It is important to determine whether the data distribution of the variables of interest is symmetrical or not. In order to test more specifically for normality of data, apart from visual histogram inspection, the Kolmogorov-Smirnov test of normality was also conducted.

		Kolmogorov-Smirnov(a)		
Variable Category		Statistic	df	Sig.
Demographic	Years in Rural Practice	.073	110	.199
	Years in Current Practice	.112	110	.002
	No of GPs in Current Practice	.186	110	.000
Network Structure	Ego(network) Density	.142	109	.000
	Degree	.117	109	.001

Network Position	Constraint	.146	109	.000
	Efficiency	.118	109	.001
Network Relations	Average Tie Strength	.068	110	.200(*)
	Geographical Diversity	.082	109	.069
	Functional Diversity	.110	109	.003
ICT Use	Task level ICT Use	.189	110	.000
	Communication related ICT Use	.099	109	.010
Performance Attitudes	Interpersonal Care	.126	110	.000
	Technical Care	.090	110	.030

* This is a lower bound of the true significance.
a Lilliefors Significance Correction

Table 4.7: Kolmogorov-Smirnov Test of Normality

The test of normality shows that only three variables - "years in rural practice" *(sig=.199)*, "average tie strength" *(sig=.200)* and "geographical diversity" *(sig=.069)* have normal distributions because the Kolmogorov-Smirnov statistic shows a non-significant result (i.e. sig. value of more than 0.05). All other variables have violated assumptions of normality (because the sig. value is lesser than 0.05). It seems therefore for most tests where the distribution of the variable of interest is not normal, non-parametric tests will have to be applied. However, the results from the Kolmogorov-Smirnov tests in this case are quite common (where n > 100) and in observing the histograms for the dependent variables "technical care" *(mean=39.07, std. dev=7.05)* and "interpersonal care" *(mean=47.45, std. dev=6.25)*, the histograms are fairly normally distributed. Given these reasons, parametric tests such as t-tests, Pearson's product-moment correlations and regression analysis can still be run as there are no clear outliers or extreme irregularities in the data distribution of these variables. Furthermore, these parametric tests are robust enough to handle variations in normality observed in the histograms in Appendix C (Tabachnick et. al., 2007).

4.2 Pearson's Product Moment Correlations

The Pearson's Product moment correlation indices of the social network, ICT use and performance attitude variables are shown in Table 4.8. These correlation coefficients are important because it allows preliminary investigation of which variables are associated with each other. The coefficients complement findings from the hypothesis test results in the following sections and also in chapter 5 where the results are discussed in light of theory and

existing literature. To visualise the relationship between variables that have shown significance in the correlation matrix below, scatterplot diagrams are available in Appendix D.

In summary, the correlations are suggestive of the following:

1. **Demographics:** Years in rural practice and years in current practice (which account for experience) are strongly correlated positively *(r=.673, p=.000).* In particular, the former variable is negatively associated with geographical diversity *(r=-.231, p<.05)* while the latter is negatively correlated with functional diversity *(r=-.230, p<.05)*. Both are negatively associated with task-level ICT use *(r=-.223, p<.05 and r=-.288, p<.01 respectively).*

2. **Network Structure:** As expected, there is a strong negative correlation between ego-network density and efficiency *(r=-.979, p=.000)* and strong positive correlation between ego-network density and constraint *(r=.455, p=.000).* There is a small negative correlation between density and average tie strength as well *(r=.199, p<.05).* Interestingly, degree centrality is positively associated with geographical diversity *(r=.207, p<.05)*, functional diversity *(r=.301, p<.01)*, Task-level ICT use *(r=.241, p<.05)* and interpersonal care *(r=.258, p<.01).*

3. **Network Position:** Surprisingly, there is a small negative correlation between efficiency and communication-related ICT use *(r=-.216, p<.05).* Furthermore, constraint is negatively associated with geographical diversity *(r=-.286, p<.01),* functional diversity *(r=-285, p<.01)* and interpersonal care *(r=-.217, p<.05).*

4. **Network Relation:** There exists a medium positive correlation between geographical diversity and functional diversity *(r=.422, p=.000).* Functional diversity was found to be positively correlated with task-level ICT use *(r=.322, p<.01).* There were no significant correlations with tie strength and ICT use and performance attitude items.

5. **ICT Use:** Task-level ICT use is strongly positively correlated with communication-level ICT use *(r=.538, p=.000)*, functional diversity *(r=.322, p<.01),* and interpersonal care *(r=.257, p<.01).*

6. **Performance:** While there exists a positive correlation between interpersonal care and technical care *(r=.230, p<.05),* there are no other variables that bear any significant correlations on technical care. The other variables that are bear significant correlations with interpersonal care are degree centrality *(r=.258, p<.01)*, constraint *(r=-.217, p<.05)*, and task-level ICT use *(r=.257, p<.01)*.

		Years in Rural Practice	Years in Current Practice	No of GPs in Current Practice	Ego Density	Degree	Constraint	Efficiency	Average Tie Strength	Geographical Diversity	Functional Diversity	Task level ICT Use	Communication related ICT Use	Interpersonal Care	Technical Care
Years in Rural Practice	Pearson Correlation	1	.673(**)	-.044	-.057	-.164	.040	.081	-.094	-.231(*)	-.166	-.223(*)	-.181	.003	-.140
	Sig. (2-tailed)		.000	.645	.554	.089	.677	.403	.330	.015	.084	.019	.060	.978	.146
	N	110	110	110	109	109	109	109	110	109	109	110	109	110	110
Years in Current Practice	Pearson Correlation	.673(**)	1	-.038	.181	-.091	.185	-.146	-.024	-.137	-.230(*)	-.288(**)	-.021	-.046	-.057
	Sig. (2-tailed)	.000		.692	.060	.345	.054	.129	.802	.157	.016	.002	.826	.630	.554
	N	110	110	110	109	109	109	109	110	109	109	110	109	110	110
No of GPs in Current Practice	Pearson Correlation	-.044	-.038	1	.183	.056	.130	-.145	.001	-.003	-.040	.015	-.011	.162	.020
	Sig. (2-tailed)	.645	.692		.057	.565	.179	.133	.989	.979	.681	.872	.908	.092	.840
	N	110	110	110	109	109	109	109	110	109	109	110	109	110	110
Ego Density	Pearson Correlation	-.057	.181	.183	1	.036	.455(**)	-.979(**)	.199(*)	-.103	-.016	-.018	.181	-.041	.064
	Sig. (2-tailed)	.554	.060	.057		.711	.000	.000	.038	.285	.867	.857	.061	.675	.510
	N	109	109	109	109	109	109	109	109	109	109	109	108	109	109
Degree	Pearson Correlation	-.164	-.091	.056	.036	1	-.720(**)	-.180	-.196(*)	.207(*)	.301(**)	.241(*)	.131	.258(**)	.176
	Sig. (2-tailed)	.089	.345	.565	.711		.000	.061	.041	.031	.001	.012	.178	.007	.068
	N	109	109	109	109	109	109	109	109	109	109	109	108	109	109
Constraint	Pearson Correlation	.040	.185	.130	.455(**)	-.720(**)	1	-.296(**)	.265(**)	-.286(**)	-.285(**)	-.182	-.003	-.217(*)	-.028
	Sig. (2-tailed)	.677	.054	.179	.000	.000		.002	.005	.003	.003	.058	.975	.023	.774
	N	109	109	109	109	109	109	109	109	109	109	109	108	109	109
Efficiency	Pearson Correlation	.081	-.146	-.145	-.979(**)	-.180	-.296(**)	1	-.160	.053	-.044	-.047	-.216(*)	.002	-.083
	Sig. (2-tailed)	.403	.129	.133	.000	.061	.002		.096	.583	.652	.627	.025	.986	.390
	N	109	109	109	109	109	109	109	109	109	109	109	108	109	109
Average Tie Strength	Pearson Correlation	-.094	-.024	.001	.199(*)	-.196(*)	.265(**)	-.160	1	-.184	.139	-.003	.052	-.074	-.118

		Years in Rural Practice	Years in Current Practice	No of GPs in Current Practice	Ego Density	Degree	Constraint	Efficiency	Average Tie Strength	Geographical Diversity	Functional Diversity	Task level ICT Use	Communication related ICT Use	Interpersonal Care	Technical Care
	Sig. (2-tailed)	.330	.802	.989	.038	.041	.005	.096		.055	.148	.977	.593	.443	.219
	N	110	110	110	109	109	109	109	110	109	109	110	109	110	110
Geographical Diversity	Pearson Correlation	-.231(*)	-.137	-.003	-.103	.207(*)	-.286(**)	.053	-.184	1	.422(**)	.106	-.088	.026	-.080
	Sig. (2-tailed)	.015	.157	.979	.285	.031	.003	.583	.055		.000	.274	.365	.791	.406
	N	109	109	109	109	109	109	109	109	109	109	109	108	109	109
Functional Diversity	Pearson Correlation	-.166	-.230(*)	-.040	-.016	.301(**)	-.285(**)	-.044	.139	.422(**)	1	.322(**)	.004	.126	.063
	Sig. (2-tailed)	.084	.016	.681	.867	.001	.003	.652	.148	.000		.001	.969	.190	.514
	N	109	109	109	109	109	109	109	109	109	109	109	108	109	109
Task level ICT Use	Pearson Correlation	-.223(*)	-.288(**)	.015	-.018	.241(*)	-.182	-.047	-.003	.106	.322(**)	1	.538(**)	.257(**)	.179
	Sig. (2-tailed)	.019	.002	.872	.857	.012	.058	.627	.977	.274	.001		.000	.007	.061
	N	110	110	110	109	109	109	109	110	109	109	110	109	110	110
Communication related ICT Use	Pearson Correlation	-.181	-.021	-.011	.181	.131	-.003	-.216(*)	.052	-.088	.004	.538(**)	1	.124	.140
	Sig. (2-tailed)	.060	.826	.908	.061	.178	.975	.025	.593	.365	.969	.000		.199	.146
	N	109	109	109	108	108	108	108	109	108	108	109	109	109	109
Interpersonal Care	Pearson Correlation	.003	-.046	.162	-.041	.258(**)	-.217(*)	.002	-.074	.026	.126	.257(**)	.124	1	.230(*)
	Sig. (2-tailed)	.978	.630	.092	.675	.007	.023	.986	.443	.791	.190	.007	.199		.016
	N	110	110	110	109	109	109	109	110	109	109	110	109	110	110
Technical Care	Pearson Correlation	-.140	-.057	.020	.064	.176	-.028	-.083	-.118	-.080	.063	.179	.140	.230(*)	1
	Sig. (2-tailed)	.146	.554	.840	.510	.068	.774	.390	.219	.406	.514	.061	.146	.016	
	N	110	110	110	109	109	109	109	110	109	109	110	109	110	110

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 4.8. Pearson's Product Moment Correlation of Network, ICT and Performance Attitude Variables

4.3 Network Position Hypotheses

The following section discusses results pertaining to the hypotheses about network position and individual performance attitudes.

4.3.1 Hypothesis 1a – Efficiency and Performance Attitudes

H1a: Efficiency of an individual's network position is positively associated with performance in knowledge-intensive work

To test the first hypothesis (H1a), the independent samples t-test was adopted to test for the significant difference between two independent groups (high and low efficiency actors) on a continuous measure of performance attitude scores. A t-test allows us find out if more efficient actors score higher on their attitudes to performance than those with lower efficiency. If the difference between high and low efficiency actors is statistically significant then it is evidence that efficiency is associated with performance attitudes in knowledge-intensive work. Whether the association is positively or negatively related can be evidenced in the direction of the difference (i.e. which group is higher).

The division or cut-point of the high and low efficiency groups was made by firstly sorting the data based on the efficiency index in ascending order. This is equivalent to ranking the cases of data based on the efficiency index. The median of the index was then chosen as the cut-point which allowed for division of the groups based on efficiency. The median for the efficiency score was 0.406 in this study (see Table 4.6 in page 102). Therefore, GPs having an efficiency score greater than or equal to the median are grouped as the "high efficiency group" and those GPs with efficiency scores lower than the median are termed the "low efficiency group".

Group Statistics

	Efficiency Group	N	Mean	Std. Deviation	Std. Error Mean
Interpersonal Care	Low Efficiency	55	47.1455	6.83243	.92129
	High Efficiency	54	47.8519	5.67486	.77225
Technical Care	Low Efficiency	55	39.6000	6.85998	.92500
	High Efficiency	54	38.7037	7.23104	.98402

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Inter-personal Care	Equal variances assumed	.178	.674	-.587	107	.559	-.70640	1.20418	-3.093	1.680
	Equal variances not assumed			-.588	104.15	.558	-.70640	1.20214	-3.090	1.677
Technical Care	Equal variances assumed	.007	.933	.664	107	.508	.89630	1.34987	-1.779	3.572
	Equal variances not assumed			.664	106.46	.508	.89630	1.35052	-1.781	3.573

Table 4.9: t-test Statistics for Efficiency and Performance Attitudes

Effect Size Calculation – Interpersonal Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-.587^2}{-.587^2 + (55 + 54 - 2)} = .003 \text{ (very small effect size)}$$

Effect Size Calculation – Technical Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{.664^2}{.664^2 + (55 + 54 - 2)} = .004 \text{ (very small effect size)}$$

In Table 4.9, the independence samples test shows that the sig. value for the Levene's test for equality of variances is larger than .05 (i.e. .674 for Interpersonal Care and .933 for Technical Care). This indicates that the assumption of equal variances for the two groups have not been violated, therefore, the t-value and its significance level of the row "Equal variances assumed" should be used.

4.3.1.1 Efficiency and Attitudes to Interpersonal Care

Table 4.9 shows that for Interpersonal Care, the two efficiency groups (high efficiency and low efficiency) have no statistically significant difference in the interpersonal attitude care scores for the high *(M=47.85, SD=5.67, n=54)* and low *(M=47.14, SD=6.83, n=55)* efficiency groups, $t(107)$=-0.587, p=0.559 (two-tailed). The magnitude of the differences in the means (mean difference =-0.70640, 95% CI: -3.093 to 1.680) is quite small (eta squared = .003). Therefore, the null hypothesis stating e*fficiency of an individual's network position is not associated with attitudes to interpersonal care in knowledge-intensive work* cannot be rejected. In other words, there is no association between efficiency and attitudes to performance with respect to interpersonal care.

4.3.1.2 Efficiency and Attitudes to Technical Care

With respect to attitudes to technical care aspects, the two efficiency groups also show no significant difference in the technical care attitude scores for the high *(M=38.68, SD=7.23, n=47)* and low *(M=39.52, SD=6.86, n=62)* efficiency groups, $t(107)$=0.933, p=0.508 (two-tailed). The magnitude of the differences in the means (mean difference = 0.89630, 95% CI: -1.779 to 3.572) is very small (eta squared = 0.004). Therefore, the null hypothesis that efficiency of an individual's network position is not associated with technical care attitudes in knowledge-intensive work *cannot* be rejected. Consequently there is no support for the alternative hypothesis (*H1a)* that efficiency is positively associated with attitudes to technical care.

4.3.2 Hypothesis 1b - Constraint and Performance Attitudes

H1b: Constraint of an individual's network position is negatively associated with performance in knowledge-intensive work

In this hypothesis, the t-test was also adopted in order to test the difference between the high constraint group and the low constraint group on attitudes to interpersonal and technical aspects of medical care. If there exists a statistically significant difference in the mean

performance attitude scores of the high and low constraint groups, then there exists an association between constraint and performance attitudes. Again, the direction of the association depends on the direction of the difference between the two groups.

The technique involving segregation of the high and low constraint groups is the same as was performed for the efficiency groups. The cases of data of the GPs were ranked in ascending order based on the constraint scores, thus ranking the constraint scores. The median constraint score or index was then picked as the cut-point to divide the dataset into higher or lower constraint groups. In this case, the median constraint score was 0.355. GPs with constraint scores greater or equal to this cut-point were termed "high constraint group" and those lesser than the median score were termed "low constraint group".

Group Statistics

	Constraint Group	N	Mean	Std. Deviation	Std. Error Mean
Interpersonal Care	Low Constraint	56	49.1964	4.71909	.63061
	High Constraint	53	45.6981	7.18327	.98670
Technical Care	Low Constraint	56	40.2321	6.97004	.93141
	High Constraint	53	38.0189	6.97383	.95793

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Inter-personal Care	Equal variances assumed	2.44	.121	3.021	107	.003	3.49832	1.15816	1.2024	5.7942
	Equal variances not assumed			2.987	89.10	.004	3.49832	1.17100	1.1715	5.8250
Technical Care	Equal variances assumed	.032	.858	1.657	107	.101	2.21327	1.33608	-.43534	4.8618
	Equal variances not assumed			1.657	106.66	.101	2.21327	1.33610	-.43548	4.8620

Table 4.10: t-test Statistics for Constraint and Performance Attitudes

Effect Size Calculation – Interpersonal Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{3.021^2}{3.021^2 + (53 + 56 - 2)} = .078 \text{ (moderate effect size)}$$

Effect Size Calculation – Technical Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{1.657^2}{1.657^2 + (53 + 56 - 2)} = .025 \text{ (small effect size)}$$

From Table 4.10, because the Levene's test for equality of variances shows a significance value of 0.121 for interpersonal care attitudes and 0.858 for technical care attitudes, both being greater than 0.05, equal variances should be assumed.

4.3.2.1 Constraint and Attitudes to Interpersonal Care

The t-test reveals a significant difference in the interpersonal care attitude scores of high constraint groups (*M=45.69, SD=7.18, n=53)* and low constraint groups (*M=49.19, SD=4.72, n=56*); *t* (107)=3.021, *p*=.003 (two-tailed). The magnitude of the difference in the means (mean difference = 3.49, 95% CI: 1.2024 to 5.7942) is moderate (eta squared = 0.079).

The direction of the difference in terms of which group is higher is highlighted in the group statistics table above where the lower constraint group has a higher interpersonal care mean of 49.1964 and the higher constraint group has a lower interpersonal care mean of 45.6981 in attitudes to interpersonal care. Further investigation from the correlation results in Table 4.8 shows a significant negative correlation *(r=-0.217; p<0.05)* between constraint scores and attitudes to interpersonal care. Consequently, there is no evidence to support the null hypothesis that constraint in an individual's network position is positively or not associated

with attitudes to interpersonal care. Therefore, there is sufficient evidence to support the hypothesis stated (H1b) in terms of attitudes to interpersonal care.

4.3.2.2 Constraint and Attitudes to Technical Care

Table 4.10 shows the results of the t-test which indicates no significant difference in the technical care attitude scores of high constraint groups (*M=38.02, SD=6.97, n=53)* and low constraint groups (*M=40.23, SD=6.97, n=56*); *t* (107)=1.657, *p*=0.101 (two-tailed). The magnitude (effect size) of the differences in the means (mean difference=2.2132, CI: -0.435 to 4.86) is small (eta squared = .02). Therefore, the null hypothesis that constraint in the individual's network position is positively or not associated with technical care attitudes *cannot* be rejected. In other words, there is no support for the alternative hypothesis *H1b* that constraint is negatively associated with technical care attitudes and will thus be rejected.

4.4 Network Structure & Relational Hypotheses

The following section provides a discussion of the results of hypotheses testing of associations between ties in the ego networks and attitudes to performance.

4.4.1 Hypothesis 2a – Strong Ties and Performance Attitudes

H2a: Strong ties will be positively associated with individual performance in knowledge-intensive work

Hypothesis 2a tests the positive association of strong ties with attitudes to interpersonal and technical care. As described in section 4.1, the dependent variables and the average strength of ties variable is reasonably normally distributed as a result of which parametric tests to compare groups (t-tests) may be conducted. In terms of hypothesis testing, the t-test tests the probability that the two sets of scores (strong tie and weak tie) came from the same population. This allows for the t-test to reveal whether there is a statistically significant difference in the mean score for the strong tie group and the weak tie group.

As stated in section 3.4.1.1.3, the operationalisation of tie strength is determined from the average of frequency of contact and closeness measures of the "ego" GP to all other GPs

within his or her network. The maximum value for frequency of contact on a scale of "daily" (coded as 1 but reverse-coded for analysis as 5) to "less often" (coded as 5 but reverse-coded for analysis as 1) is 5, which indicates frequent interaction and intuitively, a very close tie. The maximum value for degree of closeness on a scale of "especially close" (coded as 1, but reverse-coded in analysis as 4) to "distant" (coded as 4 but reverse-coded in analysis as 1) is 4, which indicates a stronger relationship and a stronger tie. Therefore, in this study, the theoretical maximum value that the "average tie strength" a GP can have is 4.5 ((5+4)/2). In order to distinguish a strong tie from a weak tie, a cut-point needs to be determined from this theoretical maximum value by dividing it by 2. Therefore, the cut-point is 4.5/2 = 2.25. Consequently, GPs who have an average strength of tie score that is greater than or equal to 2.25 are grouped "Strong Ties" and those lesser than 2.25 are termed "Weak Ties".

Group Statistics

	Average Tie Strength Group	N	Mean	Std. Deviation	Std. Error Mean
Interpersonal Care	Weak Ties	56	47.6429	5.25159	.70177
	Strong Ties	54	47.2593	7.19063	.97852
Technical Care	Weak Ties	56	38.3929	7.12914	.95267
	Strong Ties	54	39.7778	6.96261	.94749

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Inter-personal Care	Equal variances assumed	1.535	.218	.320	108	.749	.3836	1.19745	-1.989	2.757
	Equal variances not assumed			.319	96.851	.751	.3836	1.20415	-2.006	2.773
Technical Care	Equal variances assumed	.010	.922	-1.030	108	.305	-1.3849	1.34421	-4.049	1.279
	Equal variances not assumed			-1.031	107.982	.305	-1.3849	1.34362	-4.048	1.278

Table 4.11: t-test Statistics for Strong Ties and Performance Attitudes

Effect Size Calculation – Interpersonal Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{.320^2}{.320^2 + (54 + 56 - 2)} = .0009 \text{ (very small effect size)}$$

Effect Size Calculation – Technical Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-1.031^2}{-1.031^2 + (54 + 56 - 2)} = .009 \text{ (very small effect size)}$$

4.4.1.1 Strong Ties and Attitudes to Interpersonal Care

With respect to interpersonal care, there is no significant difference in the attitudes scores to interpersonal care for GPs with strong ties *(M=47.26, SD=7.19, n=54)* and GPs with weak ties *(M=47.64, SD=5.25, n=56)*; $t(108) = .320$, $p=.749$ (two-tailed). The magnitude of the differences in the means (mean difference = .38, 95% CI: -1.99 to 2.76) is very small (eta squared = .0009).

4.4.1.2 Strong Ties and Attitudes to Technical Care

With respect to technical care, there is also no significant difference in the attitude scores to technical care for GPs with strong ties *(M=19.45, SD=5.81)* and GPs with weak ties *(M=18.52, SD=5.59)*; $t(108) = -1.030$, $p=.305$ (two-tailed). The magnitude of the differences in the means (mean difference = -1.3849, 95% CI: -4.049 to 1.279) is very small (eta squared = .009).

Therefore, given the results, it is clear that there is not sufficient evidence to reject the null hypothesis that strong ties will be not associated with individual performance in knowledge-intensive work. Therefore the alternative hypothesis H2a cannot be supported.

4.4.2 Hypothesis 2b – Degree Centrality and Performance Attitudes

H2b: Degree centrality is positively associated with individual performance in knowledge-intensive work

This hypothesis tests the association between degree centrality and attitudes to interpersonal care and attitudes to technical care. Again, the t-test was deployed to assess if there is a statistically significant difference between the means of the performance attitude scores of those with high degree centrality and those with low degree centrality.

In order to dichotomise groups into high and low degree centrality, the median degree was chosen as the cut-point. In this study, the median degree centrality is 8. Therefore, those with a degree centrality lower than the median were categorised as being in the "low centrality group", and those with degree centrality equal to or greater than the median were categorised as being in the "high centrality group".

Group Statistics

	Degree Centrality Group	N	Mean	Std. Deviation	Std. Error Mean
Interpersonal Care	Low Degree Centrality	45	45.9556	7.87388	1.17377
	High Degree Centrality	64	48.5781	4.59746	.57468
Technical Care	Low Degree Centrality	45	38.6000	6.99480	1.04272
	High Degree Centrality	64	39.5469	7.07988	.88499

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Inter-personal Care	Equal variances assumed	3.847	.052	-2.189	107	.031	-2.62257	1.1982	-4.998	-.247
	Equal variances not assumed			-2.007	65.01	.049	-2.62257	1.3069	-5.232	-.012
Technical Care	Equal variances assumed	.005	.946	-.691	107	.491	-.94688	1.3705	-3.663	1.770
	Equal variances not assumed			-.692	95.58	.490	-.94688	1.3676	-3.661	1.768

Table 4.12: t-test Statistics for Degree Centrality and Performance Attitudes

Effect Size Calculation – Interpersonal Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-2.189^2}{-2.189^2 + (45 + 64 - 2)} = .04 \text{ (small effect size)}$$

Effect Size Calculation – Technical Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-.691^2}{-.691^2 + (45 + 64 - 2)} = .004 \text{ (very small effect)}$$

4.4.2.1 Degree Centrality and Attitudes to Interpersonal Care

In terms of interpersonal care, there is a significant difference in the attitudes scores to interpersonal care for GPs with high degree centrality *(M=48.58, SD=4.59, n=64)* and GPs with low degree centrality *(M=45.95, SD=7.87, n=45)*; *t* (107) = -2.189, *p=.031* (two-tailed). The magnitude of the differences in the means (mean difference = -2.62, 95% CI: -4.99 to -.247) is small (eta squared = .04). Furthermore, inspecting the correlation in Table 4.8, there exists a very significant positive correlation *(r=0.258; p<0.01)* between degree centrality scores and attitudes to interpersonal care. As such, the null hypothesis that there is no association between degree centrality and interpersonal care can be rejected. Therefore, there is sufficient evidence to support the alternative hypothesis *H2b* in terms of attitudes to interpersonal care.

4.4.2.2 Degree Centrality and Attitudes to Technical Care

With respect to technical care, there is no significant difference in the attitudes scores to technical care for GPs with high degree centrality *(M=39.55, SD=7.08, n=64)* and GPs with low degree centrality *(M=38.6, SD=6.99, n=45)*; *t* (107) = -.691, *p=.491* (two-tailed). The magnitude of the differences in the means (mean difference = -1.37, 95% CI: -3.66 to 1.77) is

very small (eta squared = .004). As such, the null hypothesis that there is no association between degree centrality and interpersonal care *cannot be* rejected. Therefore, there is sufficient evidence to reject the alternative hypothesis *H2b* in terms of attitudes to technical care.

4.4.3 Hypothesis 2c – Geographical Diversity and Performance Attitudes

H2c: Geographical Diversity is positively associated with individual performance in knowledge-intensive work

Hypothesis 2c tests the association between the geographical diversity of an ego's direct ties with attitudes to interpersonal care and attitudes to technical care. Inspecting the correlation results in Table 4.8, page 106 reveals no significant correlation between geographical diversity and performance attitudes. To investigate further, the t-test was conducted in order to test for differences between the two independent groups of high and low geographical diversity indices. The entropy-based measure is discussed in section 3.4.1.1.3 in page 74. Using the geographical diversity index, GPs were clustered into high diversity and low diversity groups. The cut-point that was used in this case was the median being 0.673. GPs with scores higher and equal to the median were regarded as "high geographical diversity group" and those lower than the median were termed "low geographical diversity group". By ranking the GP performance attitude scores based on high and low geographical diversity groups, the t-test evaluates whether there is a significant difference in the performance attitude scores. If the test yields a significant difference, it is sufficient evidence that there is an association between geographical diversity and performance attitudes.

Group Statistics

	Geographical Diversity Group	N	Mean	Std. Deviation	Std. Error Mean
Interpersonal Care	Low Diversity	56	47.4643	7.44913	.99543
	High Diversity	54	47.4444	4.77678	.65004
Technical Care	Low Diversity	56	39.7679	7.50271	1.00259
	High Diversity	54	38.3519	6.53916	.88987

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Inter-personal Care	Equal variances assumed	3.234	.075	.017	108	.987	.01984	1.19802	-2.354	2.394
	Equal variances not assumed			.017	94.14	.987	.01984	1.18888	-2.340	2.380
Technical Care	Equal variances assumed	.966	.328	1.054	108	.294	1.41601	1.34391	-1.247	4.079
	Equal variances not assumed			1.056	106.92	.293	1.41601	1.34054	-1.241	4.073

Table 4.13: t-test Statistics for Geographical Diversity and Performance Attitudes

Effect Size Calculation – Interpersonal Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{.017^2}{.017^2 + (56 + 54 - 2)} = .00 \text{ (small effect size)}$$

Effect Size Calculation – Technical Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{1.054^2}{1.054^2 + (56 + 54 - 2)} = .01 \text{ (very small effect)}$$

4.4.3.1 Geographical Diversity and Attitudes to Interpersonal Care

As can be determined from Table 4.13, the t-test revealed no significant difference in the interpersonal care attitude scores of GPs with high geographical diversity *(M=47.44, SD=4.77, n=54)* and GPs with low geographical diversity *(M=47.46, SD=7.44, n=56); t* (108)=.017, *p*=.987 (two-tailed). The magnitude of the differences in the means (mean difference = .01984, 95% CI: -2.354 to 2.394). was very small (eta squared = .00). Therefore,

the null hypothesis that geographical diversity is not associated with attitudes to interpersonal care *cannot* be rejected. As such, there is no evidence to support the alternative hypothesis *H2c* and should thus be rejected.

4.4.3.2 Geographical Diversity and Attitudes to Technical Care

Similarly, there is also no significant difference in the technical care attitude scores of GPs with high geographical diversity *(M=38.35, SD=6.54, n=54)* and GPs with low geographical diversity *(M=39.77, SD=7.5, n=56); t*(108) = 1.054, *p*=0.355. The magnitude of the differences in the means (mean difference = 1.41, 95% CI: -1.247 to 4.079) was very small (eta squared = .01). Therefore, the null hypothesis cannot be rejected and the alternative hypothesis that geographical diversity is positively associated with attitudes to technical should thus be rejected.

In conclusion, there is no support for *H2c* in terms of both interpersonal and technical care.

4.4.4 Hypothesis 2d – Functional Diversity and Performance Attitudes

H2d: Functional (tie) Diversity will be positively associated with individual performance in knowledge-intensive work

Hypothesis 2d examines the association between functional diversity of a GP's direct ties to his or her professional network and attitudes towards interpersonal and technical care.

In order to conduct the t-test, it was necessary to group the performance attitude indices of GPs based on their level of functional diversity. Two functional diversity groups, high and low, were chosen based on the median of the ranks. The functional diversity indices for the GPs were sorted in ascending order thereby providing a ranking mechanism. The median (0.8676) was then chosen as the cut-point. GPs with functional diversity indices greater than equal to the median were categorised as "high functional diversity group" and those with indices lower than the median value were categorised as "low functional diversity group".

If the t-test reveals a significant difference between the performance attitudes of the two functional diversity groups, then there is sufficient evidence that there is an association

between functional diversity and performance attitudes. The direction of the association will be determined by the direction of the difference in the mean scores of performance attitudes of the two groups.

Group Statistics

	Functional Diversity Group	N	Mean	Std. Deviation	Std. Error Mean
Interpersonal Care	Low Diversity	56	46.8750	7.66115	1.02376
	High Diversity	54	48.0556	4.33249	.58958
Technical Care	Low Diversity	56	39.0893	7.13067	.95288
	High Diversity	54	39.0556	7.03205	.95694

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Inter-personal Care	Equal variances assumed	6.291	.014	-.990	108	.324	-1.18056	1.19262	-3.544	1.183
	Equal variances not assumed			-.999	87.539	.320	-1.18056	1.18139	-3.528	1.167
Technical Care	Equal variances assumed	.430	.513	.025	108	.980	.03373	1.35079	-2.643	2.711
	Equal variances not assumed			.025	107.944	.980	.03373	1.35045	-2.643	2.710

Table 4.14: t-test Statistics for Functional Diversity and Performance Attitudes

Effect Size Calculation – Interpersonal Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-.999^2}{-.999^2 + (56 + 54 - 2)} = .009 \text{ (small effect size)}$$

Effect Size Calculation – Technical Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

Or Eta Squared = $\frac{.025^2}{.025^2 + (56 + 54 - 2)}$ = .000 (very small effect)

4.4.4.1 Functional Diversity and Attitudes to Interpersonal Care

The t-test shows that for Interpersonal Care, the two functional diversity groups (high functional diversity and low functional diversity) have no statistically significant difference in the interpersonal attitude scores for the high functional diversity *(M=48.05, SD=4.33, n=54)* and low functional diversity *(M=46.87, SD=7.66, n=56)* groups. The probability value of the test (equal variances not assumed) is not less than or equal to .05, so the result is not significant, $t(108) = -.999$, $p=.320$ (two-tailed), with the magnitude of the means (mean difference = -1.18, 95% CI: -3.54 to 1.18) being very small (eta squared = .009). The null hypothesis stating functional diversity is not associated with attitudes to interpersonal care therefore *cannot* be rejected. In other words, there is no association between functional diversity and attitudes to performance with respect to interpersonal care.

4.4.4.2 Functional Diversity and Attitudes to Technical Care

In terms of attitudes to technical care, the two functional diversity groups also show no significant difference in the technical care attitude scores for the high *(M=39.05, SD=7.03, n=54)* and low *(M=39.08, SD=7.13, n=56)* groups; $t(108) = .025$, $p = .980$ (two-tailed). The size of the difference (mean difference = .03373, 95% CI: -2.643 to 2.71) is extremely small (eta squared = .000). Therefore, the null hypothesis that functional diversity is not associated with attitudes to technical care in knowledge-intensive work *cannot* be rejected. In conclusion, there is no support for the alternative hypothesis *(H2d)* that functional diversity is positively associated with attitudes to technical care.

4.5 ICT Use & Communication Structure Hypotheses

The following section discusses the test results of hypotheses that are related to ICT use at both the sociological and task level of the individual GPs in relation to their performance attitudes and professional network.

4.5.1 Hypothesis 3a – Communication-related ICT use and Performance Attitudes

H3a: Use of ICT for professional communication activities is positively associated with individual performance

In order to test this hypothesis, the t-test was adopted to test for the difference between two independent groups of high and low communication-related ICT users on a continuous measure of performance attitude indices. Should the test results indicate a statistically significant t-value, it is sufficient to conclude that an association exists between communication-related ICT use and performance attitudes.

The cut-point for the high and low groups of communication-related ICT use was determined by ranking its scores and dividing it by the median (in this being 28.0). Therefore, GPs with a communication-related ICT use score equal or greater than 28 were categorised "high communication-related ICT users" whereas those with scores lesser than the median were categorised "low communication-related ICT users".

Group Statistics

	Communication related ICT Use	N	Mean	Std. Deviation	Std. Error Mean
Interpersonal Care	Low Users	54	46.4074	7.56985	1.03013
	High Users	56	48.4643	4.48822	.59976
Technical Care	Low Users	54	38.3519	7.34117	.99901
	High Users	56	39.7679	6.75006	.90201

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Inter-personal Care	Equal variances assumed	3.977	.049	-1.741	108	.085	-2.0568	1.18156	-4.398	.285
	Equal variances not assumed			-1.726	85.550	.088	-2.0568	1.19201	-4.426	.312
Technical Care	Equal variances assumed	.720	.398	-1.054	108	.294	-1.4160	1.34391	-4.079	1.247

	Equal variances not assumed			-1.052	106.459	.295	-1.4160	1.34597	-4.084	1.252

Table 4.15: t-test Statistics for Communication related ICT Use and Performance Attitudes

Effect Size Calculation – Interpersonal Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-1.726^2}{-1.726^2 + (54 + 56 - 2)} = .02 \text{ (small effect size)}$$

Effect Size Calculation – Technical Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-1.054^2}{-1.054^2 + (54 + 56 - 2)} = .01 \text{ (very small effect)}$$

4.5.1.1 Communication-related ICT Use and Attitudes to Interpersonal Care

Results from the above table indicates that for interpersonal care, the two communication-related ICT user groups (high and low) have no statistically significant difference in the interpersonal attitude care indices for the high *(M=48.46, SD=4.49, n=56)* and low *(M=46.41, SD=7.57, n=54)* communication-related ICT user groups; *t* (88.55)=-1.726, *p*=.088 (two-tailed). The magnitude of the difference (mean difference = 1.19; 95%CI: -4.426 to .312) was very small (eta squared = .02). The null hypothesis that use of ICT for professional communication activities is not associated with individual performance therefore *cannot* be rejected. In other words, there is no association between ICT use for professional communication and attitudes to performance with respect to interpersonal care.

4.5.1.2 Communication-related ICT Use and Attitudes to Technical Care

In terms of attitudes to technical care aspects, the two communication-related ICT user groups show no significant difference in the technical care attitude scores for the high *(M=39.76, SD=6.75, n=56)* and low *(M=38.35, SD=7.34, n=54)* user groups; t (108)=-1.054, p=.294 (two-tailed). The magnitude of the difference (mean difference = -1.416; 95% CI: -4.079 to 1.247) is very small (eta squared = .01). Therefore, the null hypothesis that communication-related ICT use is not associated with attitudes to technical care in knowledge-intensive work *cannot* be rejected. Subsequently, there is no support for the alternative hypothesis *H3a* that communication-related ICT use is positively associated with attitudes to technical care.

4.5.2 Hypotheses 3b – Communication-related ICT use and Efficiency

H3b: Use of ICT for professional communication activities is positively associated with efficiency of an individual's network in knowledge-intensive work

The relationship between ICT use for professional communication activities and efficiency of an individual's network in knowledge-intensive work is tested using the parametric t-test. In effect, this hypothesis also asks the question of whether GPs with higher (or lower) levels of ICT use for professional communication activities are associated with a higher (or lower) efficiency score in their individual network. Therefore, t-test was employed to test for the difference between the two independent groups of high and low level usage of communication-related ICT on a continuous measure of efficiency score. That is, the means across the two groups are compared. So if the means across the two groups are found to differ significantly, then there is evidence that use of communication-related ICT use is positively associated with the number of colleagues in knowledge-intensive work. The direction of the association (i.e. positive or negative) can be evidenced in the mean scores of the groups by examining which group has a higher mean.

Similar to the tests carried out previously, the cut-point used for the group categorisation was determined in the following manner. First, the scores for the communication-related ICT use were sorted in ascending order. Second, the median value of the sorted list was ascertained. In

this case, the median value was 28. The high task-level ICT users group were defined as those having scores equal to and greater than 28, while the low task-level ICT users group were defined as those with values lesser than 28.

Group Statistics

	Communication related ICT Use	N	Mean	Std. Deviation	Std. Error Mean
Efficiency	Low Users	54	.5410	.30670	.04174
	High Users	55	.4114	.27605	.03722

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Efficiency	Equal variances assumed	2.054	.155	2.320	107	.022	.12962	.05587	.01886	.24037
	Equal variances not assumed			2.318	105.398	.022	.12962	.05592	.01874	.24050

Table 4.16: t-test Statistics for Communication-related ICT Use and Efficiency

Effect Size Calculation

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-2.320^2}{-2.320^2 + (54 + 55 - 2)} = .02 \text{ (small effect size)}$$

The results from the t-test shows that the high task-level ICT user group *(M=.4114, SD=.276, n=55)* and low task-level ICT user group *(M=.541, SD=.041, n=54)* have a statistically significant difference in the efficiency scores; t (107) = 2.32, p=.022 (two-tailed). The magnitude of the difference in the means (mean difference = .129, 95% CI: .01886 to .24037) is small (eta squared = .04). Quite evidently and also by inspecting the group statistics, the low user group of communication-related ICT have higher mean efficiency scores than the high user group. Therefore, the null hypothesis stating that use of ICT for professional

communication activities is negatively or not associated with efficiency in an individual's network in knowledge-intensive work *cannot be* rejected. Therefore, there is no support for the alternative hypothesis and thus *H3b* should be rejected.

4.5.3 Hypotheses 3c – Task level ICT use and Degree Centrality

H3c: Use of ICT for task-level activities is positively associated with degree centrality of individuals in knowledge-intensive work

In order to test this hypothesis, firstly, preliminary investigation from the correlation analysis in Table 4.8 confirms that there is a significant positive correlation between task-level ICT use and degree centrality, $r=.241$, $p<.05$, with high levels of ICT use being associated with high degree centrality. As the hypothesis also questions whether higher task-level ICT use is typically associated with higher degree centrality, the t-test was adopted to test for differences between the groups of high task-level ICT use and low task-level ICT use on the continuous variable – degree centrality. In order to classify the group into high and low users, the dataset was sorted in ascending order based on the task-level ICT use score. As in section 4.5.2, the median of the score *(Md=35)* was selected as the cut-point to divide the two groups. GPs with a task-level ICT use score higher or equal to 35 were classified as "high task-level ICT use group", all else being the "low task-level ICT use group".

Group Statistics

	Task level ICT Use Group	N	Mean	Std. Deviation	Std. Error Mean
Degree	Low Users	53	7.8679	3.51392	.48267
	High Users	56	9.6250	4.16724	.55687

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Degree	Equal variances assumed	4.987	.028	-2.373	107	.019	-1.7570	.74040	-3.224	-.289
	Equal variances not assumed			-2.384	105.62	.019	-1.7570	.73694	-3.218	-.295

Table 4.17: t-test Statistics for Degree Centrality and Task-level ICT Use

Effect size calculation

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-2.384^2}{-2.384^2 + (53 + 56 - 2)} = .05 \text{ (small effect size)}$$

Results from the test above reveals significant difference in the degree centrality of high task-level ICT users *(M=9.625, SD=4.16, n=56)* and low task-level ICT users *(M=7.86, SD=3.51, n=53); t* (105.62) = -2.384, *p*=.019 (two-tailed). The magnitude of the differences in the means (mean difference = -1.757, 95% CI: -3.218 to -.295) was small (eta squared = .05). Given these results, the null hypothesis that us*e of ICT for task-level activities is negatively or not associated with degree centrality of individuals in knowledge-intensive work* can therefore be rejected thus lending support to the alternative hypothesis.

4.5.4 Hypotheses 3d – Task level ICT use and Functional Diversity

H3d: Use of ICT for task-level activities is positively associated with functional diversity of individuals in knowledge-intensive work

Similar to the above test, the correlation matrix in Table 4.8 confirms that there is a very significant positive correlation between functional diversity and task-level ICT use, *r=.322, p<.01*. This indicates that as the GPs are tied to others who are highly diverse in their occupational roles, their use of ICT for task-level purposes also increases.

In order to infer further, the t-test was used to test for the differences in the functional diversity scores of high task-level ICT user groups and low task-level ICT user groups. In the event that there exists a statistically significant difference between the two groups, one may infer that there exists an association between task-level ICT use and functional diversity of individuals in knowledge-intensive work. Whether the association is positive or negative will depend on the ranking of mean of the functional diversity scores grouped by high task-level

ICT use and low task-level ICT use. The classification scheme used for the grouping of high and low users of task-level ICT is same as in the previous section (Section 4.5.3).

Group Statistics					
	Task level ICT Use Group	N	Mean	Std. Deviation	Std. Error Mean
Functional Diversity	Low Users	53	.6674	.43983	.06042
	High Users	56	.9247	.42115	.05628

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Functional Diversity	Equal variances assumed	.069	.793	-3.120	107	.002	-.25730	.08247	-.4207	-.0938
	Equal variances not assumed			-3.116	105.96	.002	-.25730	.08257	-.4210	-.0936

Table 4.18: t-test Statistics for Functional Diversity and Task-level ICT Use

Effect size calculation

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-3.120^2}{-3.120^2 + (53 + 56 - 2)} = .08 \text{ (moderate effect size)}$$

The test results confirm significant difference in the functional diversity of high task-level ICT users *(M=.9247, n=56)* and low task-level ICT users *(M=.6674, n=53); t (107)* = -3.120, p = .002 (two-tailed). The magnitude of the difference in the means (mean difference = .08247, 95% CI: -.4207 to -.0938) was moderate (eta squared = .08). Clearly, high task-level ICT users have a higher mean in functional diversity score (*M=.9257*) than low task-level ICT users *(M=.6674).* Given these results, the null hypothesis that us*e of ICT for task-level activities is negatively or not associated with functional diversity of individuals in*

knowledge-intensive work can therefore be rejected thus lending support to the alternative hypothesis.

4.5.5 Hypotheses 3e – Task level ICT use and Performance Attitudes

H3e: Use of ICT for task-level activities is positively associated with individual performance

In order to test this hypothesis, the t-test and Pearson's Product Moment correlation were used. The former tests for the difference between the two independent groups (high task-level ICT users versus low task-level ICT users) on a continuous measure of performance attitude. Again, if the difference between high task-level ICT users and low task-level ICT users is statistically significant, then one may conclude that there is an association between ICT use and performance attitudes. The direction of the association can be determined from the direction of the difference (i.e. which group has a higher mean score). The classification scheme used for the grouping of high and low users of task-level ICT is same as in the previous section (Section 4.5.4). Results of the t-test are presented below:

Group Statistics

	Task level ICT Use Group	N	Mean	Std. Deviation	Std. Error Mean
Interpersonal Care	Low Users	53	45.5094	7.40224	1.01678
	High Users	57	49.2632	4.27838	.56668
Technical Care	Low Users	53	37.7547	7.22417	.99232
	High Users	57	40.2982	6.71609	.88957

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Inter-personal Care	Equal variances assumed	3.765	.055	-3.284	108	.001	-3.7537	1.14289	-6.0191	-1.4883
	Equal variances not assumed			-3.225	81.977	.002	-3.7537	1.16403	-6.0693	-1.4380
Technical Care	Equal variances assumed	.896	.346	-1.914	108	.058	-2.5435	1.32912	-5.1780	.0910
	Equal variances not assumed			-1.909	105.746	.059	-2.5435	1.33268	-5.1857	.0987

Table 4.19: t-test Statistics for Task-level ICT use and Performance Attitudes

Effect size calculation – Interpersonal Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-3.284^2}{-3.284^2 + (53 + 57 - 2)} = .09 \text{ (moderate effect size)}$$

Effect size calculation – Technical Care

$$\text{Eta Squared} = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

$$\text{Or Eta Squared} = \frac{-1.914^2}{-1.914^2 + (53 + 57 - 2)} = .03 \text{ (small effect size)}$$

4.5.5.1 Task-level ICT use and Attitudes to Interpersonal Care

The above table shows that for attitudes to interpersonal care, there exists a statistically significant difference in the interpersonal attitude care scores for the high *(M=49.26, SD=4.28, n=57)* and low *(M=45.51, SD=7.40, n=53)* task-level ICT user groups; t (108) =-3.284, p=.001 (two-tailed). The magnitude of the differences in the mean (mean difference = -3.7537; 95% CI: -6.019 to -1.488) was moderate (eta squared = .09). Also, the mean score of the interpersonal care attitudes belonging to the high task-level ICT user group is greater than the interpersonal care attitudes mean score of the low task-level ICT user group. One may thus infer that while there exists an association between task-level ICT use and attitudes to interpersonal care, interestingly, the mean score shows evidence that high task-level ICT use have higher interpersonal attitude scores compared to low task-level ICT use.

Furthermore, the correlation matrix in Table 4.8 confirms that there is a very significant positive correlation between task-level ICT use and attitudes to interpersonal care, *r=-.257, p<.01,* with high frequency of task-level ICT use associated with high scores in attitudes to interpersonal care. These results are sufficient to reject the null hypothesis that *use of ICT for*

task-level activities is negatively or not associated with individual performance and therefore, the alternative hypothesis proposed in H3e in terms of interpersonal care may be supported.

4.5.5.2 Task-level ICT use and Attitudes to Technical Care

With respect to attitudes to technical care, the high task-level ICT use *(M=40.29, SD=6.72, n=57)* and low task-level ICT use *(M=37.75, SD=7.22, n=53)* groups show no significant difference in the technical care attitude scores, t (108) = -1.914, p = .058 (two-tailed). The magnitude of the differences in the mean (mean difference = -2.5435, 95% CI: -5.18 to .091) was small (eta squared = .03). Therefore, there is support for the null hypothesis that *use of ICT for task-level activities is negatively or not associated with attitudes to technical care.* In effect, the alternative hypothesis described in H3e in terms of technical care will have to be rejected.

4.6 Personal Attributes, Network, ICT Use and Performance Hypotheses

In this section, the results provide evidence for interesting inferences to see whether network structure, position and ties, ICT Use, and performance attitudes are correlated to personal attributes. The results and hypothesis tests are based on the demographic data of gender, professional appointments and educational background. Therefore, within the context of the rural GPs, the discussion of the results to follow are grouped into categories of gender effects, hospital appointment effects, professional accreditation effects (FACRRM and FRACP), and education background effects.

4.6.1 Gender Effects

This section reports the results related to hypotheses that investigates the association between gender, network structure, network position, network ties, and ICT use. The independent samples t-test was most suited to test hypotheses *H4a* to *H4d* as it tells us whether there is a statistically significant difference in the mean scores for the two groups (i.e. of male and female GPs). Statistically, it is testing the probability that the two sets of scores (for males

and females) came from the same population. Firstly, the independent samples t-test results are presented below:

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Degree	Female	20	10.4000	3.88519	.86876
	Male	89	8.4045	3.88680	.41200
Constraint	Female	20	.3283	.13172	.02945
	Male	89	.4192	.20671	.02191
Geographical Diversity	Female	20	.8767	.26658	.05961
	Male	89	.6613	.37650	.03991
Functional Diversity	Female	20	1.0884	.32954	.07369
	Male	89	.7347	.44608	.04728
Task level ICT Use	Female	20	32.6000	9.50014	2.12430
	Male	90	29.8778	11.21779	1.18246
Communication related ICT Use	Female	20	26.9000	8.92601	1.99592
	Male	89	26.4382	8.39501	.88987

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Degree	Equal variances assumed	.103	.749	2.075	107	.040	1.99551	.96175	.08894	3.90207
	Equal variances not assumed			2.075	28.199	.047	1.99551	.96150	.02659	3.96442
Constraint	Equal variances assumed	4.046	.047	-1.878	107	.063	-.09086	.04838	-.18676	.00505
	Equal variances not assumed			-2.475	43.005	.017	-.09086	.03671	-.16489	-.01683
Geographical Diversity	Equal variances assumed	4.121	.045	2.421	107	.017	.21538	.08895	.03905	.39171
	Equal variances not assumed			3.002	38.194	.005	.21538	.07174	.07019	.36058
Functional Diversity	Equal variances assumed	2.898	.092	3.342	107	.001	.35375	.10584	.14394	.56357
	Equal variances not assumed			4.040	36.531	.000	.35375	.08755	.17627	.53123
Task level ICT Use	Equal variances assumed	2.164	.144	1.007	108	.316	2.72222	2.70325	-2.6360	8.08053
	Equal variances not assumed			1.120	31.943	.271	2.72222	2.43122	-2.2303	7.67480
Communication related ICT Use	Equal variances assumed	.004	.950	.220	107	.826	.46180	2.10135	-3.7038	4.62749

	Equal variances not assumed			.211	27.073	.834	.46180	2.18530	-4.0215	4.94510

Table 4.20: t-test Statistics for Gender, Network, and ICT Use

4.6.1.1 Hypothesis 4a: Gender and Degree Centrality

H4a: There is a significant difference in degree centrality between gender-based ego-networks in knowledge-intensive work

The results from the t-tests above suggest that there is a statistical difference in the degree centrality scores for males *(M* = 8.40, *SD* = 3.88) and females *(M* = 10.4, *SD* = 3.88); *t* (107) = 2.075, *p* = .04 (two-tailed). The magnitude of the differences in the means (mean difference = 1.99, 95% CI: .088 to 3.9) was small (eta squared = .03)[7]. Furthermore, it is evident that the mean degree centrality scores of females are higher than that of males. Therefore, while there is support for *H4a,* one can also infer that females have higher degree centrality in their ego-networks than males in knowledge-intensive work.

4.6.1.2 Hypothesis 4b: Gender and Ego-network Constraint

H4b: There is a significant difference in constraint indices between gender-based ego-networks in knowledge-intensive work

The results from Table 4.20 suggest that there is a statistical difference in the constraint scores for males *(M* = .4192, *SD* = .206) and females *(M* = .3283, *SD* = .1317); *t* (43.005) = -2.475, *p* = .017 (two-tailed). The magnitude of the differences in the means (mean difference = -.09086, 95% CI: -.16489 to -.01683) was near moderate (eta squared = .05). Furthermore, it is evident that the mean constraint scores of males are higher than that of females. Therefore, while there is support for *H4b,* one can also infer that males have higher constraint in their ego-networks than females in knowledge-intensive work.

[7] From this point on, the effect size calculations are not shown. It is calculated as $\frac{t^2}{t^2 + (N_1 + N_2 - 2)}$

4.6.1.3 Hypothesis 4c: Gender and Tie Diversity

H4c: There is a significant difference in professional tie diversity (geographically and functionally) between gender-based ego-networks in knowledge-intensive work.

Firstly, in terms of geographical diversity, the results suggest that there is a statistical difference in the geographical diversity scores for males *(M* = .6613, *SD* = .376) and females *(M* = .8767, *SD* = .266); *t* (38.194) = 3.002, *p* = .005 (two-tailed). The magnitude of the differences in the means (mean difference = .21538, 95% CI: .07019 to .36058) was fairly moderate (eta squared = .07). Also, it is evident that the mean geographical diversity scores of females are higher than that of males.

In terms of functional tie diversity, it appears that there also is a statistical difference in the functional diversity scores for males *(M* = .7347, *SD* = .446) and females *(M* = 1.0884, *SD* = .329); *t* (107) = 3.342, *p* = .001 (two-tailed). The magnitude of the differences in the means (mean difference = .35375, 95% CI: .14394 to .56357) was fairly moderate (eta squared = .09). Furthermore, it is evident that the mean functional diversity scores of females are higher than that of males.

Therefore, while there is strong support for *H4c,* one can also infer that females have higher tie diversity in their ego-networks than their male counterparts in knowledge-intensive work.

4.6.1.4 Hypothesis 4d: Gender and ICT use

H4d: There is no significant difference in the frequency and pattern of ICT use for task-level and communication-related activities between genders in knowledge-intensive work.

With respect to task-level ICT use, the results suggest that there is no statistical difference in the task-level ICT use levels for males *(M* = 29.87, *SD* = 11.21) and females *(M* = 32.6, *SD* = 9.5); *t* (108) = 1.007, *p* = .316 (two-tailed). The magnitude of the differences in the means (mean difference = 2.72, 95% CI: -2.636 to 8.08) was very small (eta squared = .009).

In terms of communication related ICT use, it appears that there also no statistical difference in the communication related ICT use for males *(M* = 26.44 *SD* = 8.39) and females *(M* =

26.9, *SD* = 8.93); *t* (107) = .220, *p* = .826 (two-tailed). The magnitude of the differences in the means (mean difference = 2.10, 95% CI: -3.70 to 4.63) was extremely small (eta squared = .0004).

Therefore, there is not sufficient evidence to support the null hypothesis that there *is a* significant difference in the frequency and pattern of ICT use for task-level and communication-related activities between genders in knowledge-intensive work. As such the null hypothesis must be rejected and *H4d* should thus be supported.

4.6.2 Professional Appointment Effects

This section pertains to the association between professional appointments (in terms of hospital appointments) and network structure and position. As in the previous section, the independent samples t-test was adopted to compare if there is a statistical difference between the network variables of those who are holders and non-holders of hospital appointments. Table 4.21 shows the t-test statistics below.

Group Statistics

	Hospital Appointment Code Available	N	Mean	Std. Deviation	Std. Error Mean
Ego Density	No	25	.46748	.377996	.075599
	Yes	84	.65573	.328977	.035894
Efficiency	No	25	.6198	.30295	.06059
	Yes	84	.4327	.28372	.03096

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Ego Density	Equal variances assumed	1.631	.204	-2.426	107	.017	-.188246	.077594	-.3420	-.03442
	Equal variances not assumed			-2.249	35.518	.031	-.188246	.083688	-.3580	-.01844
Efficiency	Equal variances assumed	.466	.496	2.850	107	.005	.18707	.06565	.05693	.31721
	Equal variances not assumed			2.749	37.427	.009	.18707	.06804	.04926	.32488

Table 4.21: t-test Statistics for Hospital Appointment, Network Structure and Network Position

4.6.2.1 Hypothesis 4e: Hospital Appointment and Ego-network Density

H4e: There is a significant difference in ego-network density between holders and non-holders of professional appointments in knowledge-intensive work

Inspecting the results above, it is clear that there is a significant difference in the ego-network density indices for holders of hospital appointment *(M* = .6557, *SD* = .328) and non-holders of hospital appointment *(M* = .4674, *SD* = .377); *t* (107) = -2.426, *p* = .017 (two-tailed). The magnitude of the differences in the means (mean difference = -.188, 95% CI: -.3420 to -.0344) was small to near moderate (eta squared = .05). In particular, it also appears that those who hold professional appointments also have a denser network than those who do not (by inspecting the means). Therefore, there is sufficient evidence to reject the null hypothesis in favour of *H3e.*

4.6.2.2 Hypothesis 4f: Hospital Appointment and Ego-network Efficiency

H4f: There is a significant difference in ego-network efficiency between holders and non-holders of professional appointments in knowledge-intensive work

In terms of ego-network efficiency, it is clear that there is a significant difference in the ego-network efficiency indices for holders of hospital appointment *(M* = .4327, *SD* = .283) and non-holders of hospital appointment *(M* = .6198, *SD* = .302); *t* (107) = 2.85, *p* = .005 (two-tailed). The magnitude of the differences in the means (mean difference = -.188, 95% CI: .0569 to .3172) was moderate (eta squared = .07). In particular, it also appears that those who hold professional appointments also have a less efficient network than those who do not (by inspecting the means). Therefore, there is sufficient evidence to reject the null hypothesis in favour of *H3f.*

4.6.3 Professional Accreditation Effects

This section pertains to the association between professional accreditations (in terms of Fellowship accreditations) and network structure and position, ICT use, and performance attitudes. In this study, fellowship accreditations are of two forms: Fellowship of the Royal

Australian College of General Practitioners (FRACGP) and Fellowship of the Australian College of Rural and Remote Medicine (FACRRM). As in the previous section, the independent samples t-test was adopted to compare if there is a statistical difference between the network, ICT use and performance variables of those who are holders and non-holders of hospital appointments. Below, Table 4.22 shows the t-test statistics for FACRRM and its association with network structure, position and ICT use. Table 4.23 shows the t-test statistics for FRACGP and its association with ICT use and performance attitudes.

Group Statistics

	Fellow of ACRRM	N	Mean	Std. Deviation	Std. Error Mean
Degree	No	80	8.1250	3.69528	.41314
	Yes	29	10.5517	4.12818	.76658
Functional Diversity	No	80	.7472	.47791	.05343
	Yes	29	.9440	.31342	.05820
Task level ICT Use	No	80	28.7875	11.35023	1.26899
	Yes	30	34.6000	8.55247	1.56146

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Degree	Equal variances assumed	1.437	.233	-2.936	107	.004	-2.42672	.82655	-4.065	-.78818
	Equal variances not assumed			-2.787	45.274	.008	-2.42672	.87083	-4.180	-.67308
Functional Diversity	Equal variances assumed	9.405	.003	-2.059	107	.042	-.19672	.09555	-.38614	-.00730
	Equal variances not assumed			-2.490	75.963	.015	-.19672	.07901	-.35408	-.03936
Task level ICT Use	Equal variances assumed	9.928	.002	-2.544	108	.012	-5.81250	2.28458	-10.340	-1.2840
	Equal variances not assumed			-2.889	68.922	.005	-5.81250	2.01209	-9.826	-1.7984

Table 4.22: t-test Statistics for FACRRM, Network Structure, Network Position & ICT Use

Group Statistics					
	Fellow of RACGP	N	Mean	Std. Deviation	Std. Error Mean
Task level ICT Use	No	66	27.6970	11.51717	1.41767
	Yes	44	34.3864	8.67023	1.30709
Interpersonal Care	No	66	46.3788	7.07708	.87113
	Yes	44	49.0682	4.35301	.65624
Technical Care	No	66	37.5606	6.85033	.84322
	Yes	44	41.3409	6.80268	1.02554

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Task level ICT Use	Equal variances assumed	16.032	.000	-3.281	108	.001	-6.6893	2.03904	-10.7311	-2.6476
	Equal variances not assumed			-3.469	106.331	.001	-6.6893	1.92828	-10.5122	-2.8665
Interpersonal Care	Equal variances assumed	2.459	.120	-2.251	108	.026	-2.6893	1.19482	-5.0577	-.3210
	Equal variances not assumed			-2.466	107.416	.015	-2.6893	1.09065	-4.8513	-.5274
Technical Care	Equal variances assumed	.384	.537	-2.843	108	.005	-3.7803	1.32956	-6.4157	-1.1448
	Equal variances not assumed			-2.847	92.750	.005	-3.7803	1.32769	-6.4169	-1.1436

Table 4.23: t-test Statistics for FRACGP, ICT use and Performance Attitudes

4.6.3.1 Hypothesis 4g: FACRRM and Degree Centrality

H4g: There is a significant difference in degree centrality between holders and non-holders of professional accreditations and memberships

In terms of the FACRRM accreditation, it is clear from Table 4.22 that there is a significant difference in the degree centrality indices for holders of FACRRM *(M* = 10.55, *SD* = 4.13) and non-holders of FACRRM *(M* = 8.125, *SD* = 3.69); *t* (107) = -2.787, *p* = .004 (two-tailed). The magnitude of the differences in the means (mean difference = -2.42, 95% CI: -4.065 to -.78818) was near moderate (eta squared = .05). In particular, it also appears that those who

hold the FACRRM accreditation also have higher degree centrality in their ego-networks than those who do not (by inspecting the means). Therefore, there is sufficient evidence to reject the null hypothesis in favour of *H3g* in terms of FACRRM.

4.6.3.2 Hypothesis 4h: FACRRM and Functional Diversity

H4h: There is a significant difference in functional tie diversity between holders and non-holders of professional accreditations and memberships

It is quite evident from Table 4.22 that there is a significant difference in the functional diversity indices for holders of FACRRM *(M* = .944, *SD* = .31342) and non-holders of FACRRM *(M* = .7472, *SD* = .47791); *t* (107) = -2.49, *p* = .015 (two-tailed). The magnitude of the differences in the means (mean difference = -.19672, 95% CI: -.35408 to -.03936) was near moderate (eta squared = .05). In particular, it also appears that those who hold the FACRRM accreditation also experience higher functional tie diversity in their professional networks than those who do not (by inspecting the means). Therefore, there is sufficient evidence to reject the null hypothesis in favour of *H3h* in terms of FACRRM.

4.6.3.3 Hypothesis 4i: FACRRM, FRACGP and ICT Use

H4i: There is a significant difference in ICT use for task-level and communication related purposes between holders and non-holders of professional accreditations and memberships

In terms of task-level ICT use and FACRRM, it is quite evident from Table 4.22 that there is a significant difference in the task-level ICT use scores for holders of FACRRM *(M* = 34.6, *SD* = 8.552) and non-holders of FACRRM *(M* = 28.78, *SD* = 11.35); *t* (68.92) = -2.889, *p* = .005 (two-tailed). The magnitude of the differences in the means (mean difference = -5.8125, 95% CI: -9.826 to -1.7984) was moderate (eta squared = .07).

In relation to task-level ICT use and FRACGP, from Table 4.23 that there is a significant difference in the task-level ICT use scores for holders of FRACGP *(M* = 34.3864, *SD* = 8.67) and non-holders of FRACGP *(M* = 27.69, *SD* = 11.52); *t* (106.331) = -3.469, *p* = .001 (two-

tailed). The magnitude of the differences in the means (mean difference = -6.6893, 95% CI: -10.51 to -2.86) was fairly moderate (eta squared = .10).

In particular, it appears that those who hold both the FACRRM and FRACGP accreditation also have a higher frequency of task-level ICT use than those who do not (by inspecting the means). Therefore, there is sufficient evidence to reject the null hypothesis in favour of *H3i* in terms of FACRRM and task-level ICT use, and FRACGP and task-level ICT use.

There was no statistical significance reported in difference-comparison between FACRRM-accredited GPs and non-FACRRM accredited GPs in terms of communication related ICT use. Similarly, there was no statistical significance found in the difference between holders of FRACGP and non-holders in terms of communication related ICT use. Hence, the results are not shown.

4.6.3.4 Hypothesis 4j: FRACGP and Performance Attitudes

H4j: There is a significant difference in performance attitude between holders and non-holders of professional accreditations and memberships

Recall that performance attitudes are categorised into attitudes to aspects of interpersonal care and attitudes to aspects of technical care.

Firstly, in terms of performance attitudes to interpersonal care for FRACGP accredited GPs, it can be seen from Table 4.23 that there is a significant difference in the interpersonal care attitudes scores for holders of FRACGP *(M* = 49.068, *SD* = 4.353) and non-holders of FRACGP *(M* = 46.38, *SD* = 7.08); *t* (108) = -2.251, *p* = .026 (two-tailed). The magnitude of the differences in the means (mean difference = -2.6893, 95% CI: -5.057 to -.321) was small (eta squared = .04).

Secondly, in terms of performance attitudes to technical care for FRACGP accredited GPs, Table 4.23 also shows that there is a significant difference in the technical care attitudes scores for holders of FRACGP *(M* = 41.34, *SD* = 6.80) and non-holders of FRACGP *(M* = 37.56, *SD* = 6.85); *t* (106.331) = -3.469, *p* = .001 (two-tailed). The magnitude of the

differences in the means (mean difference = -6.6893, 95% CI: -10.512 to -2.866) was small (eta squared = .04).

Therefore, in terms of the association between FRACGP and performance attitudes (for both technical and interpersonal care), the evidence is sufficient to reject the null hypothesis and lend support to *H4j*. It is also clear that those who are professionally accredited with the FRACGP are more likely to have a higher performance attitude score than those who are not (by inspecting the means for both interpersonal care and technical care attitudes).

4.6.4 Education and Training Effects

This section pertains to the association between education (in terms country of medical training/graduation) and network structure and position, ICT use, and performance attitudes. As in the previous section, the independent samples t-test was adopted to compare if there is a statistical difference between the network, ICT use and performance variables of those who are trained locally (Australia) and those who are trained overseas. The independent samples t-tests indicated no statistical significant difference in the network, ICT use and Performance scores of those who were trained locally and those who were trained overseas. As such, the results are not shown here.

4.7 Multiple Regression and Post-hoc Analyses

In this section, results from post-hoc analyses which were conducted after testing the hypotheses above are discussed. Referring to the correlation statistics in Table 4.8 and the t-tests conducted in section 4.6.3 in page 137 on professional accreditation effects, it is clear that for performance, measured by attitudes to interpersonal and technical care, the former measure (interpersonal care) demonstrates significant associations with:

- degree *(r=.258, n=109, p<.01)*,
- constraint *(r=-.217, n=109, p<.05)*,
- task-level ICT use *(r=.257, n=110, p<.01)*, and

- FRACGP (t (108) = -2.251, p = .026 (two-tailed)).

For task-level ICT use, the following variables showed significant correlations:

- Years in rural practice *(r=-.223, n=109, p<.05)*
- Years in current practice *(r=-.288, n=110, p<.01)*
- Degree centrality *(r=.241, n=109, p<.05)*
- Functional Diversity *(r=.322, n=109, p<.01)*
- Interpersonal Care *(r=.257, n=110, p<.01)*

Therefore, post-hoc analyses were conducted with the prime objective of delineating the following questions:

1. Of the variables that have shown to be associated (positively or negatively) with performance attitudes in terms of attitudes to interpersonal care, which one best explains the variance in the relationship with performance attitudes controlling for any effects that other independent variables may bear on the relationship?
2. Of the variables that have shown to be associated with task-level ICT use, which ones best predict or explain the variance in the relationship with task-level ICT use controlling for any effects that other independent variables may bear on the relationship?

As seen above, a number of variables confront us when attempting to understand which variable(s) is (are) the best predictors for the dependent variables – attitudes to interpersonal care and task-level ICT use. In order to effectively reduce the number of possible explanatory variables to a smaller set in a single regression analysis, the *stepwise multiple regression* technique with forward selection is used (Hair, 2006). With the stepwise multiple regression technique, the one independent variable that is statistically significant and explains the most variance in the dependent variable is determined, and is entered into the multiple regression equation. This process is iterated until all statistically significant independent variables have

been entered into the multiple regression equation such that the insignificant ones are excluded, leaving behind the statistically significant independent variables only. This technique thus allows us to infer the most potent predictor(s) of the dependent variable from amongst a set of significant ones. The sections following discuss the assumptions and results of the regression analyses to explaining predictors of attitudes to interpersonal care and task-level ICT use.

4.7.1 Explaining Predictors of Interpersonal Care

In order to explain the interrelationship among the set of variables that affects interpersonal care, a stepwise multiple regression was conducted in order to model the interrelationship amongst the variables. Three models were postulated. The first model simply regressed the demographic variable FRACGP on the dependent variable - attitudes to interpersonal care because of its positive correlation. In the second model, the network variables (degree centrality and constraint), FRACGP and task-level ICT use variable were entered while controlling, as a whole, for the effect of FRACGP accreditation on interpersonal care attitudes. In the third model, an interaction term (degree centrality * task-level ICT use) was added because it is clear from the correlation coefficient that as degree centrality increases, task-level ICT use also increases and interpersonal care attitudes decreases. Therefore, an interaction between degree centrality and task-level ICT use on interpersonal care attitudes is conjectured.

Prior to discussion of the results, it is important to address the assumptions of the multiple regression analysis stated in the context above. Venter and Maxwell (2000) outlines the regression assumptions which influence the use of multiple regression in terms of (1) random sampling, (2) linearity, (3) homoscedasticity and (4) normality. The first assumption has been addressed in sufficient detail in chapter 3 and the latter ones will be addressed here.

4.7.1.1 The Multicollinearity Assumption

This assumption states that the independent variables must show some relationship with the dependent variable. In this case, all variables (degree, constraint and task-level ICT use) correlate significantly with attitudes to interpersonal care. In terms of collinearity amongst variables, in model 1 and 2 in the coefficients statistics in Table 4.26, all variables demonstrate a tolerance level greater than 0.1 which is acceptable. Tolerance (calculated as 1-R Square for every variable) is an indicator of how much of the variability of the specified independent is not explained by the other independent variables in the model (Hair, 2006). A tolerance level lesser than .10 indicates that multiple correlation with other variables is high, suggesting strong likelihood of multicollinearity. Its inverse measure, the variance inflation factor (VIF) is also a measure of multicollinearity. Therefore, VIFs with values over 10 is a sign of multicollinearity. In Table 4.26 in page 147, Model 1's Collinearity Statistics shows that for FRACGP, the tolerance value is 1.00 and the VIF value is 1.00 as well. In Model 2, the reported tolerance and VIF values for both degree centrality and task-level ICT use variables are .967 and 1.034 respectively. Therefore, both models have not violated assumptions of multicollinearity.

4.7.1.2 The Normality and Homoscedasticity Assumption

Referring to Table 4.7 in page 102, it is clear that the variables degree centrality, constraint, task-level ICT use, technical care and interpersonal care failed the Kolmogorov-Smirnov Test of Normality as all the variables have a significance value of lesser than .05. Therefore, it was decided to transform the variables based on their original distribution and skewness. The transformations are made because the models are considered nonlinear in parameters (but not intrinsically nonlinear) so that they can become linear in the parameters (Venter et. al., 2000). The following is a summary of the transformations performed on the variables:

Original Variable	Transformation Performed
Degree centrality	Reflect & Square Root
Constraint	Square Root
Task-level ICT use	Reflect & Log_{10}
Technical Care	Square Root
Interpersonal Care	Square Root

Table 4.24: Original Variables and Transformation Performed

After transformations, the Kolmogorov-Smirnov Test of Normality was run again, however, without much improvement as most variables still had a sig. value of lesser than .05 (below).

	Kolmogorov-Smirnov(a)		
	Statistic	df	Sig.
Degree	.160	109	.000
Constraint	.099	109	.011
Task level ICT Use	.235	108	.000
Interpersonal Care	.089	110	.032
Technical Care	.078	110	.092

* This is a lower bound of the true significance.
a Lilliefors Significance Correction

Table 4.25: Kolmogorov-Smirnov Test of Normality (Transformed Variables)

However, inspecting the normal probability plot (P-P) of the Regression Standardised Residual and the Scatterplot (see Figure 4.3) from the multiple regression, one can see that the points lie in a reasonably straight diagonal line from bottom left to top right. This suggests no major deviation from normality. In the Scatterplot of the standardised residuals, the residuals are roughly rectangularly distributed, with most of the scores concentrated in the centre. There is no clear systematic pattern to the residuals in that they are not curvilinear, or excessively higher on one side, suggesting no violation of normality. Given this scenario, it is still feasible to conduct a regression analysis without violation of the assumption of normality (Tabachnick et. al., 2007).

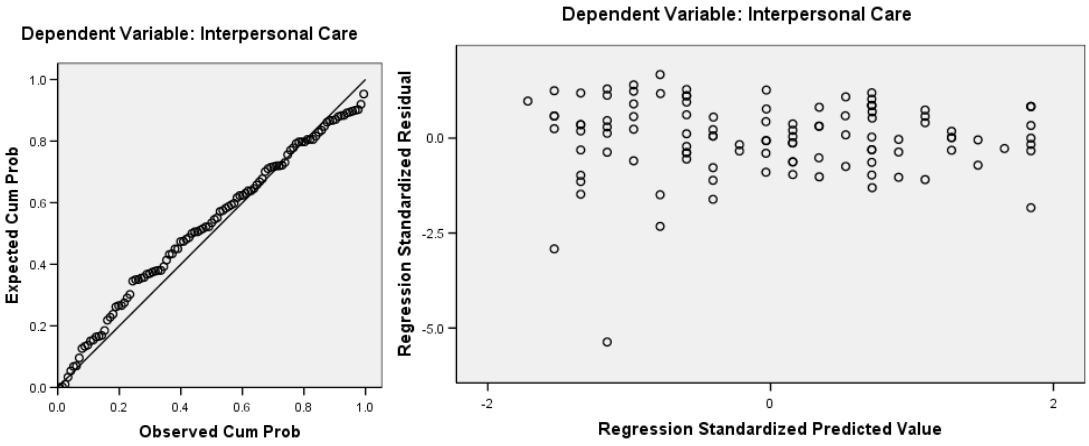


Figure 4.3: Normal probability plot (P-P) of the Regression Standardised Residual (left) and its Scatterplot (right) for explaining Attitudes to Interpersonal Care

4.7.1.3 Results

Table 4.26 below shows the results of the hierarchical multiple regression models. Two models are presented after computing the stepwise multiple regression (see "Model Summary" table). Firstly, after the FRACGP variable has been entered, the overall model (model 1) explains 4.5% of the variance (R Square = .045 in Model 1) in attitudes to interpersonal care. In the second model, the regression exercise identified only two variables - degree centrality and FRACGP although task-level ICT use and constraint had also been entered. The second model as a whole explains 9.5% of the variance (R Square = .095). That is, after statistically controlling for the effects of FRACGP accreditation; degree centrality as a whole accounted for an additional 5% (R Square Change = .05 in Model 2) of the variance in attitudes to interpersonal care. This is a statistically significant contribution, as indicated by the Sig. F Change value (.017). The ANOVA table indicates that the model (model 2) as a whole is significant [$F (2, 106) = 5.550$, $p < .01$]. The third model which introduces the interaction term, "degree * task-level ICT use" into the regression equation was dropped out.

Model Summary(c)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.212(a)	.045	.036	6.13933	.045	5.020	1	107	.027
2	.308(b)	.095	.078	6.00470	.050	5.852	1	106	.017

a Predictors: (Constant), Fellow of RACGP
b Predictors: (Constant), Fellow of RACGP, Degree
c Dependent Variable: Interpersonal Care

ANOVA(c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	189.195	1	189.195	5.020	.027(a)
	Residual	4032.983	107	37.691		
	Total	4222.178	108			
2	Regression	400.194	2	200.097	5.550	.005(b)
	Residual	3821.985	106	36.056		
	Total	4222.178	108			

a Predictors: (Constant), Fellow of RACGP
b Predictors: (Constant), Fellow of RACGP, Degree
c Dependent Variable: Interpersonal Care

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	46.379	.759		61.091	.000	44.874	47.884		
	Fellow of RACGP	2.689	1.200	.212	2.240	.027	.310	5.069	1.000	1.000
2	(Constant)	43.429	1.428		30.416	.000	40.598	46.259		
	Fellow of RACGP	2.167	1.194	.171	1.815	.072	-.200	4.534	.967	1.034
	Degree	.360	.149	.227	2.419	.017	.065	.655	.967	1.034

a Dependent Variable: Interpersonal Care

Excluded Variables(c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Degree	.227(a)	2.419	.017	.229	.967	1.034	.967
	Constraint	-.194(a)	-2.066	.041	-.197	.985	1.016	.985
	Task level ICT Use	.213(a)	2.182	.031	.207	.909	1.100	.909
	Degree * Task-level ICT use	.271(a)	2.873	.005	.269	.936	1.068	.936
2	Constraint	-.067(b)	-.500	.618	-.049	.481	2.079	.472
	Task level ICT Use	.173(b)	1.764	.081	.170	.873	1.145	.873
	Degree * Task-level ICT use	.261(b)	1.503	.136	.145	.280	3.576	.280

a Predictors in the Model: (Constant), Fellow of RACGP
b Predictors in the Model: (Constant), Fellow of RACGP, Degree
c Dependent Variable: Interpersonal Care

Table 4.26: Regression Model for Constraint, Degree Centrality and Task-level ICT use on Interpersonal Care Attitudes (controlling for FRACGP)

Given that model 2 as a whole significantly explains 9.5% of the variance in attitudes to interpersonal care, the Coefficients table indicates that in particular, degree centrality (in model 2) makes a statistically significant contribution (beta = .227, $p < .05$) in explaining the variance of attitudes to interpersonal care after the overlapping effects of the FRACGP variable have been statistically removed. All other variables including the interaction term, did not display significant contributions (as evidenced in the "Excluded Variables" table). Therefore, in conjunction with the hypotheses tested above, it is concluded that among variables – FRACGP (of personal attributes), degree centrality (of network structure), constraint (of network position) and task-level ICT use (of ICT use) that have shown significant associations with interpersonal care, degree centrality best explains performance of individuals in geographically dispersed settings.

4.7.2 Explaining Predictors of Task-level ICT Use

The stepwise multiple regression (with forward selection) was used to assess the ability of years in rural practice, years in current practice, FRACGP, FACRRM, degree centrality and functional diversity to predict the extent of task-level ICT use. These variables were chosen in the regression model because they demonstrated statistical significance in its association with task-level ICT use. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity occurred.

4.7.2.1 The Multicollinearity Assumption

First a check was made to ensure that the independent variables (number of years in current practice, number of years in rural practice, degree centrality and functional diversity) were correlated with the dependent variable – task-level ICT use. Checks were also ensured that the correlations were not extremely high (i.e. an absolute value of .7 or more). Furthermore, in order to check for multicollinearity which may not be possible to pick up in the correlation matrix, the tolerance level and VIF statistics were observed. Studying Table 4.29, it is evident that all tolerance levels are greater than 0.1, indicating that there are no high multiple correlations with other independent variables. Furthermore, the Variance Inflation Factor

index for all variables in both models are lower than 10, suggesting no violation of the multicollinearity assumption.

4.7.2.2 The Normality and Homoscedasticity Assumption

In terms of normality in the data distribution of the variables, it is evident from Table 4.7 that the variables – task-level ICT use, degree centrality, functional diversity, number of years in rural practice and years in current practice have failed the Kolmogorov-Smirnov test of normality. Therefore it was decided to transform the variables and the techniques used are summarised in the below table:

Original Variable	Transformation Performed
Degree centrality	Reflect & Square Root
Task-level ICT use	Reflect & Log_{10}
Years in current practice	Log_{10}
Years in rural practice	Log_{10}

Table 4.27: Original Variables and Transformation Performed

After transformations, the Kolmogorov-Smirnov Test of Normality was run again, however, without much improvement as most variables still had a sig. value of lesser than .05 (therefore failing the test).

	Kolmogorov-Smirnov(a)		
	Statistic	df	Sig.
Degree	.160	109	.000
Task level ICT Use	.235	108	.000
Years in current practice	.138	110	.000
Years in rural practice	.209	110	.000

* This is a lower bound of the true significance.
a Lilliefors Significance Correction

Table 4.28: Kolmogorov-Smirnov Test of Normality (Transformed Variables)

However, inspecting the normal probability plot (P-P) of the Regression Standardised Residual and the Scatterplot (see Figure 4.4) from the multiple regression, one can see that the points lie in a somewhat straight diagonal line from bottom left to top right. This suggests no major deviation from normality. In the Scatterplot of the standardised residuals, the residuals are roughly rectangularly distributed, with most of the scores concentrated in the centre.

There is no clear systematic pattern to the residuals in that they are not curvilinear, or excessively higher on one side, suggesting no violation of normality. Given this situation, it is still feasible to conduct a regression analysis without much violation of the assumption of normality (Tabachnick et. al., 2007).

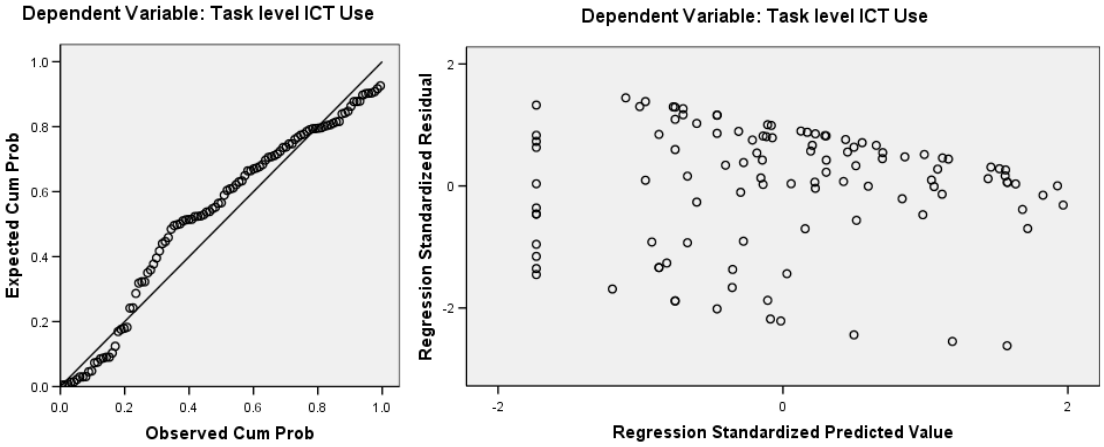


Figure 4.4: Normal probability plot (P-P) of the Regression Standardised Residual (left) and its Scatterplot (right) for explaining Task-level ICT use

4.7.2.3 Results

The stepwise multiple regression analysis identified two models of significance. In the first model, the only predictors is functional diversity, which explains 9.5% of the variance (R Square = .095 in Model 1) in task-level ICT use. The second model shows the entry of another variable – RACGP, the total variance explained by the model as a whole being 15.1% (R Square = .151). That is, RACGP explained an additional 6.3% (R Square change = .063 in model 2) of the variance in task-level ICT Use, after controlling for functional diversity, *F* change (1, 106) = 8.051, p < .01. From the ANOVA table, it is clear that models 1 [F (1, 107) = 12.350, p=.001] and 2 [F (2, 106) = 10.607, p=.000] are quite significant.

Model Summary(c)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.322(a)	.103	.095	10.40293	.103	12.350	1	107	.001
2	.408(b)	.167	.151	10.07625	.063	8.051	1	106	.005

a Predictors: (Constant), Functional Diversity
b Predictors: (Constant), Functional Diversity, Fellow of RACGP
c Dependent Variable: Task level ICT Use

ANOVA(c)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1336.477	1	1336.477	12.350	.001(a)
	Residual	11579.648	107	108.221		
	Total	12916.124	108			
2	Regression	2153.856	2	1076.928	10.607	.000(b)
	Residual	10762.269	106	101.531		
	Total	12916.124	108			

a Predictors: (Constant), Functional Diversity
b Predictors: (Constant), Functional Diversity, Fellow of RACGP
c Dependent Variable: Task level ICT Use

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	24.086	2.048		11.762	.000	20.026	28.145		
	Functional Diversity	7.863	2.237	.322	3.514	.001	3.427	12.298	1.000	1.000
2	(Constant)	22.639	2.048		11.054	.000	18.578	26.699		
	Functional Diversity	6.838	2.197	.280	3.112	.002	2.482	11.194	.973	1.028
	Fellow of RACGP	5.667	1.997	.255	2.837	.005	1.707	9.627	.973	1.028

a Dependent Variable: Task level ICT Use

Excluded Variables(c)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Years in Rural Practice	-.174(a)	-1.902	.060	-.182	.972	1.028	.972
	Years in Current Practice	-.225(a)	-2.453	.016	-.232	.947	1.056	.947
	Fellow of ACRRM	.182(a)	1.976	.051	.188	.962	1.040	.962
	Fellow of RACGP	.255(a)	2.837	.005	.266	.973	1.028	.973
	Degree	.159(a)	1.668	.098	.160	.909	1.100	.909
2	Years in Rural Practice	-.102(b)	-1.077	.284	-.105	.870	1.150	.870
	Years in Current Practice	-.172(b)	-1.849	.067	-.178	.889	1.125	.889
	Fellow of ACRRM	.169(b)	1.887	.062	.181	.959	1.043	.940
	Degree	.124(b)	1.329	.187	.129	.892	1.121	.892

a Predictors in the Model: (Constant), Functional Diversity
b Predictors in the Model: (Constant), Functional Diversity, Fellow of RACGP
c Dependent Variable: Task level ICT Use

Table 4.29: Regression Model for FRACGP, Degree Centrality and Functional Diversity on Task-level ICT use

In the final model (model 2), functional diversity and FRACGP were statistically significant with functional diversity recording a higher beta value (beta = .280, $p < .01$) than FRACGP (beta = .225, $p < .01$). Therefore, one may conclude that among variables – of FRACGP accreditation (professional accreditation), degree centrality (network structure) and functional diversity (network relations), functional tie diversity makes the largest unique contribution to explaining the variance in task-level ICT use.

4.8 Conclusion

This chapter has reported results from the data analysis which includes descriptives, test of normality, inferential statistics consisting of Pearson's Product Moment correlations, independent sample t-tests for hypothesis testing, and stepwise multiple regression model to explain best predictors for performance attitudes and ICT use. In the following chapter, a discussion is provided to shed light on the current findings in light of existing theory and social networks-ICT use literature.

Chapter 5

5. Synthesis: Social Network, ICT use and Performance in Geographically Distributed Knowledge-intensive Work

The primary objective of this study is to understand the influence of social network and ICT use on individual performance[8] in the context of geographically distributed knowledge-intensive work. As stated in chapter 2, the following research questions motivate this study: (1) How can individual performance be understood through the emergent patterns of social processes that constitute performance? How does one evaluate performance? (2) What is the role of social influence and social networks (that create such influence) in understanding individual performance? Why is understanding social network structure and position important for understanding individual performance? (3) Is there a relationship between the configuration of social network structures and the patterns and frequency of use of communication technologies as well as individual performance? (4) How does one account for social factors that are important for designing and implementing ICT for enhanced performance apart from personal and demographic characteristics?

In attempting to answer the above questions, this chapter is devoted to discussing and interpreting results and findings in light of existing theory and within the context of geographically distributed knowledge workers. In particular, the discussion is structured and driven by: (1) the *network position* hypotheses, which discusses the influence of ego-network efficiency and constraint on individual performance, (2) the *network structure and relational* hypotheses, which discusses the influence of degree centrality, tie strength and diversity on individual performance, (3) the *ICT use* hypotheses, which discusses the influence of ICT use at both the task-level and sociological-level on both network and individual performance, and (4) the personality attribute hypotheses which account for the importance of personality traits of individuals in the relationship between social networks, ICT use and performance. Finally, the validity of the theoretical model is discussed as a whole along with major findings.

[8] Readers are advised that individual performance in the study is measured by performance attitudes as justified in sections 2.9.2 and 3.4.1.3. Therefore, it is important to note that only attitudes to performance were measured as no measures of direct performance were available in the GP domain.

5.1 Ego-network Position and Individual Performance

Prior research has claimed that ego-network measures of an actor's network position are influential predictors of performance (Burt, 1992; Rosenthal, 1997; Aral et. al., 2006). In particular, ego-network efficiency, the degree to which an individual obtains information and control benefits from non-redundant ties, is theorised to positively influence performance. Conversely, constraint, the degree to which an individual lacks opportunity to benefit from information and control benefits, is claimed to negatively impact performance. At the individual level, the findings from this research are quite interesting in that it questions the notions and assumptions from past research and contributes to the few studies of ego-network position and individual performance.

Although ego-network efficiency is claimed to be an influential predictor of performance (Aral et. al., 2006), the results in this study indicate no support for this particular variable in the research model. The correlation coefficients in Table 4.8 for instance, are indicative of the fact that there is no significant association between efficiency and performance. This can be attributed to the fact that individuals (such as rural GPs) involved in knowledge-intensive work within dispersed communities and groups are satisfied or performing relatively well with sources of information and advice based on their professional network of peers and colleagues. It does not seem crucial for such knowledge-workers to be *efficient* in terms of obtaining information for the delivery of quality care at the technical or interpersonal level. Unlike real estate agents, or managerial personnel where the competition for information gains is likely to provide competitive advantage so as to boost sales incentives, bonuses and salary promotions (Burt et. al., 2000; Crowston et. al., 2001; Burt, 2007), GPs in rural areas have no such motivations and the nature of their occupation is non-competitive.

Having said this, the study's findings shift its focus towards the importance of ego-network *constraint*. An individual's professional network is highly constrained to the extent that the individual seeks advice and information from peers and colleagues which lead back to the same person. In the context of rural GPs, results show that constraint has a marginal

detrimental effect to performance, not in terms of technical care but in terms of attitudes to interpersonal care. That is, higher the constraint for the individual GP, lower the score for attitudes to interpersonal care *(r=-.217, p<.05)*. A highly constrained professional network for a GP means that the GP seek advice and information from within her professional network which leads back to the same contact. This constrains her from learning novel ideas, interacting with new and diverse range of personnel in the related profession, which contributes to a better level of interpersonal care.

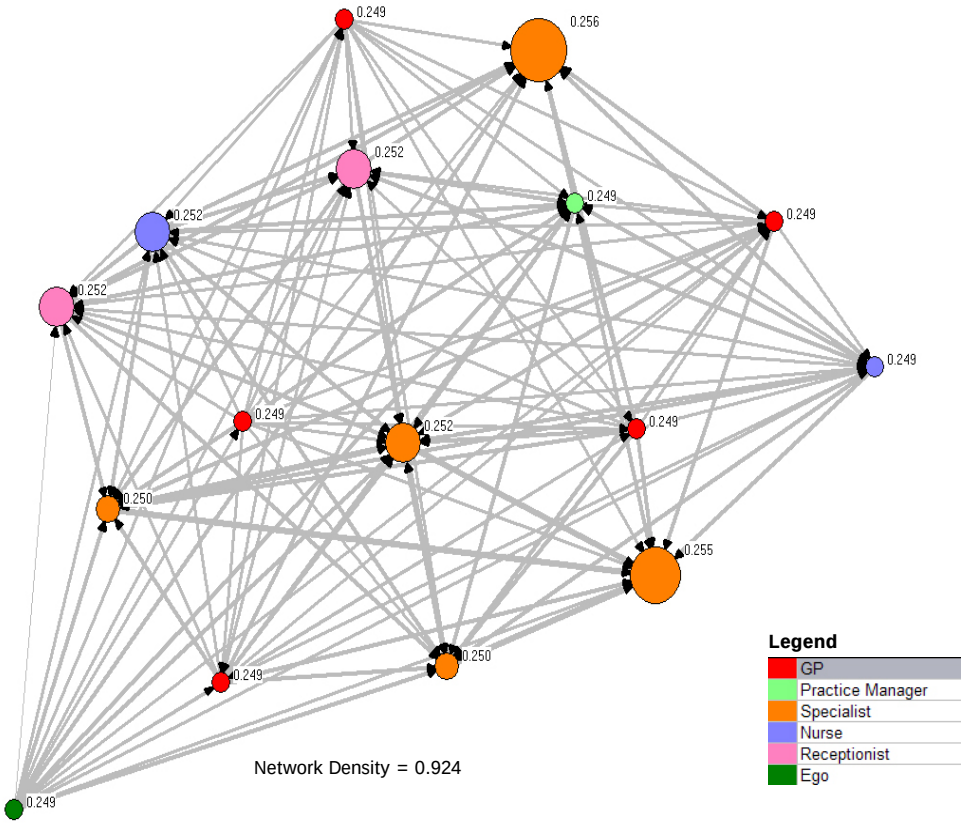


Figure 5.1: A GP's Professional Network

Figure 5.1 illustrates a professional network of a rural GP. The rural GP is the ego (node highlighted in green) in the sociogram. The density of the overall network is 0.924 (which indicates high cohesion and possibly information-redundancy). Despite the high density level, the ego's constraint score is 0.249 and is relatively *unconstrained* compared to others in the network. The size of the nodes also shows the relative constraint index (i.e. larger nodes have a higher constraint index). The ego GP has quite a number of strong ties with others (colours of node depict occupation) in the network, demonstrated by the thickness of lines (1=distant,

5=very close). Thicker lines denote stronger ties. The low constraint score of the ego GP indicates her ability to seek advice and information from non-redundant contacts.

With respect to performance in terms of attitudes to interpersonal care, the finding of ego-network constraint being negatively associated with performance conforms with literature (Rosenthal, 1997; Aral et. al., 2006). However, it was surprising and interesting to note that efficiency did not display its hypothesised correlation with performance in individual knowledge-intensive work. It can thus be speculated that whilst the measures of ego-network position such as efficiency were developed based on theories of social structure and competition, its documented effects toward performance may not be clearly reflected or applicable in occupational communities of knowledge-intensive work where individuals are geographically distributed in isolated settings. This naturally translates into an avenue for further research with respect to the effects of ego-network efficiency and performance in non-competitive domains.

5.2 Ego-network Structure and Individual Performance

The two constructs that conceptualised and operationalised ego-network structure in this study are ego-network density and degree centrality. These concepts are essential and relevant in this study because traditional sociocentric network studies dating back to Coleman et. al.'s (1966) linked density with faster innovation diffusion and Bavelas' (1950) and Freeman's (1978) work linked the importance of degree centrality and centralisation to better performance. In a nutshell, the research question based on these concepts motivates the question of what configuration of actors and relations are conducive to performance at the individual level.

In terms of ego-network density, there was literally no association (negative or positive) with performance. Degree centrality, on the other hand, demonstrated significant positive association between performance with respect to attitudes to interpersonal care, the correlation coefficient for the association being $r=.258$, $p<.01$. Furthermore, the t-tests also demonstrated significant difference in the scores of attitudes to interpersonal care between

two independent centrality groups (high and low centrality groups) of GPs. In particular, GPs with higher degree centrality scored higher than those with lower degree centrality in terms of attitude to interpersonal care. These findings resonate similarly with that of Cross and Cummings (2004) where significant support was found between degree centrality (measured as an individual's ties to and from her department) and individual performance ratings. Consensus can therefore be reached regarding degree centrality in that it represents the extent of information activity which in turn is conducive to performance (Freeman, 1978).

5.3 Ego-network Ties and Individual Performance

The ego-network ties hypotheses were examined from the perspective of strength of relational ties and diversity of relational ties. Firstly, this research hypothesised that strong ties in an individual's ego-network will be positively associated with performance in knowledge-intensive work. Beginning with theory on the strength of ties (Granovetter, 1973), arguments to formulate the hypothesis were put forward as to how strong ties connect individuals who frequently work with each other, how it has greater motivation to be of assistance and are typically more available than weak ties (Granovetter, 1983). Furthermore, it was also claimed that strong ties generate trust which allow influx of useful knowledge (Reagans et. al., 2003; Levin et. al., 2004) and that its "affect" level is conducive to performance (Krackhardt, 1992). Secondly, tie diversity in terms of geographical and functional (or occupational) diversity was postulated to be positively associated with performance. This hypothesis was derived from previous research primarily by Cummings (2004) and Monge et. al. (1985) who found that structural diversity played an important role in obtaining new and novel information for performance. However, contrary to inferences from literature, findings from this study show no statistical support for the hypotheses that strong ties or tie diversity are positively associated to individual performance in knowledge-intensive work. The results are interestingly surprising as it contradicts past research thus questioning the generalisability of the strong tie and tie diversity hypotheses to the extent of individuals within geographically distributed knowledge-intensive work.

5.4 Social System Effects of ICT Use

The social system effects of ICT use is concerned with how the sociology of ICT use relates to individual performance and how the sociological patterns of an individual's professional network is related to ICT adoption and use.

The hypothesis relating to the sociology of ICT use and individual performance is driven mainly by the work of Sproull and Kiesler (1991) on the effects of ICT use, Nardi et. al. (2000) on the effects of technology revolution towards information acquisition and sharing, and Butler (2001) on how ICTs deal with both relational and non-relational information needs. It was concluded that knowledge-intensive workers who rely on updated and correct information through ICTs would provide higher quality of work than those who do not. Subsequently, it was hypothesised that the use of ICT for professional communication activities is positively associated with individual performance (*H3a*). However, contradictory to literature, results from the statistical analyses did not support the hypothesis.

It seems that for GPs, the use of ICT for professional communication does not directly or indirectly impact their practice experience at the technical or interpersonal level. This seems fairly reasonable given that GPs, despite the importance of being updated with current information and technological advances, are somewhat routine in their consultation practice such that ICT use for communication purposes does not directly affect performance. To understand the consultation routine, a model based on the work of Fafchamps (1991) and Gask and Usherwood (2002) depicting the workflow of GPs is shown in Figure 5.2. Note that the model is indicative in nature and does not exhaustively cover all aspects of the GP-patient consultation.

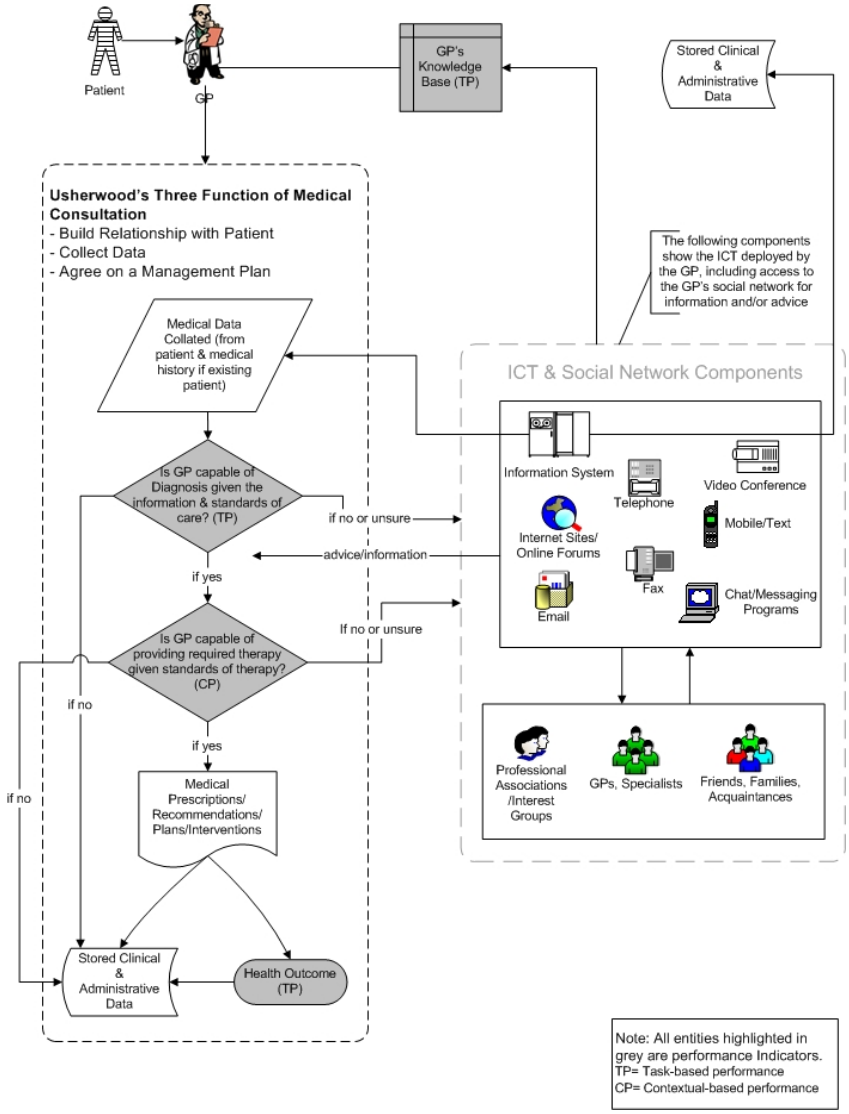


Figure 5.2: The General Practice Workflow Model

The first phase commences when the patient visits the GP. The GP collates medical information from the patient and possibly from existing clinical records if the patient is re-visiting. In the case of the latter, the collation of medical information may include retrieval of the patient's previous medical history via an information system or some form of stored clinical data. Once the medical data has been collated, the GP should be in a position to diagnose the patient based on the standards of clinical care. Alternatively, the GP should also be in a position to provide appropriate therapy based on the standards of therapy. If the GP successfully diagnose the patient's problem and provides appropriate therapy, the GP may then prescribe an appropriate medical plan if necessary. Otherwise, the GP may utilise ICT (if available) to facilitate decision-making (e.g. medical decision support system, or diagnosis

software tool) or seek further information from his or her social network (e.g. other GPs or a GP reading group). Clearly, at this stage, the use of ICT for communication purposes does not facilitate improved performance as evidenced by the findings. The final outcome as a result of the consultation process is the patient's health outcome.

The hypotheses relating to the relationship between social network and ICT use at the task-level sought to answer the research questions: (1) what forms of network structure at the individual level are conducive to ICT use at the task and sociological levels? (2) Alternatively, does the uptake and use of ICT foster change in network structures at both task and sociological levels? To this end, there are various theories that have been postulated as reviewed in chapter 2. For instance, the rational choice model explains that individuals choose to use technology based on the best match between the kind of technology available and the task at hand along with a whole set of factors such as media accessibility, usage experience, personal preference, time and cost advantages (Culnan et. al., 1987). In particular, media use theory, a proponent of the rational choice model, argues that individuals choose media through a matching process. This matching involves assessing the requirements of the particular communication task at hand and selecting a medium with communication capabilities that match the requirements (Williams, 1979). Along the same lines of the rational choice model, social presence theorists argue that individuals choose media based on social presence, which is the degree to which the medium facilitates awareness of the other person and interpersonal relationships during the interaction (for example, on a scale from high to low social presence, face-to-face is highest and print media has lowest social presence) (Short et. al., 1976). Yet another alternative view of the rational choice model is the information richness theory whereby communication media are arrayed along a continuum of "information richness" based on four factors: the degree to which the source is personal enough, speed of feedback, types of channels used for communication and the richness of the communication (Daft et. al., 1981). However, the social influence model is a more comprehensive model that encapsulates and accounts for the dynamics of social influence in

explaining ICT use. While the rational choice model argues that choice of ICT use is objectively rational and that behavior is efficiency-motivated, it fails to explain why certain individuals choose to use ICT although their motivations may not be efficiency-motivated. Both the technology acceptance model (Davis, 1989) and the social influence model (Fulk et. al., 1990) emphasise the significance of social influence and norms in affecting ICT use. These models however, do not clearly indicate the kind of social structures or relations that are conducive or detrimental to the adoption or use of ICT.

In this study, it was speculated that there would be a positive correlation between the use of ICT for professional communication activities and the efficiency of the individual's ego-network in knowledge-intensive work (*H3b*). The general idea from current literature is that as individuals adopt more ICTs for professional communication, they have greater propensities to reach out to different groups or individuals beyond temporal, spatial and organisational barriers. However, the results show no support for this hypothesis. Rather, there was a significant negative correlation between efficiency and communication-related ICT use *($r=-.216$, $p<0.5$)* and the independent samples t-test confirmed that GPs with high levels of ICT use for communication purposes were in fact less efficient than those GPs with a lower use. There are two possible conjectures at this point – (1) that the rural GPs who use high levels of communication-related ICTs are reaching out to the same group of people where the group themselves are well connected, thereby decreasing ego-network efficiency; (2) that the rural GPs already knows where to obtain information from through their professional network within the community and therefore does not need to rely solely on communication-related ICT. This probably explains why they may be highly efficient within their professional network although a low-frequency user of communication-related ICT. This is reflective of a remark that one of the respondents made in the preliminary qualitative interview contrasting the use of ICT for task and communication purposes –

> *"ICT is not essential (for practice). It is possible to practice without a computer sitting on the desk. However, in the last two years, more than 50% of the practice is*

now using computers. About only 3-4 years ago, computers were only used for billing purposes. Now, computers are definitely helpful in saving writing time and improving accuracy. A major advantage of ICT is in terms of indicating potential drug interactions for patients. This is the key area where computers are really adding real value to the decision support process."

As mentioned in the respondent's remark above, it seems that ICT is more conducive at the task-level rather than the communication-level in terms of individual performance. Therefore, the next set of hypotheses explored certain structural and relational factors that influence ICT use at the task-level. In particular, the hypotheses (*H3c* and *H3d* respectively) tests whether degree centrality (a potent indicator of communication and information flow) and functional diversity (an indicator of the extent to which a social or professional tie is diverse based on job roles) are correlated with task-level ICT use. Results from this study support hypotheses *H3c* and *H3d.*

In fact, for hypothesis *H3c,* the correlation matrix shows a significant positive correlation between degree centrality and task-level ICT use *(r=.241, p<.05)*. In particular, the t-test confirms that individuals who have a large number of direct ties (equivalent to network size and degree centrality) in their professional network are more frequent users of ICT at the task-level than those with a small number of direct ties. Effectively, it is plausible that GPs who interact with a larger number of professionals related to general practice are more likely to be users of ICT for their general practice. This includes usage of computers for medical prescription, setting up reminders, patient recalls, and drug interaction checking. This confirms findings from past literature such as the diffusion of medical innovation by Coleman et. al. (1966).

Similarly, for hypothesis *H3d,* the correlation matrix shows an extremely significant positive correlation between functional diversity and task-level ICT use *(r=.322, p=.001).* This suggests that functional diversity at the network relations component is conducive to task-level ICT use. Again, the t-test confirms the support for this hypothesis. It is clear from the

results that individuals who experience greater diversity in terms of their function, role and occupation are ones who have a higher frequency of task-level ICT use. At the domain level, it is quite reasonable to expect that GPs who interact with a large number of other GPs, nurses, and specialists such as gynaecologists, pathologists, surgeons and so on are prone to be exposed to more technologies for task-level purposes. For example, the medical director software, which is the most commonly used software in general practice, is capable of transmitting pathology results to and from the laboratories to the general practice office. It is also equipped with other document and information sharing features so that GPs may share information about patient records, reports and so on with other GPs. As such, GPs who communicate with a diverse range of professionals from various occupations related to medical practice tend to be higher users of ICT for task-specific purposes. In the words of one of the respondents in the qualitative interview:

> *"Because the senior GPs have practised for over 37 years, they know anyone who walks in the door…so I look forward to getting help from the two senior GPs in my practice and also from the practice manager. Over here, the (internet) connection is very fast so I will also be depending a lot on the ICT aspects of the Medical Director Software."*

Another respondent contends that the roles and occupation of people he interacts with is an important for ICT use, given that he and the other are part-timers in the practice:

> *"Looking at my own practice, because we are all part-time, (there are 12 doctors working in the clinic and sometimes none of us are there) the only way, apart of occasional evening meetings, we interact is by emails and that's quite important. This has only happened over the last 18 months. Amongst colleagues, i.e. other GPs in other practices in the region, there's a fair amount of email activity going on within a group of people who spend a lot of time. These tend to be the 'movers and shakers' of GPs – e.g. people from the local medical association and the like."*

5.5 Task Level Effects of ICT use

The task-level effects of ICT use is concerned with the primary or direct effects of ICT use on performance in terms of productivity gains or improved efficiency in undertaking context specific tasks. The literature that motivates the ICT-task-performance hypothesis is primarily based on the work of Sproull and Kiesler's (1991) – who contend that the first order effects of ICT is the improved efficiency and productivity gains, Orlikowski's (1992) – who claim that technology affects not just the people using it but organisational processes as well, and Goodhue's (1995) – who claims that technology-based task performance is optimal where a task-technology fit is achieved. Based on the seminal work of these authors, the hypothesis postulated was that the use of ICT for task-level activities is positively associated with individual performance.

In the context of rural GPs in NSW, Australia, ICT use at the task-level includes frequency of computer use for clinical functions such as prescribing, electronic health recording, and auto-generation of patient lists. Therefore, the pattern and frequency of task-level ICT use were measured and correlated with performance measured in terms of attitudes to interpersonal and technical care. The results from the study indicate a very significant positive correlation with task-level ICT use and attitudes to interpersonal care *($r=.257$, $p<.01$)*. In contrast, there is no significant correlation with task-level ICT use and attitudes to technical care. The independent samples t-tests also confirmed the same. In particular, with respect to attitudes to interpersonal care, the independent samples t-test confirmed that individuals with a higher frequency of task-level ICT use were also the ones who scored higher in terms of attitudes to interpersonal care.

For rural GPs, it is highly likely the efficiency and productivity gains from ICT use for task-level purposes translate into more time available for querying and consulting patients during the GP-patient encounter thereby adding further value to the interpersonal aspects of care. For example, instead of writing consultation notes, it is much faster to type them into a computer. The mechanisms of drug-interaction checks or drug recall are also much better handled by

medical softwares (e.g. Medical Director). Therefore, as a memory prosthesis tool, the efficiency gains from task-level ICT use aid human memory thereby allowing GPs more time to focus on the interpersonal aspects of the consultation. Thus, it is highly plausible that GPs who efficiently and regularly use ICT for drug-interaction checking, billing and administration are ones who benefit by being able to devote more time to the interpersonal aspects of medical care. Task-level ICT use, however, in this study did not affect attitudes to technical aspects of care in any way. It seems that while ICT use does provide benefits, it does little to improve the first-hand technical care that the GP provides directly to the patients. A comment that was written in one of the surveys from one of the respondents surmises this point clearly –

> *"Computers I find useful at home and in the office, but in the consulting room, I find them a distraction which detracts from the consultation, wastes time and causes me to make more mistakes. I tried to comply (a 6 month trial) but in the end the computer had to go."*

An interesting but contrasting comment from another respondent in the qualitative interviews focused on the benefits of technology but mentions the fact that it is not impossible to practice without ICT –

> *"ICT is not essential. It is possible to practice without a computer sitting on the desk. However, in the last two years, more than 50% of the practice is now using computers. About only 3-4 years ago, computers were only used for billing purposes. Now, computers are definitely helpful in saving writing time and improving accuracy. A major advantage of ICT is in terms of indicating potential drug interactions for patients. This is the key area where computers are really adding real value to the decision support process. Printed prescriptions are a lot safer than written prescriptions, therefore more accurate."*

5.6 Personal and Demographic Attributes and Network, ICT use and Performance

In relation to personal and demographic attributes and its effect on network structure, ties and position, ICT use and individual performance attitudes, the hypotheses are categorised according to personal and demographic attributes of gender, professional appointment, professional accreditation and education. The hypotheses that test the association between gender and social network were motivated by the work of Roter et. al. (2002). The results from the independent samples t-tests in this study confirmed hypotheses *H4a - H4c* that there is a significant difference in degree centrality, constraint and functional and geographical tie diversity between the professional networks of male and female individuals.

In the context of rural GPs, of ego-network structure, it was shown that degree centrality of female GPs is much higher than that of male GPs. Of ego-network position, it was shown that for male GPs, their ego-networks are much more constrained than compared to the ego-network positions of female GPs. Of tie diversity, both geographical and functional diversity and its association with gender were tested. It was evident from the independent samples t-test that female GPs enjoy a higher diversity of ties (both geographically and functionally) than compared to their male counterparts within their ego-networks. While these findings are consistent with West et. al.'s (1999) work to some extent, it extends their work as well as previous work on the association between gender and communication patterns, as in Hall's (1984) and Roter et. al.'s (2002) work by empirically showing how gender is correlated with aspects of network structure, position and ties. For instance, while West et. al. (1999) explored the differences in the hierarchies and cliques of networks of clinical directors of medicine (comprised of mainly males) and directors of nursing (comprised of mainly females), they failed to incorporate social network position and ties in its appraisal of network differences.

The ICT use and gender hypotheses were developed based on the work of Singh (2001) and Bray (2007). In relation to hypothesis *H4d*, there is no association between gender and ICT use at the task-level or communication-level. This confirms findings and results from

previous work on gender and technology that there is no difference in the usage of technology between male and female individuals in knowledge-intensive work (Western et. al., 2003).

In terms of professional appointment (measured by hospital appointment), it was found that individuals with professional appointments have denser networks, which also translates into an inefficient network (*H4e and H4f)*. In the context of rural GPs, some of them also practice in hospitals whilst practicing in their general practice as well. Such GPs tend to meet, interact, seek advice and share information from the same people within their ego-network, who in turn communicate with one another. Dense networks such as these usually develop into cliques, where the network becomes prone to inefficiency as a result of redundancy because new and novel information cannot be obtained in such close-knit clusters.

In terms of professional accreditation and membership, an independent samples t-test was conducted to test for significant differences between holders of professional membership and accreditations in terms of their network structure, position, tie, ICT use, and performance attitudes. In the context of rural GPs, two dummy variables that measured professional accreditation and membership were FACRRM and FRACGP. With regards to FACRRM, the t-test confirmed that GPs who are accredited with FACRRM have higher degree centrality and have more functionally diverse ties in their professional network than those who are not accredited with the FACRRM. Moreover, FACRRM-accredited GPs are also more frequent users of ICT for clinical functions and task than non FACRRM-accredited GPs. Likewise, FRACGP-accredited GPs are also more frequent users of task-level ICT. Furthermore, FRACGP-accredited GPs score higher on attitudes to performance in terms of *both* technical care and interpersonal care than those who are not FRACGP-accredited. Re-capitalising on Azjen's (1988) theory of reasoned action, where attitudes toward behaviour is a major proponent for behavioural intention which in turn constitutes actual behaviour, it can therefore be argued that FRACGP-accredited GPs deliver higher quality of interpersonal and technical care in general practice. While these findings are quite interesting, it also adds

weight to existing literature (and the lack of it) by the empirical evidence provided in this study.

It seems that FRACGP accreditation is quite conducive to a GP's technical care aspect as well as the interpersonal care aspect of primary care although the latter is associated with social network and ICT use as well. In order for GPs to maintain their fellowship accreditations, they are compelled to undertake a continuing medical education (CME) and professional development programme that include seminar and conference attendance, workshops, etc. Rather than a form of assessment, the CME programme is a form of engagement in learning activities which contributes directly to the performance of GPs in clinical and technical care (Davis et. al., 1995). In the words of one of the respondents during the qualitative interview session –

> *"In the field of general practice, what you learnt 2-3 years ago might not be true today. The Continuous Medical Education (CME) initiative provided points to GPs based on the activities undertaken (e.g. RACGP meeting or lecture attended, RACGP evening CME attendance, papers published). This is possibly one way of measuring GP performance. However, this is not mandatory and a low CME point does not warrant the loss of a GP's licence to practice. The RACGP is quite strict on the fellowship examinations. Most GPs cannot obtain the fellowship unless they finish the 3 year vocational training program."*

Another GP also reflected the same comment –

> *"Every GP has to have done their training and has to have passed their RACGP Fellowship exam. We all have to keep up with our continued medical education and we have to produce documentation that we have done a certain amount of study over a triennium and gotten a certain number of points doing certain things…but apart from them, no (there is no standard of measure). At each triennium, you have to do a certain amount of research or study. You can do all these quite easily by doing them*

on the internet or going to structured lectures or seminars or doing audits of certain things in your practice."

It should be noted that an independent samples t-test was also undertaken to see whether education background, operationalised as the country in which the GP received medical training and graduated from, had any associations with network, ICT use, and performance variables. The groups of GPs were segregated into Australian-trained and Overseas-trained GPs. The results from the t-tests indicated no significant difference between the two groups in terms of professional network, ICT use, and performance. This allows one to infer that the country of training has no effect on an individual GP's network structure, position, ties, ICT use, and attitudes to performance. It is quite reasonable to expect that the stringent rules, which include medical training, examination, immigration laws and practice regulations, have to be satisfactorily met with before legally practicing in Australia. Thus, one may conclude that there is no significant difference in the network structure, position and ties, patterns and frequency of ICT use, and performance attitudes of GPs trained in Australia or overseas.

5.7 Social Network, ICT use and Performance - Overall Patterns and Summary

The emergent pattern of relationships amongst network, ICT use and performance variable in this study is quite clear. Examining the dependent variables closely, firstly, there is no significant association between the independent variables of network structure, position and tie on attitudes to technical care (dependent variable). There is also no significant association between ICT use (at the task or communication level) and attitudes to technical care. As mentioned in the section above, performance in terms of attitudes to technical care is mainly attributed to the FRACGP membership accreditation. Performance in terms of attitudes to interpersonal care is also attributed to FRACGP accreditation, although, other variables such as degree, constraint and task-level ICT use are also important predictors. It is therefore interesting to note that amongst the dependent variables of attitudes to interpersonal care and

technical care, the former emerged to be closely associated with network position, network structure and task-level ICT use.

In the post-hoc analyses that was undertaken after all hypotheses were tested, the following question was postulated – 'among the variables which have shown significant correlations with attitudes to interpersonal care, which variable amongst network position (i.e. constraint), network structure (i.e. degree centrality) and ICT use (i.e. task-level ICT use) best predicts attitudes to interpersonal care?'. The stepwise multiple regression model revealed two important predictors – FRACGP and degree centrality. Degree centrality, however, explained 22.7% of the variance in attitudes to interpersonal care as a whole, while FRACGP explained 17.1% of the variance in attitudes to interpersonal care as a whole, after statistically controlling for the effects of FRACGP. Therefore, degree centrality emerged as the most potent predictor for performance in terms of attitudes to interpersonal care for individuals in geographically distributed knowledge-intensive work.

The post-hoc analyses also included another multiple regression model using task-level ICT use as the dependent variable because of the number of personal attributes and network variables that were significantly correlated with it. The stepwise multiple regression was deployed to assess the ability of FRACGP, FACRRM, degree centrality, functional diversity, as well as experience in terms of years in rural practice and years in current practice to explain the variance in task-level ICT use. The stepwise multiple regression proposed two models. In the first model, functional diversity was identified as the sole predictor of task-level ICT use. In fact, it explained 32.2% of the variance in task-level ICT use. In the second model, the FRACGP variable was also included accounting for 25.5% of the variance as a whole after the overlapping effects of functional diversity have been removed. In this model, functional diversity still accounted for 28% of the variance in task-level ICT use as a whole therefore making it the most potent predictor for task-level ICT use in the context of rural GPs in NSW, Australia.

To surmise, in ego-networks of individuals in knowledge-intensive and geographically distributed work, network structure (i.e. degree centrality), rather than network position, network ties, ICT use or demographic attributes, is the most potent predictor of performance (in terms of attitudes to interpersonal care). In contrast, within the same context, network ties (i.e. functional diversity), rather than network structure, network position, or demographic attributes, is the most potent predictor of task-level ICT use.

Recalling the study by Choudhry et. al. (2005) where the age and experience of GPs were negatively associated with performance and technology acceptance and use, in this study, no support is found for the negative association between age and experience of GPs and task-level ICT use. That is, as GPs practice longer in rural practice or in their current rural practice, the frequency of use of task-level ICT declines. The emergent inference from this finding allows us to conclude that older GPs who have had much practice experience are ones who don't use ICT for clinical tasks often. On the other hand, this study also indicates that task-level ICT use is positively associated with the number of professional colleagues and peers that one interacts and communicate with. Furthermore, the more frequent one interacts with others from different professional backgrounds, their frequency of ICT use at the task-level increases. Therefore, one cannot discount the importance of network degree centrality and tie functional diversity when designing processes for introducing or streamlining ICT within knowledge-intensive work.

Similarly, while Choudhry et. al.'s (2005) work demonstrated that GPs' age and experience were negatively correlated with performance, this study finds no empirical support for it. Instead, ego-network constraint was found to be negatively associated with attitudes to interpersonal care and degree centrality, task-level ICT use and RACGP fellowships were found to be positively correlated with attitudes to interpersonal care. Thus, the study advocates the importance of network position, network structure and task-level ICT use as useful and important indicators of performance in terms of attitudes to interpersonal care.

5.8 Causation versus Association

In the research model shown in Figure 2.13 in page 60, ICT use and social network variables are presented as predictors of performance. Theories of structural hole, the strength of weak ties and models of the duality of technology and social influence suggest the directionality of causation. However, there is the possibility of reverse causation whereby the level of attitudes on the performance aspects may be a predictor of social network and ICT use variables. While any argument for causality is conceptually and theoretically based, it is important to note that statistical correlation and regression models cannot prove causation. The relationships shown in Figure 5.3 below are not causal but associative in nature. While the figure seems to be suggestive of a path analysis and somewhat similar to what one may find in structural equation models, the model below represent relationships in the form of correlations and associations only. It is also vital to note that not all associations are represented here; only presented are ones hypothesised in chapter 2, the test results of which are presented in chapter 4. For example, the inherent negative association between constraint and efficiency is not noted in the correlation model below. Similarly, the positive associations between the ICT use variables are also not noted, although inherent. Variables that did not have significant associations with other variables of interest are excluded from the model below.

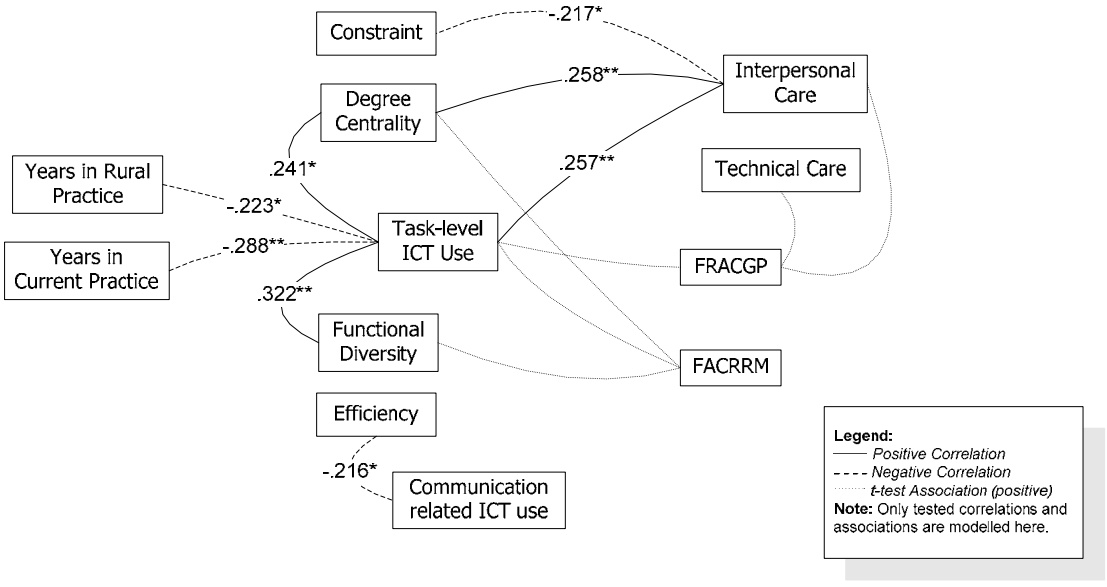


Figure 5.3: Correlation Model: Tested Variables with Pearson's Correlation Coefficient

The explanatory power of the correlation models are validated against previous literature findings and from what respondents in the study reported through the qualitative interviews as documented in the previous sections. For example, how does one explain degree centrality as a predictor of interpersonal care and not technical care? It is quite plausible that interaction with others and seeking advice from them do not directly improve technical care; rather the frequency, quality and experience in the interaction itself with many other professional builds and contributes toward the interpersonal aspect of primary medical care. Workshops and seminars from the RACGP for example are more conducive to technical or clinical care directly because it provides additional educational insight into how to treat medical problems - hence, the association between FRACGP and technical care.

Similarly, it is also interesting to question how task-level ICT use is only associated with interpersonal aspects of care and not the technical side of it. Task-level ICT use does not benefit attitudes to technical care because it merely *supports* the task of general practice but does not *improve* it directly. For example, the decision for the GP to prescribe medication or finalise the medical diagnosis of the cause of the problem will still depend on the expert judgement of the GP based on her experiences, medical background and education (as evidenced from the results in this study). For this reason, it is clear that ICT use supports GPs on the interpersonal aspects of care and not at the technical aspects although ICT use supports the clinical functions of GPs.

It is not expected that high performance of GPs (who rank highly in attitudes to interpersonal and technical care) would contribute or affect their levels of ICT use. It is fair however, that GPs are high performing may be heavily engaged in other professional activities which may cause them to interact more frequent with other professionals and develop stronger and more diverse ties. This remains a question of causality and thus an avenue for future research.

Future studies might also assess the directionality of causality either through conducting a longitudinal study or an experiment. The study may also be conducted to determine the order of effects of the variables of interest.

5.9 Conclusion

This chapter has provided a comprehensive synthesis of existing theory and current findings from the study. It concludes that social network position, structure and ties are crucial components of an individual's sociological characteristics that are closely linked to outcomes of technological-innovation diffusion, adoption and performance. In particular, results from the study suggest that ego-network degree centrality is the single most potent predictor of individual performance. Tie functional diversity, on the other hand, best explains use of ICT at the task level amongst other variables. These results are interpreted within the context of knowledge-intensive work such as that of rural GPs who work in geographically distributed settings. While most results from the study confirm findings from past literature, it also asks new question and challenges assumptions from past theory. The next chapter concludes the dissertation by providing an overall summary of key findings, including implications for research and practice, future directions for research and limitations of the study.

Chapter 6

6. Conclusion: Implications and Future Directions

In this final chapter, concluding remarks are made about key findings of the study in terms of theory, method and domain. Finally, limitations of the study along with implications for future research and practice are presented towards the end.

6.1 Overall Summary and Key Findings

This dissertation contributes to the growing literature of the relationship between the sociological and technological aspects of individual performance by providing task-level evidence. In summary, the key findings confirm evidence from network theory that structure and position play a vital role in individual performance[9]. While network properties of structure, position and ties influence performance, network structure is a much more potent predictor although network position is important. The second key finding addresses a major gap in the literature concerning understanding social processes that influence ICT use. As the technology acceptance and the social influence models lack empirical evidence from a networks perspective, this research shows that rather than the strength of ties which functions as a conduit of novel ideas and information, it is the functional tie diversity within individual professionals networks that increase ICT use at the task-level.

Methodologically, the study contributes towards a triangulation approach that utilises both qualitative and quantitative methods for operationalising the study. The quantitative method includes a non-traditional "networks" method of data collection and analysis to serve as a fine complement to traditional research methods in behavioural studies. An outcome from this is a survey tool that allows collection of both individual attribute and social network data. The tool is theoretically driven, practically feasible to implement, time-efficient and easily

[9] Readers are advised that individual performance in the study is measured by performance attitudes as justified in sections 2.9.2 and 3.4.1.3. Therefore, it is important to note that only attitudes to performance were measured as no measures of direct performance were available in the GP domain.

replicable for other similar studies. Overall, a key strength of the study is its methodology which is reliable and validated with theoretically vigour.

At the domain level, the key finding contradicts previous literature that professionals in occupational communities such as GPs decline in performance as they age. In fact, the findings from this study suggest that age and experience do not affect for performance; rather, there is a negative relationship between experience and task-level ICT use, and that task-level ICT use is positively associated with performance in terms of attitudes to interpersonal care. Furthermore, degree centrality is also positively related, with professional accreditations such as FRACGP being conducive to performance in terms of attitudes to interpersonal and technical care. Below is a short summary of key findings from the research at hand followed by a summarised overview in terms of theory, methods and domain.

- Performance in terms of attitudes to interpersonal care is significantly positively associated with degree centrality, task-level ICT use and FRACGP accreditation.
- Performance in terms of attitudes to interpersonal care is significantly negatively correlated with ego-network constraint.
- Performance in terms of attitudes to technical care is significantly positively associated with FRACGP accreditation.
- ICT use at the task-level is significantly correlated with degree centrality, functional tie diversity and interpersonal care attitudes.
- Task-level ICT use is negatively associated with experience in terms of years in rural practice and years in current practice.
- Communication-related ICT use, on the other hand, is positively correlated with task-level ICT use but negatively associated with ego-network efficiency.
- There are significant differences in network structure, position and relations of male and female individuals. Females experience higher degree centrality and tie diversity

(both functional and geographical) in their professional ego-networks, while males are more constrained in their professional ego-networks than females.

- Individuals with professional appointments (in terms of FRACGP and FACRRM accreditations) have higher frequency of task-level ICT use, higher scores in performance attitudes (technical and interpersonal) and higher degree centrality than those who do not.
- Post-hoc analysis conducted through a stepwise multiple regression model show that for attitudes to interpersonal care, degree centrality and FRACGP are the most potent predictors while for task-level ICT use, the most potent predictors are functional tie diversity and FRACGP.

6.1.1 Theory

The questions that currently challenge philosophical notions of the relationship between social network, ICT use and its impact on individual performance were addressed in chapter 2. In particular, the key motivating question asked if individual performance could be understood through the emergent patterns of social processes that constitute performance - that is, if there exists a relationship between the configuration of social network properties (structures, positions, and ties), the patterns and frequency of ICT use, and individual performance. If so, what is the role of and to what extent does social networks that create social influence impact individual performance.

This study extends the classical work of Bavelas (1950) and Leavitt (1951), who commenced their laboratory controlled experiment with the following research question – "under what principles may a pattern of communication be determined that will in fact be a fit one for effective and efficiency human effort?" There are two notable differences between the current study and that of the Bavelas-Leavitt experiment. Firstly, Bavelas and Leavitt only explored associations between network structure and performance with much emphasis on node centrality and network centralisation. This study however, provides additional evidence of

network position and ties to complement the network structure-performance association. In particular, it empirically shows that network structure (degree centrality in particular) is the most potent predictor of performance; however, the ego-network position measure of constraint negatively impacts performance. While these findings have been individually examined in previous studies at the group or organisational level, this study has tied in both network structural and positional concepts together to explain performance at the individual level. Secondly, observations of social processes that constitute the interactions were obtained from real-life settings of GPs working in rural practice as opposed to individuals working together in a controlled laboratory setting. The fact that data was gathered from these GPs practicing in environments characterised by geographical and social isolation also serves as a good augmentation to the few literature that exists as most current work is carried out in traditional organisational contexts such as corporate environments (Burt et. al., 2000; Gabbay et. al., 2001; Burt, 2007). In this sense, the key finding here is that the theory of structural holes that was initially developed to study the social structure of competition in traditional organisational contexts is also valid and applicable to a large extent in the context of non-competitive environments such as rural occupational communities.

The second major contribution this study makes is in the theoretical understanding of ICT use. In chapter 2, it was documented that both the technology acceptance model (Davis, 1989) and the social influence model (Fulk et. al., 1990) emphasise the significance of social influence and norms in affecting ICT use. These models however, do not clearly indicate the kind of social structures or relations that are conducive or detrimental to the adoption or use of ICT. Therefore, the ICT use construct was developed in the theoretical model by understanding its task-level and sociological-level effects. This component of the model was guided by the question that if the social influence model is based on the precept that people act towards things based on the meanings that the things have for them, and that the meaning of these things is derived out of social interaction with others and is always changing, then a subsequent question is what form of social structures and positions constitute these

interactions that influences the meaning of things. This research shows that within the context of occupational communities such as rural GPs, the strength of ties play no significant role in explaining performance. However, the role of network ties was found to be crucial for influencing the usage of ICT. In particular, functional diversity in ties rather than the strength of ties was found to be a more potent predictor of use of ICT at the task-level. This finding is instrumental for researchers and advocates of the social influence model (Fulk et. al., 1990) because it helps scholars in this area understand the nature social influence of ICT use further using a social networks perspective that is both empirically and theoretically motivated.

6.1.2 Method

In executing and operationalising the conceptual model for this research, this research provides an analytical framework that moves beyond the traditional focus on the individual to a relational analysis. In many ways, it is a radical shift because it moves away from the standard "behavioural research" approach that links individual attributes to individual outcomes to a "networks perspective" approach that uses individual relations to explain individual outcomes. Having said this, network analysis is still a primitive field in terms of methodology, given the lack of training in majority of disciplines and the lack of large empirical projects that span more than a year. With network analysis techniques itself, there are a variety of techniques to gather relational data, with most being sociocentric, few egocentric. Even then, there are very few which are conducted within a triangulation approach.

In this study, a triangulation methodology that consists of both qualitative and quantitative methods is adopted. Chapter 3 describe the process of designing a reliable and valid instrument for collecting network and attribute data for exploring the relationship between social networks structure, ICT use and attitude towards performance in knowledge intensive work. Firstly, a conceptual model was developed in conjunction with field experts and random samples of rural GPs in NSW, Australia. Using current surveys, appropriate item sets were then developed for measuring different independent (network structure, ICT use) and dependent variables (performance). The instrument was then subject to pre-testing using a

simulation approach where synthetic datasets for performing analyses were generated. The key contribution here is that the triangulation methodology offers a theoretically-motivated survey instrument that is (i) valid (ii) reliable (iii) easily replicable and (iv) feasible to administer in terms of time and media. It should be noted that the methodology itself is replicable such that it allows one a more comprehensive and practical way of thinking about and operationalising studies on individual behaviour and its consequences on ICT use and performance. These aspects thus form the greatest strength of the methodology.

6.1.3 Domain

At the domain level, the primary motivation for considering GPs in rural NSW, Australia as the context for the study is based upon the systematic review of studies on the relationship between clinical experience and quality of health care where 52% of the studies consistently found quality care declining with GP experience or age, and another 21% of the studies partially reporting the same (Choudhry et. al., 2005). As documented in chapter 1, the cause of the problem is attributed to obsolescence of technological and explicit medical knowledge and peer support. In this study, finer details of this relationship are presented. Analysis of data from a sample of 110 rural GPs shows no support for the fact that performance of GPs declines with years in current or rural practice. Within the scope of this sample, there is clear evidence about the inverse relationship between years of current or rural practice and ICT use at the task-level, however. Again, within this scope, there is also clear evidence of task-level ICT use being positively associated with performance in terms of attitudes to interpersonal care. In this similar line of inquiry, there is much clearer evidence of the associations between experience, ICT use and performance. In other words, GPs who are older tend not to use task-level ICT which in turn leads to lower interpersonal care attitude scores. Upon further investigation, it was also found that GPs who are professionally accredited with FRACGP and FACCRM are more likely to use task-level ICT. These GPs are also more likely to rank higher in performance in terms of attitudes to both interpersonal and technical care as they attract diverse source of information through their occupational ties with other professionals.

In short, it seems that the results from this sample of 110 rural GPs suggest that network structure (degree centrality), ICT use (task-level) as well as professional accreditations (FRACGP) are more conducive to performance than years of experience.

6.2 Implications of the Study

The following section discusses the implications of the study for research and practice.

6.2.1 Towards Research (Theory and Methodology)

There are several contributions that this study has made in terms of theory. It has:

1. Utilised a social network perspective to understand individual performance in knowledge-intensive work within geographically isolated settings.
2. Developed a conceptual model to explore the associations between social network structure, position, ties, ICT use and performance within an occupational community.
3. Extended traditional theory of social networks and performance within the micro and individual level:
    a. to include geographically dispersed groups and individuals involved in knowledge-intensive work
    b. by examining the patterns and frequency of ICT use to explain the relationship between social network structure and individual performance
4. Extended the social influence model of technology use by showing how network structure, position, and ties can be used to empirically measure and validate major constructs of the sociological component of the social influence model.
5. Demonstrated how the research model can be operationalised in the context of rural GPs in NSW, Australia. It is also the first study in Australia to measure GPs' usage of ICT for social network communication.

Studies on the associations between social networks and performance at the group and individual level have been largely based on organisations within a competitive environment – such as multi-national companies, large corporations, geographically distributed teams and so

on. There have been very few studies devoted to studying organisations of a non-competitive nature such as occupational groups. This study contributes to the theory of social networks as applied at the micro level within the context of occupational communities such as the rural GPs of NSW, Australia. As such communities are a particular form of organisation, empirical literature informing the social networks research community on its effects on performance in such organisations are extremely few.

Furthermore, most studies of social network and performance are based on sociocentric networks. Even if there are ego-centric network studies conducted, they are usually based on extraction of particular egos from within a sociocentric network. This study builds upon the methodological tradition established by Burt (1984) to study the effect of social networks on performance from an egocentric network perspective. Although the network is somewhat partial in that the entire network information is not available, the patterns and trends of ego within the sample are observable and generalisable to a reasonable extent.

While most social network studies have neglected the importance of ICTs that extend traditional network ties, this study includes ICT as an important variable because of its primary and secondary effects it bears on people and organisation. In accordance with Sproull and Kiesler's (1991) categorisation, ICT use affects individuals firstly at the task level through productivity and efficiency gains. There is plenty of information systems literature that confirms this empirically. The secondary effects of ICT use is the sociological component of technology in that it allows one to overcome various boundaries of time, space, and organisation hierarchy. While this claim cannot be countered, current literature on technology adoption and innovation of technological diffusion fail to explain the social processes that motivate individuals to choose particular ICTs and use them in various patterns and frequencies. The rational models, which include the technology acceptance model, also fail to explain this to a large extent. The social influence model however offers useful theoretical arguments but lack empirical evidence. This research augments the social influence model in that aspect by (i) using a social network perspective to analyse the social process to (ii)

provide empirical evidence to understand how social network structure, ties and position is crucial for understanding ICT use.

At the domain of rural GPs in NSW, Australia, there have been national-wide studies conducted in Australia to measure the rate of computerisation, technology use and perceived ease and confidence of use. There have also been studies that have measured performance attitudes of GPs. However, none of the studies have measured (i) ICT use for communication purposes (e.g. seeking advice, frequency of interaction), (ii) social capital, and (iii) correlated social network data with ICT use and performance attitudes. Therefore, this is the first in Australia to understand and measure performance of GPs through a sociological and technological perspective.

Methodologically, this research has produced a validated and reliable survey tool which can be easily administered to individuals in knowledge-intensive work. The cost of filling up the survey is lesser than 15 minutes per individual. Therefore, to administer it at a large scale (e.g. nation-wide) at various domains (e.g. other professions such as consultants, real estate agents) is quite feasible as well. Obviously in the case of a different domain, the survey items pertaining to network, ICT use and performance will have to be contextually adjusted. The notion behind the analysis however remains the same. More importantly, a key benefit offered by the survey is its ego-centric nature such that it is able to obtain both relational data as well as attribute data for a richer analysis of individual patterns and outcomes in a simple and feasible manner. Furthermore, it is definitely possible to build up a sociocentric network from the collection of the ego-centric network data obtained from all the respondents, given that the respondents belong to the same domain or occupation. For example, in the case of the rural GPs within NSW, it is highly likely that GPs who work within the same division interact with each other through meetings, seminars or referrals. It is also highly likely that they interact with other professionals who are known to them. As such, the methodology offers a unique method for the collection of complete network data.

6.2.2 Towards Practice (Context of the Study)

In terms of practice, this research informs GPs and other medical professional involved in primary care about the importance of peer-to-peer support, technology use and its interplay that is crucial to performance. From the sample of 110 rural GPs surveyed, the implication (arising *from* and *within this context*) is clear that while personal characteristics such as professional experience, education and professional accreditations and appointments are important, one cannot discount the importance of professional networks and technology when it comes to performance, measured by attitudes.

The results from this research suggest quite strongly that rural GPs who are accredited with FRACGP are those who rank higher in terms of performance attitudes (in both technical and interpersonal care aspects). Those who are accredited with FRACGP and FACRRM are also higher users of task-level ICT which is positively correlated with performance attitudes in terms of interpersonal care. Thus FRACGP and FACRRM accreditations play an important role in sustaining GPs' attitudes to primary care.

From a professional social network's perspective, it should be noted that GPs who have a larger professional network size (degree centrality) are those who have more sources of information in terms of advice-seeking and professional interaction. However, it is also important to highlight the fact that GPs who are always seeking advice from the same contacts (who also interact with their same contacts and so on) within his or her professional network are most likely to suffer from high information redundancy and therefore a highly constrained network. As Burt (2004) shows, high constraint is negatively geared towards performance and in this study, constraint is also negatively linked to attitudes to interpersonal care. Therefore, a fine balance needs to be struck between a large professional network size and the redundancy of ties. Ideally, interactions with a lot of useful but non-redundant sources of information from diverse groups would contribute to better performance.

In terms of ICT use, for practice managers or solo practices (of the rural GPs surveyed at least) for instance, while designing computerised based practices, it is important to pay attention to experience, age and social characteristics of potential users of the technology.

Results suggest that those who have had a long practice experience tend not to use ICT for clinical tasks as compared to new or younger GPs. For such GPs, this means more training and support needs to be devoted. It would also help to understand the social structure of the people with whom such GPs interact with. The more people they interact with and the more diverse groups of people they interact with means they would be more open to use ICT for clinical tasks. Results from this study also show that GPs who tend to isolate themselves in practice without much interaction in terms of frequency and diversity tend to be slow adopters or low users of ICT. Thus, implementing ICT in such practices would be faced with much resistance. Therefore, a strategy could be to introduce ICT through peers, colleagues, other professionals who the GP liaises with or through a trustworthy source, rather than by doing so bureaucratically or forcefully. This point needs to be accounted for also at the macro-level for policy makers. For example, injecting more funding to computerise practices itself does not translate into productivity gains. An understanding of how network structures interplay with technology and its users would go a long way in reaping benefits required at the organisational, individual and macro level. For example, organisational policy in human resource may require that a knowledge repository be kept of a key personnel's professional network of contacts as that personnel leaves. This allows for a transfer of "social capital" onto the new personnel who joins the organisation instead of having to personally build up one from scratch.

At this point, caution needs to be exercised in interpreting the implications of the results towards general practice. Although the implications suggested above may not necessarily be reflective of the entire population of rural GPs in NSW or Australia, it is at least fitting for consideration within the context of the rural GPs surveyed. To extent to which these implications may be generalised is discussed in the limitations of the research at the end of this chapter.

6.3 Directions for Future Research

This research builds upon the work of Papa (1990) and Aral (2006) who seek to understand the interplay between social networks, ICT use and performance. This understanding is useful in informing inter-disciplinary studies and practitioners for suggesting enhanced performance or optimal technology use strategies from a social networks perspective.

Indicated earlier, as an area of further research, it would be useful to investigate the order and direction of causality of the variables. For example, the motivating question may be to ask if network structure affects performance or if performance affects network structure. This study lays the foundation to ask such questions by examining associations first amongst these variables. Furthermore, the presence of mediating or moderating variables (which may not be known presently) may be questioned and further research. For instance, it is highly likely that FRACGP mediate the relationship between task-level ICT use and performance in terms of attitudes to technical care. It could be equally likely that task-level ICT use mediates the relationship between experience and performance in terms of attitudes to interpersonal care. Techniques such as structural equation modelling and further multivariate statistical analysis such as complex multiple regression with multiple dependent variables may be used to obtain further results and inference.

The ego-centric network component of this research represents a snapshot in time about relationships of a particular actor at a particular space and time. The exchange, interaction and flow of information through these professional ties and how value is extracted out of it through the network represent a distinctive phenomenon. As time progresses, ties develop and networks change. Longitudinal research capturing data on how these actors activate their network and how structures, position and ties change over time would definitely serve as a valuable complement to this research. ICT use trends, performance attitudes and more importantly, the relationship between these variables and the network variables can be compared to establish change in relationship patterns over time.

As indicated earlier, a nice complement to the current study would be to extend it to a sociocentric study using a bottom up approach. There is evidence to some extent that the elicited alters of many egos (respondents) are also elicited alters of other egos. In some cases, the elicited alter of one ego is also an ego node (respondent) in this study. The reason for this is because GPs tend to seek professional help from those within close proximity (e.g. in the same town, or a nearby town). It would certainly be useful to map out these links and conduct a sociocentric analysis to determine for example, which ego nodes demonstrates highest centrality in the overall network and associate it with either his or her ICT use or performance. Further whole network analysis such as cliques and structural equivalence analyses can then be conducted which would provide a richer picture in terms of understanding network, ICT use and performance patterns at the macro-level.

Another extremely valuable task for further research would be to apply the existing theoretical model in the context of another domain, preferably within the domain of knowledge-intensive work. For example, the model could be applied to sales consultant team to understand what factors of sociological and technological factors may affect sales performance. It would be very interesting to note if the model is robust enough to produce similar or dissimilar results in other knowledge-intensive work domains.

One of the most interesting findings of this study is that network structure (degree centrality) is correlated with and best explains performance. A pressing question is – "to what extent does degree centrality contribute towards performance and to what extent does it not?" Put another way, the following question is obvious – "how does one strike the balance between network degree centrality and network tie redundancy?" As hard as these questions are, there are no clear answers presently. However, they still need to be asked and thus beg for answers from future research.

Finally, another avenue for further research could be to obtain direct measures of performance at the domain level if possible and subject the existing theoretical model to further empirical testing. It would be interesting to contrast the differences obtained from the current study and

the one proposed. Furthermore, the theoretical and methodological strengths and contributions from this study may also be applied in current general practice evaluation programmes such as the BEACH (Better Evaluation And Care of Health - http://www.fmrc.org.au/beach.htm) project in Australia, where data about clinical activities in general practice is continually collected. Social network and ICT use data is however, not collected and the methodological strengths from this study can be viewed as a valuable contribution.

6.4 Limitations of the Study

As with most research, there are several limitations to the study which needs to be acknowledged. The first limitation concerns the extent of generalisability of the results in this research. Firstly being a triangulation study, it can be argued that the quantitative component of the research is faced with a small sample size (with only 110 respondents). For this reason, various predicaments arose in terms of conducting further advanced multivariate statistical analyses. Although the current sample size just about meets the requirements for the stepwise multiple regression, a normal rule of thumb as stated by Tabachnick and Fidell (Tabachnick et. al., 2007, p. 123) is to use the following formula to calculate sample size *(N)* requirements, taking into account the number of independent variables: $N > 50 + 8m$ (where m = number of independent variables). So for 5 independent variables, 90 cases will be needed. In this study, there are more than 10 independent variables if multivariate techniques were to be used. As such, ideally, the sample size required would be at least 130.

The other issue pertaining to generalisability is that the domain of this study is quite special and unique in that rural GPs are considered knowledge workers who are geographically distributed and working in geographical isolation from most peers. GPs, as knowledge workers, are hence quite different from knowledge workers as found in typical organisations such as large corporations, small enterprises and so on. As such, the question of generalisability of the results to other domains may become quite difficult. As indicated earlier in the implications of research section, the results are interpreted with caution and within the context of surveyed GPs working in rural areas as this is the domain within which

the theoretical model was tested. Also suggested in the further research section above is that the model be tested in other domains while maintaining the theoretical motivations and strategies for data collection and analysis.

Nevertheless, given the scope of this PhD study, it was a boon to be able to obtain access into GP practices across several rural areas especially noting the fact that rural GPs in NSW Australia are extremely hard-pressed for time, dealing with much more complex problems from a huge patient load compared to urban GPs, and are much more pressured at work. It is hoped that the qualitative and quantitative results are able to stir up new conversations, discussions and generate new questions that would help understand the interplay between social network, ICT use and individual outcomes better. It is important to re-iterate at this point that the proposed model of this study was predictive in nature, not causal and that it does have some explanatory power through the tests of association and correlations. In other words, the intent was not to explain all of the variance accounted for, but to explore theoretical propositions that suggest that social network structure, position, and ties are important sociological constructs and factors which contribute to technology use and improved performance. In effect, their interplay was investigated although the thesis emphasised much on the social networks perspective. It is certainly plausible that other perspectives may be used to understand knowledge-intensive work; an example of which could be to focus on specific models of organisation that individuals use in knowledge-intensive work given the uniqueness of their work context.

It is in the structure of the system, not the effort of the people in it, that determines the outcome. The way to gain more influence is to understand the structure of the system. It helps you to understand the complexities of processes within the system so you can see how to improve it. – O'Connor & McDermott (1997)

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APPENDIX A: Program for Converting Doctor Details to CSV File

```
# Author: Kenneth Chung
# Date: 01/07/2006
# Script: make_csv.sh
# Description: A short script to quickly create a csv file by parsing
through the doctor contact details
# Usage: make_csv <inputfilename>
#        where inputfilename is name containing doctor first name, surname,
address, suburb, state, postcode
#        area code and telephone number.
#        The output is a csv file in the name format <inputfilename>.csv
# Version: 1.0.3: 06/07/2007: Included checking of valid file as argument to
script execution.
#          1.0.2: 03/07/2007: Included argument checking so that make_csv
forces intake of filename.
#          1.0.1: First creation
#
#!/bin/sh

check_details()
{
  name_count=`grep Name $1 | wc -l`
  address_count=`grep Address $1 | wc -l`
  suburb_count=`grep Suburb $1 | wc -l`
  state_count=`grep State $1 | wc -l`
  postcode_count=`grep Postcode $1 | wc -l`
  telephone_code=`grep Telephone $1 | wc -l`

  echo "Doctor Details Count:"
  echo "Name: $name_count"
  echo "Address: $address_count"
  echo "Suburb: $suburb_count"
  echo "State: $state_count"
  echo "Postcode: $postcode_count"
  echo "Telephone: $telephone_code"
}

collate_details()
{
  #grep Name $1 | awk '{print $4}' | tee name.txt
  grep Name $1 | awk -F"Name " '{print $2}' | awk -F", " '{print $2}' | tee
name.txt # accounts for names such as O' silva
  #grep Name $1 | awk '{print $3}' | awk -F"," '{print $1}' | tee
surname.txt
  grep Name $1 | awk -F"Name " '{print $2}' | awk -F"," '{print $1}' | tee
surname.txt # accounts for de name
  grep Address $1 | awk -F"Address " '{print $2}' | tee address.txt
  grep Suburb $1 | awk -F"Suburb " '{print $2}'| tee suburb.txt
  grep State $1 | awk -F"State " '{print $2}' | tee state.txt
  grep Postcode $1 | awk -F"Postcode " '{print $2}' | tee postcode.txt
  grep Telephone $1 | awk '{print $2}' | awk -F")" '{print $1}' | awk -F"("
'{print $2}' | tee areacode.txt
  grep Telephone $1 | awk -F")" '{print $2}' | tee telephone.txt
  paste -d"," name.txt surname.txt address.txt suburb.txt state.txt
postcode.txt areacode.txt telephone.txt | tee $1
.csv
  rm name.txt surname.txt address.txt suburb.txt state.txt postcode.txt
areacode.txt telephone.txt
}

### MAIN FUNCTION ###

## Usage
[ $# -gt 1 -o $# -lt 1 ] && {
  echo "Usage: make_csv.sh <filename>"
  exit 1
```

```
}

## Check existence of argument file
[ ! -f $1 ] && {
  echo "$1 is missing or does not exist!"
  echo "Program aborted!"
  exit 1
}

echo " "
check_details $1

echo " "
echo "Check detail accuracy. Proceed [y/n]?"
read RESPONSE
if [ $RESPONSE = 'y' -o $RESPONSE = 'Y' ] 2> /dev/null
 then
     echo "Collating data..."
     sleep 1
     collate_details $1
   elif [ $RESPONSE = 'n' -o $RESPONSE = 'N' ] 2> /dev/null
     then
       echo "Program aborted!"
       exit
   elif [ $RESPONSE != 'n' -a $RESPONSE != 'N' -a $RESPONSE != 'y' -a
$RESPONSE != 'Y' ] 2> /dev/null
     then
       echo "Invalid Choice! Program aborted."
       exit
 else
   echo "You entered nothing! Program aborted."
   exit
 fi
```

APPENDIX B: Qualitative Interview Questionnaire

Phase I - Semi-Structured Interview Questionnaire

The following questions are used in the in-depth interview in phase I of the data collection process. The main objectives of the interview are to validate the workflow model and refine the hypotheses developed so far. The interviews are semi-structured and the question serves as a guide for putting the questions within the context of the rural GPs. Memos and personal notes of the interviewer are indicated in italics.

Start off the interview by introducing myself and provide the respondent with a broad description of the project/thesis. In particular, explain to the respondent the purpose of the thesis, and that I am here to understand the relationship between the social network position, ICT use and their impact on performance. In particular, I believe I can do this by first understanding the general practice workflow (as in the conventional tasks that a GP carries out in his normal practice in order to provide the required standards of care to the patients), and then by asking questions about the performance, social networks and ICT use within the context of this workflow.

Explain to respondent what a social network, performance, and ICT use is by my study definition. Then proceed on to asking the following questions.

Generic Opening Questions -

1. Could you please provide me with a brief background of yourself (*i.e. age (if possible), number of years in practice, year graduated from medical school, etc)*?
2. Could you please provide me with a brief background of your rural practice?

Questions Pertaining to the GP Workflow Model

3. Can you provide me with a general overview of the nature of services you provide as a General Practitioner?
    a. How are they different from the urban practices (*if the GP has practiced in an urban practice before*)?
    b. What are the general problems that plague the rural practice?
4. Assume that a patient arrives in your practice and seeks medical treatment. Could you please step through the processes of treating the patient (*probe if necessary - i.e. diagnosis, intervention, prescription, etc?*)
    a. Are the processes the same if you were to provide for medical care outside your practice?
5. Show the GP a copy of the developed general practice workflow model and explain to him/her in detail the processes as we understand it. Discuss with the GP in detail to refine the model.

Questions Pertaining to the GP social network

6. From time to time, you may come across difficulties in your practice as a GP. Do you seek help in professional matters from other people? (*Professional matters need to be explained to the GP as discussing about activities or*

information that are related to the provision of medical and preventative health care).

7. Who are the people whom you consider important for the provision of your medical practice and service? These people may be professional (e.g. nurses, other GPs, Specialists, etc.) or non-professionals (e.g. family, relatives, friends).
8. In your opinion, are social networks an important requirement in terms of task-based activities or contextual-based activities?

Questions Pertaining to ICT use

Information and Communication technologies are defined in this study as the technology that facilitates the transfer of information and communication to and from the General Practice. Video conferencing, satellite communications, PDAs, Email and so on are examples of ICT. *ICT is also to be defined more narrowly.*

9. What mediums of ICT are used in the practice? *Identify which ones are most useful in context of their workflow.*
10. Are the ICTs usually used for administrative and functional tasks (e.g. patient record keeping, clinical decision systems) or for social tasks (e.g. email, discussion forums, searching for information from the internet)?
11. In your opinion, do you feel that ICTs are beneficial for the performance of your work? (*Relate this to the context of the workflow model).*
12. Are ICTs important for establishing and maintaining a sense of connectedness especially in rural communities?

Questions Pertaining to the GP Performance Constructs

13. I understand that in Australia, there is no strict measure of GP performance. Could you please explain to me firstly, whether this is correct or incorrect? Secondly, could you please tell me how GPs are measured in terms of their performance (*try to keep it within the context of the workflow model)*?
14. Show the GP the workflow model. Explain the difference between the task-based and the contextual-based constructs of performance. Ask them for their opinions of what constitutes the two constructs of performance besides the given examples.
15. I am aware about the standards of care provided by health and medical organisations (e.g. RACGP) regarding clinical standards and guidelines. Are there any standards in general that measure the performance of GPs with respect to task-based and contextual-based activities?

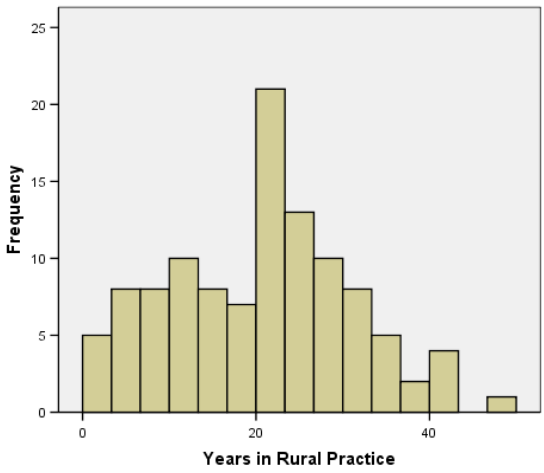
Generic Closing Questions -

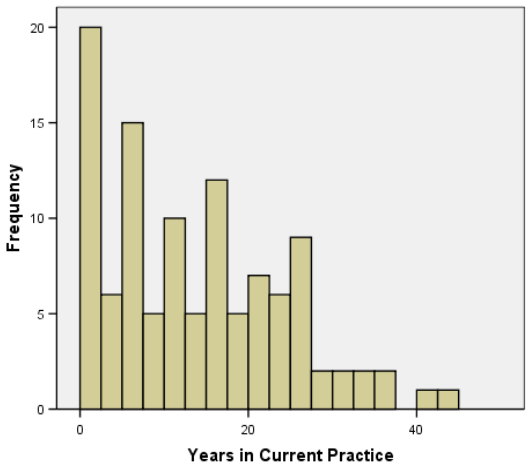
1. Ask GPs to have a look at the theoretical framework. Explain to them the relationship between ICT, social network position and performance. Elicit an understanding of whether GPs are positive or negative to the model.
2. Refine the model with the GP if possible.
3. Explain some hypotheses to the GPs. Elicit an understanding of their opinions.

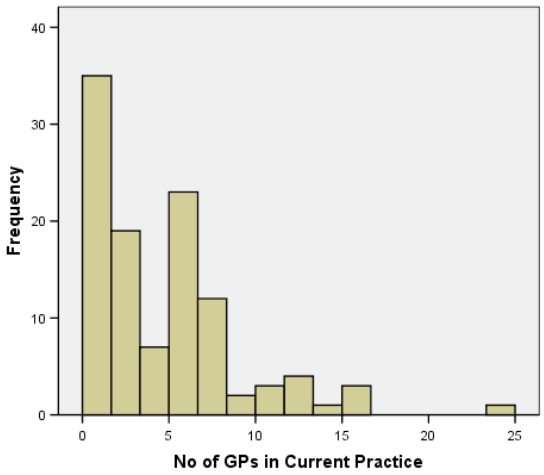
You have reached the end of the questionnaire. Thank the respondent for his time and patience. Also, ask him if there are other GPs that would be interested in conducting

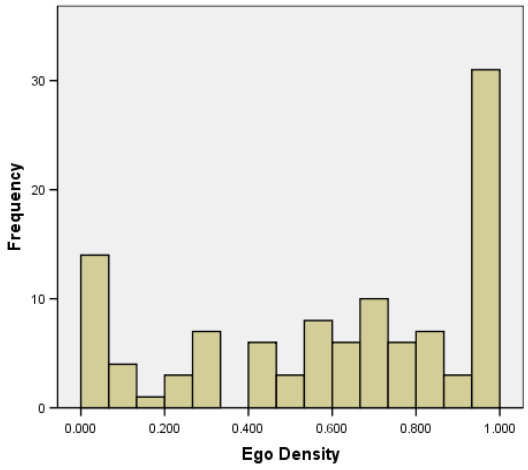
such a survey. Ask for any related documents, which I may find useful. E.g. Diaries, white papers, surveys.

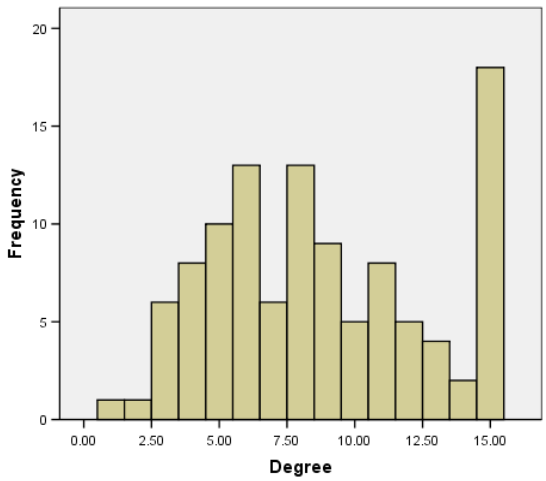
APPENDIX C: Histograms Depicting Variable Distributions

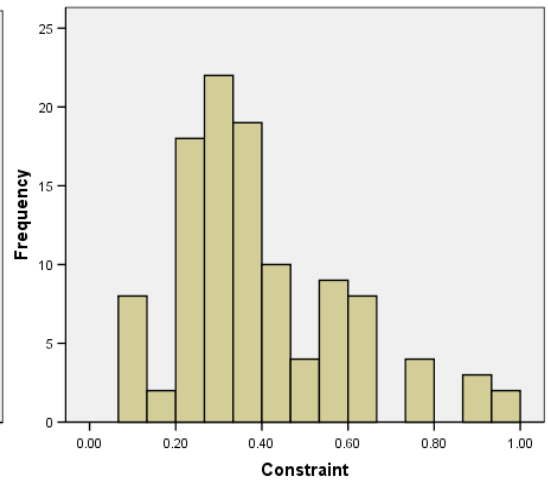


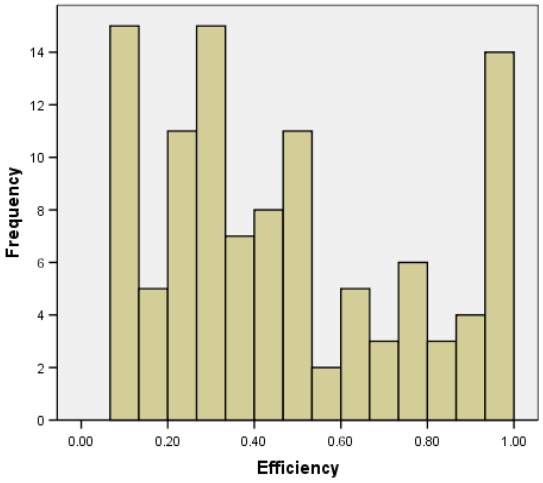


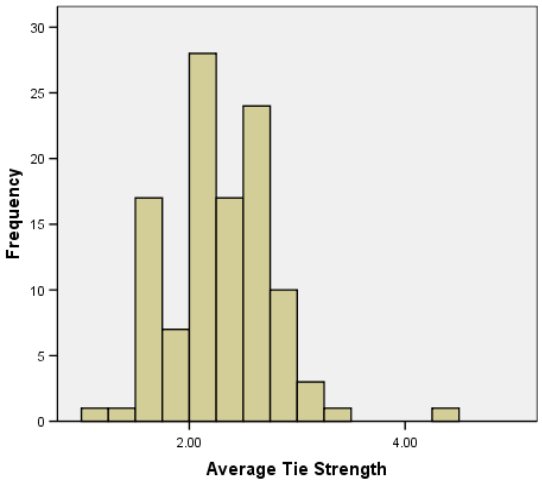


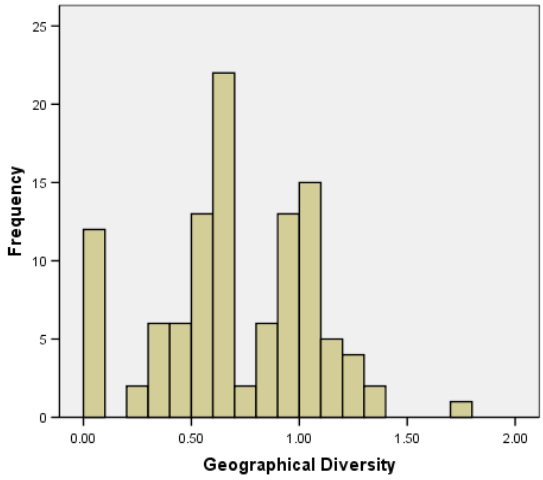


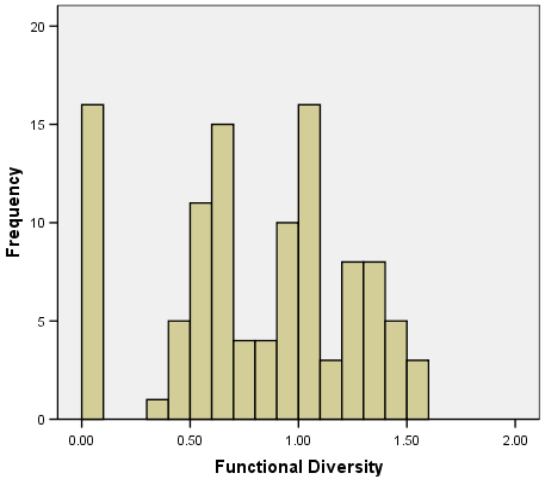


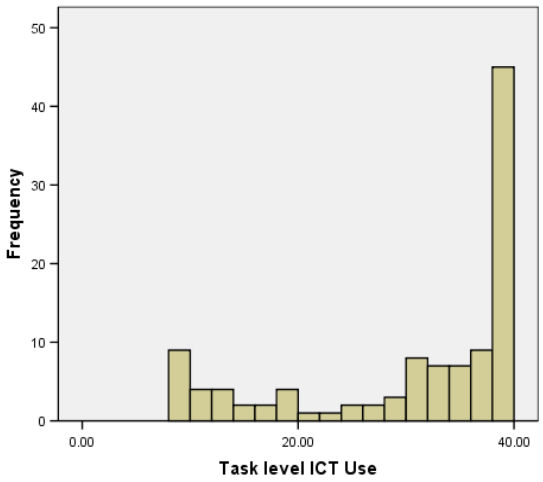


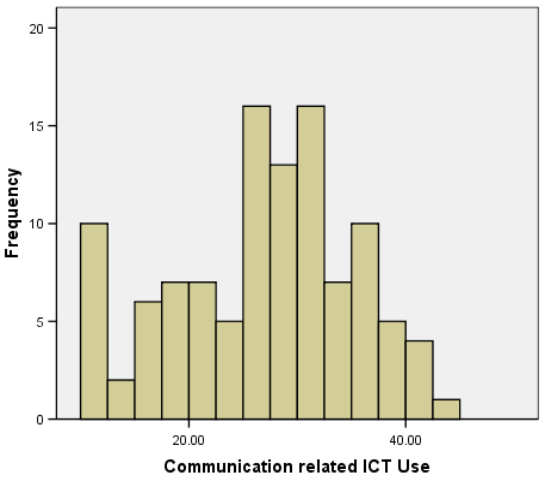

Frequency
Efficiency

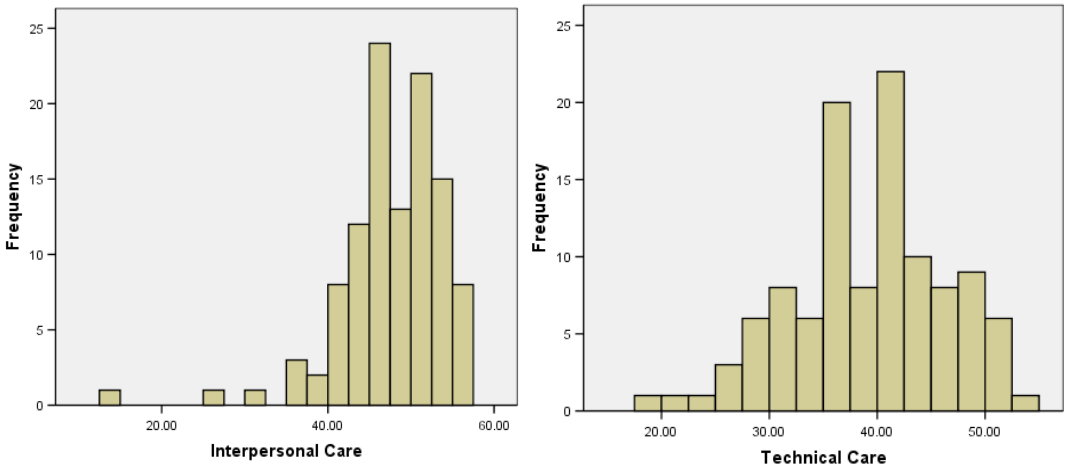

Frequency
Average Tie Strength


Frequency
Geographical Diversity


Frequency
Functional Diversity

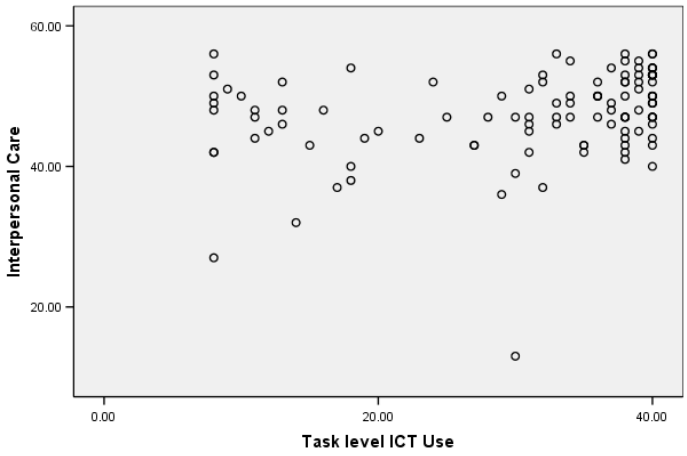

Frequency
Task level ICT Use


Frequency
Communication related ICT Use

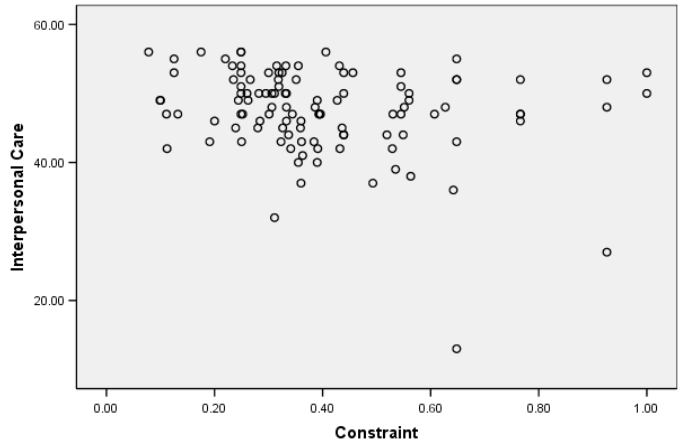

Frequency
25
20
15
10
5
0
20.00
40.00
60.00
Interpersonal Care
Frequency
25
20
15
10
5
0
20.00
30.00
40.00
50.00
Technical Care

APPENDIX D: Scatterplots

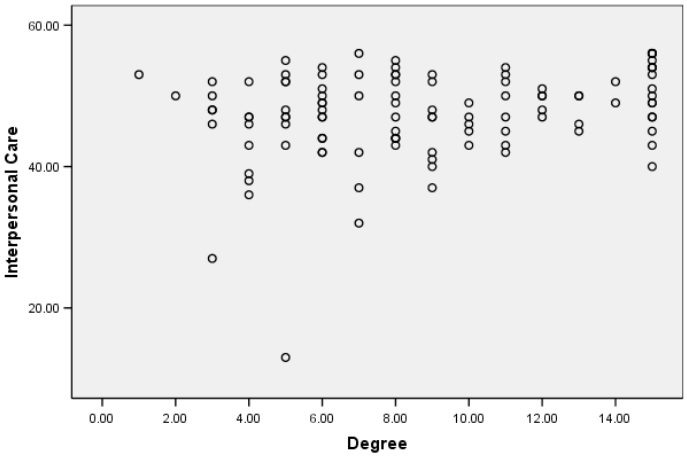
Scatterplot of Task-level ICT use on Interpersonal Care Attitudes



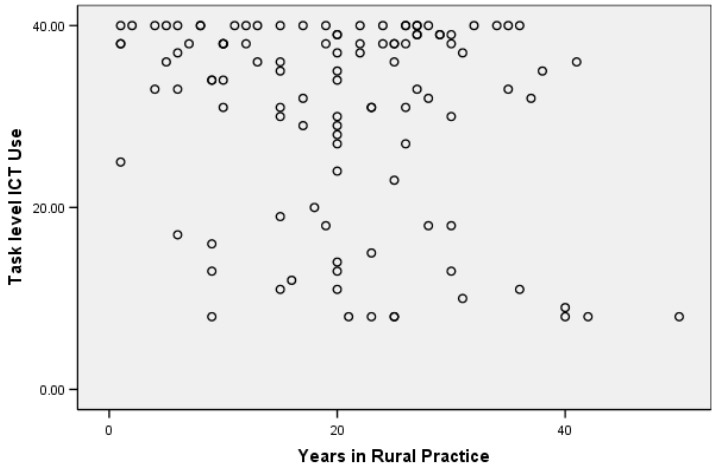
Scatterplot of Constraint on Interpersonal Care Attitudes



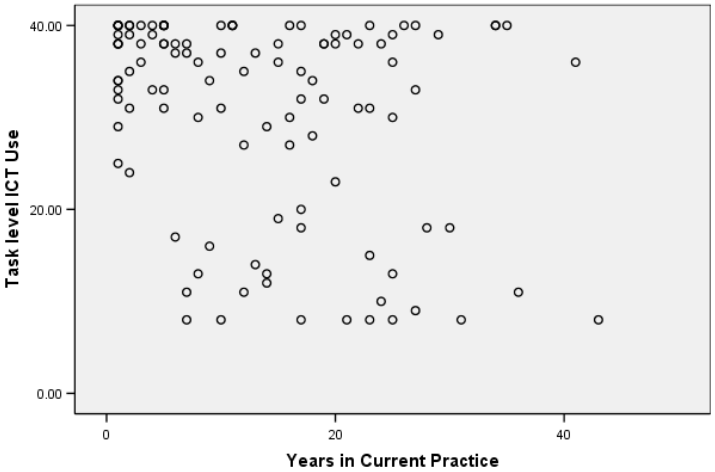
Scatterplot of Degree on Interpersonal Care Attitudes



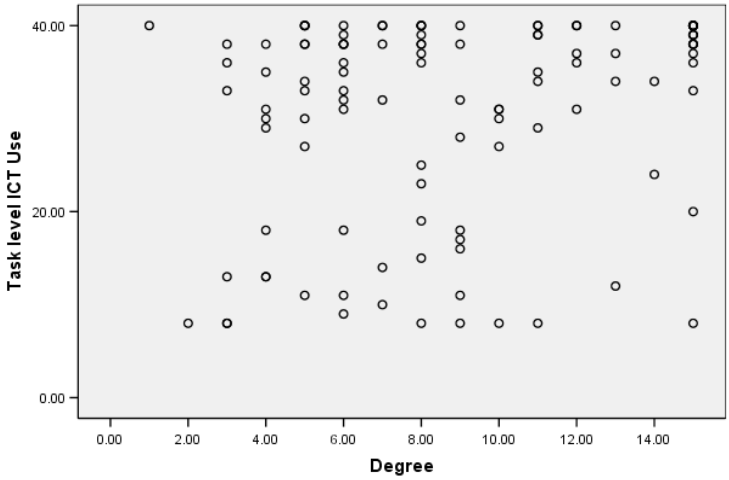
Scatterplot of Years in Rural Practice with Task-level ICT Use



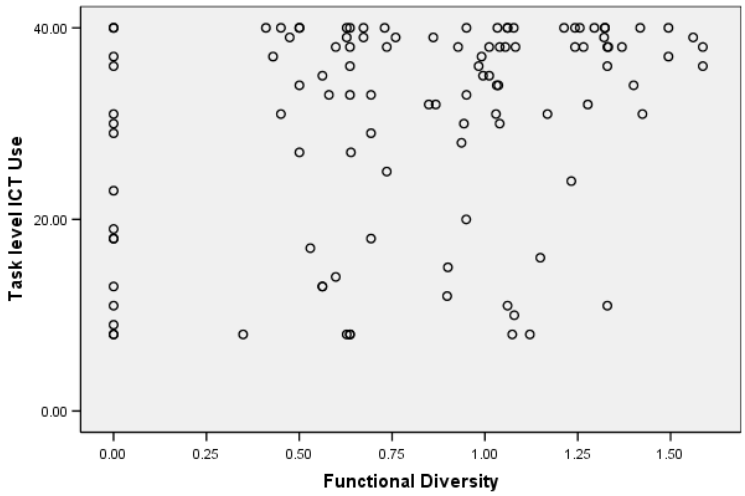
Scatterplot of Years in Current Practice with Task-level ICT Use



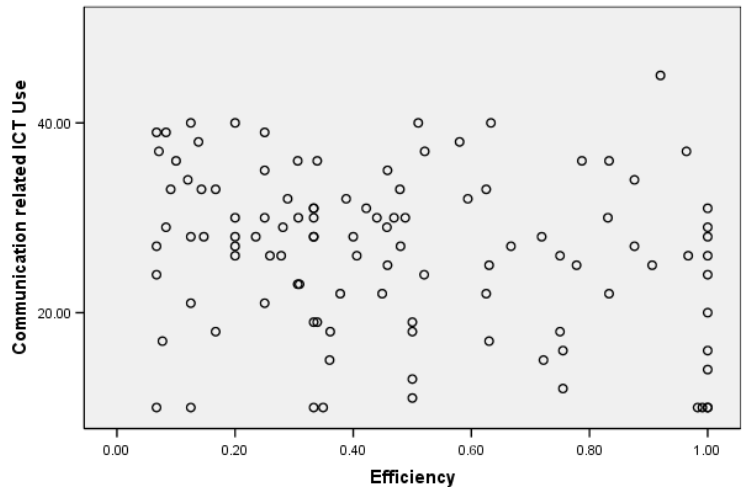
Scatterplot of Degree on Task-level ICT Use



Scatterplot of Functional Diversity on Task-level ICT Use



Scatterplot of Efficiency with Communication-related ICT Use



APPENDIX E: Survey Instrument

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Survey instrument is found on the following page.

The University of Sydney
NSW 2006 Australia

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PARTICIPANT INFORMATION SHEET

Measuring the Professional Network, ICT Use and Attitudes to Medical Care

The role of medical practitioners in rural Australia is extremely crucial for the healthcare of patients especially where access to health personnel and facilities is limited. General Practitioners including medical specialists in rural areas require support from various people and technologies to deliver high quality care. Research on how medical practitioners are able to obtain information and advice from their professional network (eg. peers, colleagues, senior doctors, etc) using both face-to-face communication and information technology is not well understood.

The purpose of this questionnaire is to assemble data for a computer network analysis of your professional network structure together with Information and Communication Technology (ICT) use and attitudes to medical care. The questionnaire asks about the nature of ICT use and people whom you work with – friends, colleagues, associates and other people relevant to your professional activity. You are also asked to provide some demographic details and some attitude ratings about the provision of medical care to patients. It will take no more than 15 minutes to complete. Please remember that there are no right or wrong answers. Your honesty is most appreciated.

This project has been approved by the University of Sydney's Human Ethics Research Committee (No. 12-2006/9584). The opinions and information that you provide will be critical to our ability to promote a richer understanding of how a general practitioner's professional network and ICT use can affect the delivery of quality care. Your completion and return of this survey constitutes your consent to participate in this survey research study. Although you are not obligated to participate, declining to participate will in no way affect you whatsoever.

Everything you write here is strictly confidential. This is assured in two ways. First, no people are identified. Use first names or initials only. The computer only knows your network as a system of nodes, lines and equations. Second, no individual responses will be reported and no one will see your questionnaire except the data entry staff (based at the University of Sydney in the School of Information Technologies).

As a token of appreciation, we will provide you a summarised report upon completion of the research. The report will include a summary of research overview, results and findings. We believe that implications from the research will be of immense value to the rural general practice of NSW, Australia and to the wider healthcare community.

Yours sincerely

Kenneth Chung

Any person with concerns or complaints about the conduct of a research study can contact the Senior Ethics Officer, Ethics Administration, University of Sydney on (02) 9351 4811 (Telephone); (02) 9351 6706 (Facsimile) or gbriody@usyd.edu.au (Email)."

SECTION A. Practice Profile and Demographic Questions

In this section we ask some basic demographic questions about you. Please write your answers in the column on the right.

QUESTION	ANSWER
1. Please state your occupation (eg. GP, Paediatrician, Orthopaedist, etc)	……
2. How many years you have been practising in your occupation?	Year(s)
3. How many years you have been working in this current practice?	Year(s)
4. Which year did you graduate from medical school/college?	(yyyy)
5. Which medical school/college/university & country did you graduate from?	
6. Are you male or female? (Please circle)	Male / Female
7. How many practitioners, including yourself, work in the current practice? If not applicable, leave the answer blank.	
8. Do you have a hospital appointment?	Yes / No
9. If you are a GP, are you a fellow of the ACRRM?	Yes / No
10. If you are a GP, are you a fellow of the RACGP?	Yes / No
11. What are the other qualifications you are accredited with?	……

SECTION B. Professional Network Questions

By 'professional network', we mean professional people whom you associate, interact or work with for the provision of care to patients (eg. nurses, admin staff, specialists, pathologists, doctors etc.)

1. **Looking back over the last six months, please identify people (up to 15 maximum) who are <u>important</u> in providing you with information or advice for providing care to patients. Please also identify their occupation and the proximity of their workplace using the codes below.**

   These people may or may not be people you communicate with on a regular basis or whom you would seek help from. They can come from within your practice or outside (eg. administration staff, doctors, nurses, GP registrars, radiologists, pathologists, health specialists, etc.)

   Please enter their first names or initials in the table below. Then, enter the respective codes for their occupation and workplace proximity. The names or initials will be coded in numbers to protect your privacy and to maintain confidentiality.

Code	Occupation
1	GP
2	Nurse
3	GP Registrar
4	Specialist
5	Receptionist
6	Other

Code	Proximity
1	Works closely with me (eg. as trainee)
2	Same Practice
3	Different Practice
4	Different City/Town
5	Different State
6	Different Country

	First name or Initials	Occupation Code	Proximity Code
Person 1			
Person 2			
Person 3			
Person 4			
Person 5			
Person 6			
Person 7			
Person 8			
Person 9			
Person 10			
Person 11			
Person 12			
Person 13			
Person 14			
Person 15			

Table 1: Members of your Professional Network

*Well done! Now please **<u>tear off this page</u>** and keep it next to you as you fill out answers in sections C, D, and E.*

You can **tear off the previous page**

and keep it next to you

to answer sections C, D, and E.

SECTION C. Questions relating to You and your Professional Network

In this section, we are interested in the relationship between your professional network members and you.

1. **Using each of the names filled in Section B (table 1), please indicate <u>the time you have known the person</u> using the following codes.** *(The numbers on the right below corresponds to the number associated with the name of the person you named in table 1. Eg. 1. refers to person 1, 2. refers to person 2 and so on.)*

Code	Time Known
1	Less than 1 year
2	1-3 years
3	3-5 years
4	5-10 years
5	10+ years

Person 1 → 1. ____ 8. ____
Person 2 → 2. ____ 9. ____
Person 3 → 3. ____ 10. ____
Person 4 → 4. ____ 11. ____
5. ____ 12. ____
6. ____ 13. ____
7. ____ 14. ____
15. ____

2. **Using each of the names filled in Section B (table 1), please indicate <u>the frequency of your interaction</u> with them using the following codes:**

Code	Interaction Frequency
1	Daily
2	Weekly
3	Monthly
4	Quarterly
5	Less Often

1. ____ 8. ____
2. ____ 9. ____
3. ____ 10. ____
4. ____ 11. ____
5. ____ 12. ____
6. ____ 13. ____
7. ____ 14. ____
15. ____

3. **Using each of the names filled in Section B (table 1), please indicate <u>the type of relationship</u> with you using the following codes. If more than one relationship applies, insert the codes using commas to separate them (eg. 1, 3):**

Code	Relationship Type
1	Work Colleague
2	Professional Acquaintance
3	Friend
4	Family/Relative
5	Other

1. ____ 8. ____
2. ____ 9. ____
3. ____ 10. ____
4. ____ 11. ____
5. ____ 12. ____
6. ____ 13. ____
7. ____ 14. ____
15. ____

4. **Using each of the names filled in Section B (table 1), please indicate <u>the degree of closeness</u> between the contact and you using the following codes:**
Especially Close *– if the person is your closest personal contact;*
Close *- if you are friendly with the person but don't count him/her among your closest personal contacts;*
Less than Close *– if you don't mind working with the person, but you have no desire to be friends;*
Distant *– if you really don't enjoy spending time with the person unless it is necessary.*

Code	Degree of Closeness
1	Especially Close
2	Close
3	Less than Close
4	Distant

1. ____ 8. ____
2. ____ 9. ____
3. ____ 10. ____
4. ____ 11. ____
5. ____ 12. ____
6. ____ 13. ____
7. ____ 14. ____
15. ____

SECTION D. Medium of Communication

In this section, we are interested in the information and communication technology (ICT) medium used for communicating between you and your professional network members for work related information or advice. Some of these people may be the same ones you talk to over face-to-face, some of them may be people you only communicate with over ICT. If you do not communicate with the person using a particular ICT medium, please leave the space blank.

1. **Please indicate who you communicate with over <u>email</u> (electronic mail) using the following codes:**

Code	Frequency
1	Daily
2	Weekly
3	Monthly
4	Quarterly
5	Less Often
(blank)	Never use

Person 1→ 1. ____ 8. ____
Person 2→ 2. ____ 9. ____
Person 3→ 3. ____ 10. ____
Person 4→ 4. ____ 11. ____
5. ____ 12. ____
6. ____ 13. ____
7. ____ 14. ____
15. ____

2. **Please indicate who you communicate with over <u>video conferencing</u> using the following codes:**

Code	Frequency
1	Daily
2	Weekly
3	Monthly
4	Quarterly
5	Less Often
(blank)	Never use

1. ____ 8. ____
2. ____ 9. ____
3. ____ 10. ____
4. ____ 11. ____
5. ____ 12. ____
6. ____ 13. ____
7. ____ 14. ____
15. ____

3. **Please indicate who you communicate with over <u>telephone</u> (includes mobile phone) using the following codes:**

Code	Frequency
1	Daily
2	Weekly
3	Monthly
4	Quarterly
5	Less Often
(blank)	Never use

1. ____ 8. ____
2. ____ 9. ____
3. ____ 10. ____
4. ____ 11. ____
5. ____ 12. ____
6. ____ 13. ____
7. ____ 14. ____
15. ____

4. **Please indicate who you communicate with over <u>other forms of ICT</u> (eg. online messaging) using the following codes:**
Other form of ICT used: _____

Code	Frequency
1	Daily
2	Weekly
3	Monthly
4	Quarterly
5	Less Often
(blank)	Never use

1. ____ 8. ____
2. ____ 9. ____
3. ____ 10. ____
4. ____ 11. ____
5. ____ 12. ____
6. ____ 13. ____
7. ____ 14. ____
15. ____

SECTION E. Questions about relationship between your professional contacts

In this section we would like to determine how the members of your professional network relate to each other. This is most <u>essential</u> for conducting an analysis of your professional network.

How to answer:
Refer to the list of names you provided in Section B (table 1). Answering the question is a simple task when taken *one row at a time*.

1. Start with 'Person 1' (in row).
2. Ask, "How close is Person 1 (in row) with Person 2 (in column)?" Enter answer using codes below.
3. Then ask, "How close is Person 1 (in row) with Person 3 (in column)?" and so on… for other persons (in column) until no more persons are available.
4. Then move to Person 2 (in row) and ask, "How close is Person 2 (in row) with Person 3 (in column)?" and so on.

Code	Degree of Closeness	Description
1	Especially Close	if both persons are the closest contact
2	Close	if they enjoy each other's company or work well together, but don't count each other among their closest personal contacts
3	Less than Close	if they don't mind working with each other, but you have no desire to be friends
4	Distant	if they really don't enjoy spending time with each other unless it is necessary
5	Do not know each other	if they do not know each other
	Unsure	Leave cell blank to indicate you are unsure

Example: A code '2' in this cell means that 'Person 1' and 'Person 2' are close to each other

Example: A code '5' in this cell means that 'Person 1' and 'Person 15' do not know each other

	Person 1	Person 2	Person 3	Person 4	Person 5	Person 6	Person 7	Person 8	Person 9	Person 10	Person 11	Person 12	Person 13	Person 14	Person 15
Person 1	X														
Person 2	X	X													
Person 3	X	X	X												
Person 4	X	X	X	X											
Person 5	X	X	X	X	X										
Person 6	X	X	X	X	X	X									
Person 7	X	X	X	X	X	X	X								
Person 8	X	X	X	X	X	X	X	X							
Person 9	X	X	X	X	X	X	X	X	X						
Person 10	X	X	X	X	X	X	X	X	X	X					
Person 11	X	X	X	X	X	X	X	X	X	X	X				
Person 12	X	X	X	X	X	X	X	X	X	X	X	X			
Person 13	X	X	X	X	X	X	X	X	X	X	X	X	X		
Person 14	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Person 15	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

6

SECTION F. Information and Communication Technology (ICT) Use

In this section we would like to ascertain your level and attitude towards ICT use. ICT includes computers, technological software applications and systems such as Medical Director, PDA (Personal Digital assistants), email, fax, telephone, video conference and so on. If you do not use ICT, please skip to Section G.

1. Please indicate how often ICT is used for the following tasks:

	Clinical Tasks	Daily	Few Times a Week	Few Times a Month	Almost Never	Never
1	Generating health summaries	❑	❑	❑	❑	❑
2	Recording progress notes	❑	❑	❑	❑	❑
3	Using decision support functions to help you solve diagnostic problems or make decisions about dispensing or treatments	❑	❑	❑	❑	❑
4	Writing prescriptions	❑	❑	❑	❑	❑
5	Accessing educational material for patients	❑	❑	❑	❑	❑
6	Receiving or storing information electronically such as pathology results and reports	❑	❑	❑	❑	❑
7	Preparing referral letters for patients	❑	❑	❑	❑	❑
8	Running a recall system to remind patients to return for routine tests	❑	❑	❑	❑	❑
	Tasks requiring Internet access *(skip to section G if access to internet is not available)*	**Daily**	**Few Times a Week**	**Few Times a Month**	**Almost Never**	**Never**
9	Accessing medical journals (eg. BMJ)	❑	❑	❑	❑	❑
10	Accessing databases (eg. PUBMED)	❑	❑	❑	❑	❑
11	Accessing clinical guidelines	❑	❑	❑	❑	❑
12	Accessing evidence-based medicine related information (eg. InfoPOEMS)	❑	❑	❑	❑	❑
13	Communicating with professional associations (including email)	❑	❑	❑	❑	❑
14	Continuing medical education (CME)	❑	❑	❑	❑	❑
15	Professional development	❑	❑	❑	❑	❑
16	Finding information to help patients	❑	❑	❑	❑	❑
17	Consultation with colleagues (including email)	❑	❑	❑	❑	❑
18	Communicating with special interest groups	❑	❑	❑	❑	❑

SECTION G. Attitudes towards Medical Care of Patients

In this section we would like to ascertain your attitude towards medical care delivered by you to patients. Please circle the answer you think is most appropriate.

1. I feel that it is a waste of time trying to persuade patients to give up smoking.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

2. I believe that I should always inform patients about their prescribed treatment, making sure they understand my expectations.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

3. An important part of my role is simply to listen to patients' worries.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

4. Counselling patients with personal problems can help them to cope better in the future.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

5. My medical expertise is often wasted because I see so many people who are not sick.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

6. Identification of modifiable risk factors such as smoking is a very important aspect of my work.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

7. Often patients make a convenience of me by bringing problems which they should solve themselves or take elsewhere.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

8. I believe that effective medical treatment depends on a partnership in which the patient plays an active part.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

9. Providing emotional support for patients is important for my personal satisfaction.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

10. It is important for me to be frank and open with patients.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

11. I believe that GPs are very influential in persuading patients to change their lifestyles.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

12. I think that it is my job to treat physical disease and leave tasks such as counselling to their professions.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

13. Patients are more likely to follow my advice concerning their physical complaints than advice concerning their social or emotional problems.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

14. The majority of patients do not wish to be involved in the decision making about their treatment.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

15. The more information I give patients about their diagnosis and treatment, the more likely they are to comply with instructions.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

16. I usually don't attempt to help patients with psychological problems because they are the result of life situations over which I have little or no control.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

17. Most patients would prefer the doctor to take responsibility for their medical problems.

|---|---|---|---|---|---|---|
strongly agree agree somewhat agree not sure somewhat disagree disagree strongly disagree

You have reached the end of this survey. Thank you very much!

For providing you with a report of research findings, please fill in your contact details:

Name: _____
Surname: _____
Address: _____
_____
_____
Telephone: _____
Email: _____

Please ensure that you have answered all the questions.
Please return **all the pages** (including page 2 if torn out) using the reply-paid envelope.

Kenneth K S Chung
School of Information Technologies, J12
The University of Sydney
NSW 2006

APPENDIX F: Contact Summary Sheets of Qualitative Interviews

CONTACT SUMMARY SHEET	
Date and Time	11:30am, Friday 23rd December 2005
Location of Interview	Sydney University, via Telephone to 02-9845 [redacted]
Name of General Practice/Health Care Organisation	University of Sydney at Westmead Hospital [redacted]'s clinic has 12 GPs in total.
Person interviewed	Prof [redacted]
Job Title	Professor of General Practice
Purpose	To obtain an overview of the workflow of general practice. refine the workflow model and also question the validity of the hypotheses
Description	[redacted] qualified 1978, finished GP training in 1984, worked in UK until 1995 and came to Australia. Worked in Academic GP since 1987. Currently in General practice part-time in an Aboriginal Medical practice. However, the problems pertaining to the General Practice are common all throughout the practice.
Overview of General Practice activities	Seeing new patients, or returning patients for follow-up visits with known problems. This occupies most of the GP's day. The other activities are business management, and back-room activities (e.g. writing letters, making referrals and professional development).
Comments on Performance Measures	Performance is measured in some sort of ratios and in some form of attributes. It is designed in terms of what is needed. If what is needed is the sort of measure of clinical appropriateness, then it will be measured "across the basket of clinical problems." E.g. Appropriateness of Clinical care measures will include such measures such as hospital admission rates for bacteria pneumonia, or heart failure, for example. UK is the leader in performance measures in such examples. Other people try to measure performance in terms of a generic outcome measure which is quite tricky. Performance is defined in many different terms, ways by different people and therefore is quite difficult. In my study, Tim thinks that performance is defined in terms of the quality of care literature. Performance in Consultation usually denotes competence. A lot of the Consultation based performance measures are process measures (E.g. does the GP greet the patient, does the GP obtain information from the patient). Therefore, a lot of the consultation process drills down to the micro level concerning the processes of the consultation. Ultimately, it is about asking what you want to measure.
The Consultation Process	1. Patient goes to desk 2. Patient says who they are 3. Patient provides their Medicare details (unless they are acutely ill) 4. The consultation is on a first come first serve

	basis. However, the ones who are acutely ill are served immediately (e.g. emergency) 5. Reception staff pulls out their file 6. Patients are asked their doctor preference (e.g. male, female) 7. Wait in waiting room 8. Doctor comes and calls them in 9. Doctor greets patient and asks the problems 10. Conversation hopefully focused on the problem. 11. ([redacted] suggests the Stott & Davis model (1979) of the consultation process 12. Doctor then examines patient 13. Recommends investigations (maybe) 14. Discusses findings with patient 15. Reviews with patient the assessment of the problem 16. Checks with patient whether he/she is comfortable with the assessment 17. Review Management options along with major recommendation (The above process is a very prescriptive kind of process)
Social Network (seeking information, advice and help)	For clinical matters (i.e. professional matters), questions may arise about the best possible diagnosis and recommendations. Most doctors seek advice from other doctors. Tim personally talks to other doctors in the practice to explore best options available to a given problem. If there are no doctors available or if the recommendations are not feasible, then Tim looks at text books, or online information. Fairly rarely (e.g. once a year), he would phone up a specialist colleague.
Who are the people involved in the practice whom you consider as important for the provision of medical practice	Others in the practice - Other doctors, clinical staff, and administrative staff
ICT use	Online information is fairly easy to access these days. Google is often used to find suitable information. PubMed is also a good source of medical information. The NHMRC also has useful guidelines for Tim to follow in the course of his practice. [redacted] acknowledges that he is also far more knowledgeable and comfortable about accessing such databases compared to most other GPs.
Information Systems used	▪ Medical Director is used. This is a kind of decision support systems but they are more like databases. They have interfaces, alerts, referral letters features, prescriptions, advice on prescriptions, calculators, medicine leaflet features. It does not really aid in making medical diagnostic support. This kind of support has not come through in Australian General Practice ▪ Ferret is also used. Ferret is a patient health information management systems developed

	specifically for Aboriginal medical services. It is like Medical Director but it has more reporting functions designed specifically for Aboriginal patients. It is merely a database rather than a decision support system. ▪ Therapeutic Guidelines
ICT Use and Task based activities	ICT is not essential. It is possible to practice without a computer sitting on the desk. However, in the last two years, more than 50% of the practice is now using computers. About only 3-4 years ago, computers were only used for billing purposes. Now, computers are definitely helpful in saving writing time and improving accuracy. A major advantage of ICT is in terms of indicating potential drug interactions for patients. This is the key area where computers are really adding real value to the decision support process. (Drug interaction is when on the basis of prescribing more than one drug, one or other drug may enhance/reduce the activity of the other drug. They have an adverse affect and neither of them have 'individualing'. ICT helps when you have thousands of drug interactions in your mind (because)…some ICTs inform or warn of drug interactions if drug A or drug B is prescribed.) Printed prescriptions are a lot safer than written prescriptions, therefore more accurate.
ICT Use and Social Networks	[redacted] – "I am sort of an unusual GP because compared to other GPs; I spend far more time on my emails…because of what I do." "Looking at my own practice, because we are all part-time, (there are 12 doctors working in the clinic and sometimes none of us are there) the only way, apart of occasional evening meetings, we interact is by emails and that's quite important. This has only happened over the last 18 months. Amongst colleagues, i.e. other GPs in other practices in the region, there's a fair amount of email activity going on within a group of people who spend a lot of time. These tend to be the "movers and shakers" of GPs – e.g. people from the local medical association and the like." "For the GPs who are more interested in their own clinical practice, less interested in education, working in other health areas, and developing general practice, they generally spend lot less time (on ICT). A majority of the GPs fall into this category."
Performance Assessment for GPs	After one becomes a vocational registered doctor (FRACGP), then there is a requirement to participate in a three yearly cycle of continuing professional development. However, this is not a form of assessment. Rather, it's a form of engaging in learning activities. However, this also does necessarily indicate that you learn. There is therefore, no on-going performance assessment. That may all change. In the UK, Britain now has re-accreditation based on performance, but this has not happened as yet in Australia.

Other comments	[redacted] ends the interview at 12:25pm, as he is busy and has been cut-short of time in the interview unexpectedly.

CONTACT SUMMARY SHEET	
Date and Time	03:30pm, Friday 24th February 2006
Location of Interview	Sydney University, via Telephone to 02-6685 [redacted]
Name of General Practice/Health Care Organisation	Member of the University of Sydney Discipline of General Practice, Dubbo
Person interviewed	Dr. [redacted]
Job Title	General Practitioner in Dubbo Medical Practice
Purpose	To obtain an overview of the workflow of general practice, refine the workflow model, discuss quality of care in general practice and also question the validity of the hypothesis
Description	[redacted] has been a general practitioner since 1984 and graduated from the University of Colombo. Specialised in Family Medicine (Sri-Lankan) or General Practice (Australian). Used his first computer in early 1990s (IBM Sinclair 80x). Computers completed changed his life since after 7-8 years of his practice. Started computerisation of his general practice as a hobby but developed into a Project (e.g. MD (Doctor of Medicine) Project). By 1995-96, he programmed a freely-distributed software called EPI-INFO (Epidemiological Info) for a US Company called WXO and CDC. The program is for medical statistical analysis and has helpful database properties. [redacted] has been working in the rural setting (Dubbo) since February 2005. He has travelled extensively and has trained rural Health Modules to other GPs. He is currently been a trainer, learner, and an observer to the rural Health Practice in Australia. He has just recently obtained his health provider number, which enables him to officially practice in Australia.
Overview of General Practice activities	In Dubbo, there are about 70 GPs with around 10 in the city centre. The practices are usually group practices, not individual ones. Basically, there are two kinds of practice in Australia. 1. Office based General Practice – No surgical or obstetrics procedures are done. Only prescriptions and minor procedures are provided and undertaken. E.g. Removing minor parts of skin for patients. 2. Procedural General Practice – Such practices involve surgical or obstetrics procedures. However, the insurance, especially in rural practices, is quite expensive which is why rural GPs tend to revert to office-based practice.
Comments on Performance	** See below (Performance Assessment for GPs)

Measures	
The Consultation Process	Workflow: 1. Patients book an appointment 2. In exceptional cases, patients walk in 3. When patient gets called, the doctor pulls up the patient's file or creates a new one. 4. GPs consult with the patient for an average of 10-15 minutes. Sometimes, it is 30-40 minutes in rare cases. 5. According to the nature of the consultation, the payment(s) are made by the patient. 6. After the consultation, the GP records the details into paper (or electronic records (although very seldom)). 7. If drugs are ordered, the prescription will be given to the patient. 8. In some cases, patients are referred to the specialists (e.g. Pathology labs). 9. Investigations are then faxed or electronically faxed to the surgery (or medical centre). [*The workflow seems quite similar to metropolitan practices.* [redacted] *agrees also. He thinks Dubbo is not extremely "rural".*]
Social Network (seeking information, advice and help)	In Dubbo, there are not only GPs but also GP trainers and registrars who are studying for the fellowship program (RACGP). Therefore, registrars ask the senior/principal GPs for help when in difficult or doubtful situations. "When GPs are in doubt regarding a diagnosis or a problem, they always refer to specialist or their colleagues or the hospital. The other thing that I would certainly do (and wish others would do) is refer to some electronic resources. For example, there is the ciap.health.nsw.gov.au website which is the most fantastic site I have ever seen. In there, you can read most of the electronic journals and medical textbooks for free….I have seen 60-70% of the medical textbooks online and it is free for all doctors. This includes books about detailed prescriptions and also the website provides you external resources as well such as PubMed." "Comparing this (resource) with that of Sri Lanka, if a rural GP there has difficulty in travelling to more urban centres, then that GP has no access to any kind of medical resources….However much rural you are in Australia, I think that more than 95% of the doctors have internet connection in Australia….The town (Narromine – 20 minutes away from Dubbo city centre) where I am going to practice have been given all kinds of facilities – brand new network servers, computer servers and broadband access, by the government." "I am very particular about the practice that I am going to – they should have computers!"

Who are the people involved in the practice whom you consider as important for the provision of medical practice	In the GP's practice, senior GPs are very important for the provision of medical practice because the context of general practice differs from regions to regions and also the types of illness vary from population to population (e.g. Dubbo to Narrowmine). "Because the senior GPs have practised for over 37 years, they know anyone who walks in the door…so I look forward to getting help from the two senior GPs in my practice and also from the practice manager. Over here, the (internet) connection is very fast so I will also be depending a lot on the ICT aspects of the Medical Director Software." "GPs usually have a monthly regional meeting where updates are provided. Most of them come to meet their own fellow GPs and have a chat in the evening. At the same time they get a dose of continuous medical education. So that kind of social network is important and I think that it will give rise to an improvement of their performance to some extent because they would have had a talk with their specialist or fellow GP. Sometimes, I also remember things (that are useful) that I chat to my friends when I meet."
ICT use	IT use is mostly restricted to billing and administrative tasks. [[redacted] *points out at this point that there was a GP in a town called Gilgandra 60 minutes away from Dubbo who won the "Best Australian GP" whose practice is not computerised. All medical documents should be faxed to him.* [redacted] *believes that the support that the doctors are getting is not adequate for computerisation. He provides the example of how the GPs in Narrowmine use the MD program. Although all the computers and connections are brand new, they still could not download pathology reports because of lack of disk space. The problem was not because of disk space but because of the way the disk partition has been configured. The solution is merely to enlarge the partition. Therefore, the problem originates from those who set up the computer configurations and the staff and GPs in the practice are put off by the problem.*]
Information Systems used	Apart from hardware, Medical Director (MD) is used as the primary software in Narrowmine. It is quite a popular software used by 80% of the GPs in Australia. [redacted] believes that the software is quite intelligent.
ICT Use and Task based activities	ICT and task based activities do not seem to be as streamlined nor well fit with each other. E.g. In the Skin Cancer Project for rural areas, most of the doctors do not use coding and use free-text to enter notes. The records are entered in the progress notes section and although it is possible to access them by SQL, the access is restricted and encrypted by password. Coding of the records using medical codes will streamline data retrieval and also allow for analysis later on.

	ICT is under-utilised for the purpose for which it was designed for. For example, pathology reports are still being handled and delivered physically although the MD program can download them electronically. To date, only about 5-6 practices in Dubbo have been trialling this initiative. Compare this to the Dubbo hospital, there is no computerisation whatsoever. The pathology reports are still being handled physically. "The specialist will have to invariably type the letter on a computer and print it and send the letter…just because the hospital is not computerised, although the same service can be provided to use MD." ICT benefits the GP performance through prescription writing. Medical Director catches "drug interactions" through its Clinical Decision Support System for prescription writing function. The government has initiated "care plans" – a programme which uses computer templates for medical professionals to complete, which upon completion rewards the medical professionals financially. "For example, if you are diabetic, the patient will fill up the diabetic template and over three or four consultations, it will have everything the doctor will need to ask the patient. It is helpful for both the GP and the patient. Specialists, nurses and other professionals may be involved also. Communication is hence done via email (amongst all the parties). When the template is completed by all the parties, the Health Insurance organisation is notified electronically automatically and the care plan is said to be complete. The GP is then rewarded financially." The implication of the use of care plans are thus: 1. Encouragement of GPs to use computers and standard templates 2. Ability for health organisations to track and monitor the number of diagnoses and treatments undertaken in a specific consultation 3. The number of medical professionals involved in a particular treatment 4. The ability for health organisations to measure performance (e.g. in terms of time taken to complete a care plan, or number of care plans completed in a month, etc.) *On the question of whether ICT is crucial for your performance* – "Without ICT, you cannot practice! My view is biased in that to be updated in medicine, you need to read a journal paper every three minutes. Even then, you are 8-10 years behind of the medical advances and developments. I don't think it is possible to practise without ICT; the patients expect you to be updated in medical know-how."

ICT Use and Social Networks	General Practices usually are equipped to use email. Newsletters are circulated through emails. However, other than that, there is no other use for ICT in terms of social use. "Doctors will be isolated (in rural areas). I think the rural GPs should be given not only computers but at least video conferencing facilities. This is because if they need to call another doctor, they need to be able to just dial and talk to them (through video-conference). I believe this is quite important otherwise they will be practicing in isolation." "Our school of rural health (Sydney University) is dependant entirely on video conferences. In our school of rural health in Dubbo, for our students, the entire curriculum is delivered to their classroom from the Sydney hospitals – Royal Prince Alfred and Westmead. There is a very fast and independent connection from here to Sydney to facilitate the video conferences."
Performance Assessment for GPs	The "Care plan" is the new initiative advocated by the government. GPs are encouraged to fill out the templates online. Care plans for certain health checks (e.g. diabetic checks) are undertaken periodically (e.g. 3 months) and the templates are coded. Therefore, this allows for the monitoring of the GPs activity. There is no specific standard or threshold as to the number of care plans one should complete in a given year. However, the care plans are positively tied to the income of the GPs as a financial incentive. In the field of general practice, what you learnt 2-3 years ago might not be true today. The Continuous Medical Education (CME) initiative provided points to GPs based on the activities undertaken (e.g. RACGP meeting or lecture attended, RACGP evening CME attendance, papers published). This is possibly one way of measuring GP performance. However, this is not mandatory and a low CME point does not warrant the loss of a GP's licence to practice. The RACGP is quite strict on the fellowship examinations. Most GPs cannot obtain the fellowship unless they finish the 3 year vocational training program. Performance Measure: 1. Monitoring what they do – how they write prescriptions, how they diagnose diseases, how many asthma patients they have and how much of heat flow rate they have measured. 2. Most work is done on Clinical Measurements of Quality of care. 3. Measurement Paradox: Patient satisfaction should be included, but it is a dimension that cannot be measured.

	4. Crude Way: Complaints against GPs.
Other comments	N/A

CONTACT SUMMARY SHEET	
Date and Time	02:30pm, Friday 3rd March 2006
Location of Interview	Sydney University, via Telephone to 02-6828 [redacted]
Name of General Practice/Health Care Organisation	Member of the University of Sydney Discipline of General Practice, Dubbo
Person interviewed	Dr. [redacted]
Job Title	General Practitioner in Dubbo Medical Practice
Purpose	To obtain an overview of the workflow of general practice, refine the workflow model, discuss quality of care in general practice and also obtain a view of the validity of the hypothesis
Description	[redacted] has been working for the NSW Outback Division in July 2003 after doing a placement for a Health Management Degree at University of New England. She's been an RN (Registered Nurse) as well as a Lawyer with a Bachelors of Arts Degree in 1969. She hasn't practiced as a Nurse for ages. She has been around hospitals and health services. She has done legal practice work, taught for Charles Sturt University and also in TAFE. The community she works and lives in is Walgett – which is in the north western part of NSW and is a large Aboriginal community. There are around 1,800 people in the community. Walgett is about 2 hours from Dubbo and about 8 hours from Sydney. There are about 15 GPs around Walgett. This is considered quite good. Currently, she provides executive support to the Division and runs the Walgett office and looks after other GPs.
Overview of General Practice activities	The division is situated in a large Aboriginal community that carries a "large burden of disease". Diabetes, chronic diseases are by far the biggest burden of disease in the area along with heart and cancer diseases. Poisoning and accidents are major causes of death in the area. Also, there are no good emergency response services in the area. E.g. Car, machinery, and farm accidents happen. So accidents and poisoning usually prevail. General Practice provides consultation, although the GPs have a "very heavy clinical workload. **GPs have a lot of GP-peer isolation.**" In terms of mentoring, support for rural GPs, it is very difficult for the GPs. Apart from office-based general practice and procedural-based general practice, a lot of "emergency trauma sort of work" is also involved. There are 2 GPs trained especially for that. They would take on the task of being VMO (Visiting Medical Officer) to the area of health service

	under a contract with the area of health service. The normal day-to-day activities in a GPs life can be regarded as "Out of control. The waiting list in a GPs office blows me away. In Walgett, the GPs are always (burdened) with heavy workloads, big waiting lists. I've seen the GP office staffs go home at around 7pm in the evenings. Also, they usually have long travelling distances to their homes."
Comments on Performance Measures	** See below (Performance Assessment for GPs)
The Consultation Process	Workflow: 1. Patient comes in with an appointment, or have an appointment. In AMS (Aboriginal Medical Services), there are no appointment systems, but is served on a first-in first-out basis. 2. They wait their turn and then see the doctor 3. From the consultation, if there are any clinical work that needs to be done, then the GP employs practice nurses and Aboriginal health workers and they assist the GPs to get their incentives through (e.g. EPC – Enhanced Primary Care – for all Aboriginal patients over 15). They assist the doctors to progress the patient's care and treatment, follow-ups, recall, reminders, etc.
Social Network (seeking information, advice and help)	In Walgett towns and communities, the area health services provide audio video facilities for GPs and health service staff, other organisations and the town. So you are able to go up and book that room for telehealth services. A lot work, e.g. diabetic work is done there. E.g. The system is connected to the Royal Prince Alfred Hospital and they can have a picture of the support person from the hospital itself. The access to the technology is therefore in place. "Another example is the project I am doing called: 'Alcohol substitution: Your mental health – Managing the mix'. Here a GP will be able to plug (connect) into a psychologist or psychiatrist who will mentor that GP in that area or advise that GP in the performance of that project or plan of management for that patient. This is the shared care." Telehealth is part of the Greater Western Health Service which is based in Dubbo that manages the telehealth systems. Dubbo has excellent IT and IM (Information Management) services. Doctors also seek help and have the assistance and support of the Rural Doctors Association and the Rural Doctors Network (RDN). Within the RDN, there are GP advisors, GP support, GP assistance and GP mentoring. The RDN

	office is located in Newcastle, NSW. The medium used to contact these personnel is via telephone, email and the internet. There is also the locum service offered by the RDN. E.g. If you need time off from work, then the RDN will ensure someone practice in your place for the time you are gone. The RDN also developed a model (Easy Entry, Gracious Exit model) for GP practices together with Rural and Remote Medical Services. There are also other people around to provide medical support. For example, Case conferencing is also a useful tool for GPs to obtain medical advice. They may do that with Area Mental Health. They may organise it with an endocrinologist for a diabetic patient. "In terms of emergency advice and help, GPs have their nominated sources of advice for whatever area they are working in, or the emergency they need. The level of support is very good! From the area of Health Services through to GP peers, psychologists, psychiatrists, everybody seems to get on board and help each other." ** See the example of the assistance from school teacher" under heading *ICT Use.*
Who are the people involved in the practice whom you consider as important for the provision of medical practice	"Other than GP peers, by far, our biggest support in the community are the Aboriginal Medical Services. They mesh very well and they complement General Practices. The Area of Health Services also plays an important role. The RACGP and the Australian Divisions of General Practice are also big support for us."
ICT use	"We all love broadband…everything out here seems to be a lot more sophisticated in terms of ICT use. One problem is IT personnel is sadly lacking almost all the time. In the last couple of years, *we've had assistance from a school teacher* whose work isn't really IT but he was willing to help after hours and that has happened a fair bit. So while the equipment is here and it's all new and flashy, it's just the lack of IT support (that is the problem)." ICT is used for social, administrative and functional tasks. GPs also communicate using email especially in rural areas. Without ICT, things will simply shut down and don't work.
Information Systems used	Medical Director is used for medical tasks. Internet websites such as Google are often used for information and literature searches.
ICT Use and Task based activities	By far, Broadband is very essential for the performance of our tasks. Video conferences and satellite communication technologies are available in the more remote areas closer to the Queensland border. These are provided and managed by the Area Health Service rather than by the GP provider.

ICT Use and Social Networks	"Absolutely, nothing would move, nothing would work here. Everything would just shut down! I've experienced that now for a couple of weeks. Since about the 9th February, my computer broke down and I felt frustrated. The IT personnel just came down and had it all up and running. But I just felt frustrated, like my life had no meaning. I didn't have access to my emails and documents."
Performance Assessment for GPs	"I can't think of any performance indicators. I'm not sure. What happens at times in the Area Health services (especially after hours) though is that a lot of people come to me with complaints that the doctor would not see them. This seems to be a consistent problem. (*However, this issue does not address the issue of Doctor performance (in my opinion). E.g. a GP who cannot see a patient in his busy practice does not necessarily mean that he cannot perform well).* "Doctors are always watched. They have the doctor's medical board. Doctors have strict legal obligations in the performance of their work as doctors. Doctors all need to be accountable." On the question of what makes a good consultation? - "Being able to listen, being able to interpret what a patient is saying, especially for an Aboriginal patient." "Performance as a GP in my terms is to be able to identify illnesses, treat illnesses and to be able to heal the patients. The GPs connection, how they integrate with other services to treat the patient is important. **So it is not just the doctor performing, the doctor is getting aid from a lot of other people in his performance.** The consultation is hence a focal point…. GPs need to be inquisitive and not to just accept at face value what the patient is saying, particularly, where alcohol addictions and drug addictions are concerned. This is a huge mental health problem in Australia."
Other comments	Doctors usually have peer-groups to consult when they run into problems. However, they are always not close together, hence the use of ICT amongst GPs – e.g. telephones, mobiles and for some doctors who have several phones, they always have one phone which they always keep switched on in case the Area Health Service (hospital) calls. In the cooler months of winter, the community becomes relaxed and tend to socialise more. GPs however, don't socialise much, except through dinners organised by the Divisions. The GPs like the social side of the Divisions very much. Usually, it is held every month across several

	towns each month (e.g. Coffs Harbour). The socialising events are always a plus – with continuous education and networking. "The Division has a monthly face to face meeting and they alternate it with a video conference sometimes. We talk about various things – social networks, programs, fundings, how we can do things better."

CONTACT SUMMARY SHEET	
Date and Time	04:30pm, Thursday 23rd March 2006
Location of Interview	Sydney University, via Telephone to (02) 6332-[redacted]
Name of General Practice/Health Care Organisation	The General Practice in Bathurst (part time) The University of Sydney (Part-time) - Rural Undergraduate Support and Coordination Program (RUSCP).
Person interviewed	Dr. [redacted]
Job Title	General Practitioner
Purpose	To understand the general practice workflow model, what constitutes general practice, whether social networks and ICT are important and what constitutes performance.
Description	Graduated in Medicine in 1977 from UNSW. In 1980, moved to a very small country town (approx 3,000 population) to start general practice with her husband. Later moved to a smaller town (about 1,200 to 1,400 population) and practiced there for seven and a half years. In those days, there was very little peer support. Computers were not part of our lives. There was no **peer support** and divisions of General practice. Got worn out because of **no peer support**, and moved to a bigger centre – Bathurst. She has stayed ever since, while her husband moved into emergency practice. She's learnt the importance of **peer support** and time off in order to strike the balance of general practice life.
Overview of General Practice activities	My practice is the ideal practice – the kind where you can sustain. The practice is fully computerised. Accounts, CMEs (Continuing Medical Education) stuff comes through the computer. There are 4 partners, 3 associates (Cathy being one), GP Registrar (doctor in training), Students (3 practice nurses), Visiting psychologist and ancillary staff – admin staff.
Problems in General Practice	The problems are not so much as it was then as it is now. The problems are still greater in the city – especially **continuing with medical education** without leaving your town – **that's especially important for people in very small town with 1 or 2 practices and they cannot leave their towns so they need the internet**. That's a huge benefit and that's how a lot of them would get their education. This is supplemented by how people go into the city. In the olden days, the only way to upskill yourself was to read journals in hard copies. **The practice is now fully computerised. It is a paperless practice.**

	On shortage of GPs – it is a major issue in Australia. On GP performance as they age – "Not so much as it used to be. Because the Divisions of GPs have done a lot to bring in regular upskilling and medical education to practices in all of the town and making sure the GPs have the most up to date information (e.g. New things on immunisation) and they are very good at giving information out and they usually come through the fax or through the computer. So it's not the problem that is used to be. However, the problem of ageing doctors is huge. For example, the practice that I am in, there are 5 GPs over 50. **So there are very few young GPs**. In just about every Bathurst practices, almost all GPs are over 50. In the next 10 years, there's going to be a huge exodus. This problem is the same all across the state." The rural medical schools and GP Training providers are helping to place young doctors in practices. It's very common to see young medical students and registrars being placed in rural areas. "Also, if you are an old doctors and you are taking in young medical students or registrars, **you tend to keep yourself upskilled and thoughtful** because you got young people you are teaching asking you why you are doing what you are doing."
The Consultation Process	• Patient rings in to see doctor or makes an appointment • Patient sees doctor • If first time, then medical history of patient is elicited. • GP treats the presenting problem of patient • If test is needed, send them for the test • Get the test back for review or send them to a specialist if needed • **GPs in rural areas treat more complex problems than the rural ones (because of lack of specialists)** • **GPs in rural areas tend to refer less** because they just do not have the ability to refer to available specialists or because the patient would need to leave town to see a specialist. • Most rural GPs also have hospital visiting rights and as such if the patients are hospitalised, they can treat them at the hospitals. • **Rural GPs are more likely to home-visit the patients.**
Social Network (seeking information, advice and help)	During difficulties, often **you would ring a specialist** to ask their advice prior to sending the patient on or whether the patient needs to be sent on. Sometimes, **you would get a second opinion from**

	another doctor in the practice. This is quite common. GPs tend to get areas of interest, especially rural GPs because there aren't other specialists around, **you tend to pick up areas of interest** (usually privately) and do extra studies in those areas. (E.g. A GP might do a Masters in Sports Medicine, or specialise in HIV etc.) So **these GPs benefit not only the GPs in the practice but also others in the town**. *What kinds of ties facilitate information/advice-seeking?* You **would do referrals with people who have the expertise** on what you are looking for. But often you would find in rural areas, that **there are networks that are linked back to the city** that are often linked with where the doctor did their training or the university they went to. **Or over time, you may find that you build up a rapport with a specialist** that is in your closest referral hospital. You, you know, usually get to know people over time as you sent patients off (to them). *Such relationships over time become social ties and become stronger over time.* *Do you feel that social ties are important especially in rural areas when you practice?* "Oh, I think so! I think **if you know someone that you are referring to** at a distance, if you have met them or have had some kind of interaction with them, like, maybe a specialist has come out and given a talk in your town about something, and so you've met them and spoken with them or maybe had a meal with them, **then you are more likely to feel comfortable about ringing them** and talking to them about a patient, and also if they know the environment that you come from, then **they can give you advice that is relevant to your environment**." *Do you feel that this (social network) enhances your ability to care for patients?* "Oh sure!" *In a direct or an indirect way?* "I think probably in a direct way…because I think if you've got a problem, it can be quite stressful but **if you know someone that you can speak to** and know that they will treat you in a certain way rather than ringing just someone whom you know nothing about, and whatever, **you feel much more at ease and much more likely to get advice.**" ** (*On how social networks help to keep up knowledge)* "We have **clinical meetings in the practice** and **also the clinical meetings in the towns** which help a lot to keep up with medical knowledge. I do a lot of education – I **certainly interact with lot of doctors in a lot of different practices so that gives me a lot of insight into how other people work and how their practices work so that helps me personally**. Every doctor would have regular clinical

	meetings. Peer reviews are needed when there are bad outcomes in the practice to work out what happened and how to change it."
Who are the people involved in the practice whom you consider as important for the provision of medical practice	• Other GPs you work with, • the staff at the surgery, • the other health professionals in the town (because you rely quite heavily on the district nurses, chiropractors, etc.) **Again, if you know them on a social context, it makes it easier to interact with them.** • Staff at hospital, police, ambulance – all of those people, even local religious people (for patients who die, you need to interact with the local pastor, or whatever)
ICT use	*What are the kinds of ICT is being used in the practice? Which ones are important to you in delivering quality care?* "Every desk as a computer on it and all our medical notes are kept on the computer. The software is very important because it is very user-friendly. If it wasn't, we wouldn't be able to use it. The software is constantly being upgraded. We seem to have fairly good IT support. The computers are always up and never seem to be down. The practice manager is very good at keeping the computers up and running. I've been to other practices where they do not want to completely computerise their practice because of lack of IT support. Therefore, IT support is quite crucial." "In our practice we do not have satellite communications, but in the hospitals, we do." *Do you use the computer frequently to email doctors to seek for advice or information?* "No, I would use the phone. If I send the patient to the doctor, I would write a letter, and the patient would take it to the referred doctor. When the doctors write back to us, we scan all of that information into the patient's file. Currently, we are looking to getting all the replies by email. However, the pathology results and xray results are downloaded straight away into our system and no longer come in hard copies. That's been very very good. So I would say in the future, we will use the email a lot more. **At the moment, the email is a system mainly for communication within the practice**. E.g. The practice manager wishes to communicate all the GPs in the practice, or when patients arrive for their appointments, the receptionist emails the GP and not by phone. As for external email, a few patients email me if they want to talk to me, or to ask for a script. There are not many at the moment, but it is the way of the future.

	I have **my email on all the time for other social tasks** – e.g. **Speaking (emailing) to my children** half a dozen times a day; I **would use the web cam** to talk to them as they live in Montana and I would use it every day."
Information Systems used	Medical Director
ICT Use and Task based activities	"**ICT is definitely beneficial for the performance of my work**. I think it's the way of the future. I have done video conferencing at the Bluefield hospital in Orange for GPs to video conference about mental health patients and I've been involved in a couple of those over the years. It's definitely the way of the future and especially in rural communities as well. Video conferencing is so much better than teleconferencing." I also use Google for example, during a consultation, if the patient wanted information on something. I might also have a lot of information sheets that I know of that I might download for them.
ICT Use and Social Networks	"**ICT also gives me a sense of social connectedness** because I use the email a lot to keep up with friends and family. I use email a lot for my work at Sydney University also because I work out from home."
Performance Assessment for GPs	"**No, there is no standard of measure being used.** Every GP has to have done their training and has to have passed their RACGP Fellowship exam. **We all have to keep up with our continued medical education** and **we have to produce documentation that we have done a certain amount of study over a triennium** and gotten a certain number of points doing certain things…but apart from them, no (there is no standard of measure). At each triennium, you have to do a certain amount of research or study. You can do all these quite easily by doing them on the internet or going to structured lectures or seminars or doing audits of certain things in your practice."
Comments on Performance Measures	*On existing measures…* "We do **patient surveys each year on practice satisfaction and doctor satisfaction** and such information is fed back to us. This is one way to get back some feedback. I suppose subjectively, if you are always booked out and your patient seems to be fit and healthy and going alright, that's all very good. We do certain statistics on our practice as to what percentage of the children are being immunised, what percentage of the diabetics are being assessed in a period of time, and what the control of their sugar is like, blood pressure control of high-blood pressure patients. These are the types of objective measures we are looking at in order to assess whether we (the practice) makes a difference. Hence, these are clinical type measures."

	"As for interpersonal measures, **the patient surveys are the only ones we have in order to measure the GP's interpersonal care**." *On standards of care…* "**Every practice these days undergoes accreditation**, and within the accreditation process, they look at a whole gamut of things as to whether you are meeting certain standards and **they use the RACGP standards as the standards**. Hence, I would say that more so than it used to be, practices are trying to adhere to the standards." *What qualities (interpersonal characteristics) make a good doctor?* "GPs have to be …people person, emphathy, non-judgemental, have to listen to what people say and not be reactive, have to think about self-care so that you do not become very stressed. Clinically, you need to have **competent knowledge and keep your knowledge up (to date) (see ** above)**. You need to be an advocate of your patient – i.e. not just treating illnesses but need to look at people as a whole, their lifestyle, so that you can help them. You need to be able to work in a team. Need to be ethical and confidential."
On ICT use, Social Networks and Performance	"ICT and Social Networks are absolutely important for my performance. What I really like about the ICT side of things is using it for prescription and for the notes and for the collection of patient information. It's much more foolproof than having written notes which can be lost easily. You can build into the system a lot of safeguard about reviews, about telephone consultations, about when patients produce a certain tests, about what specialists have said, etc. It's a fabulous way of the future."
Other comments	N/A

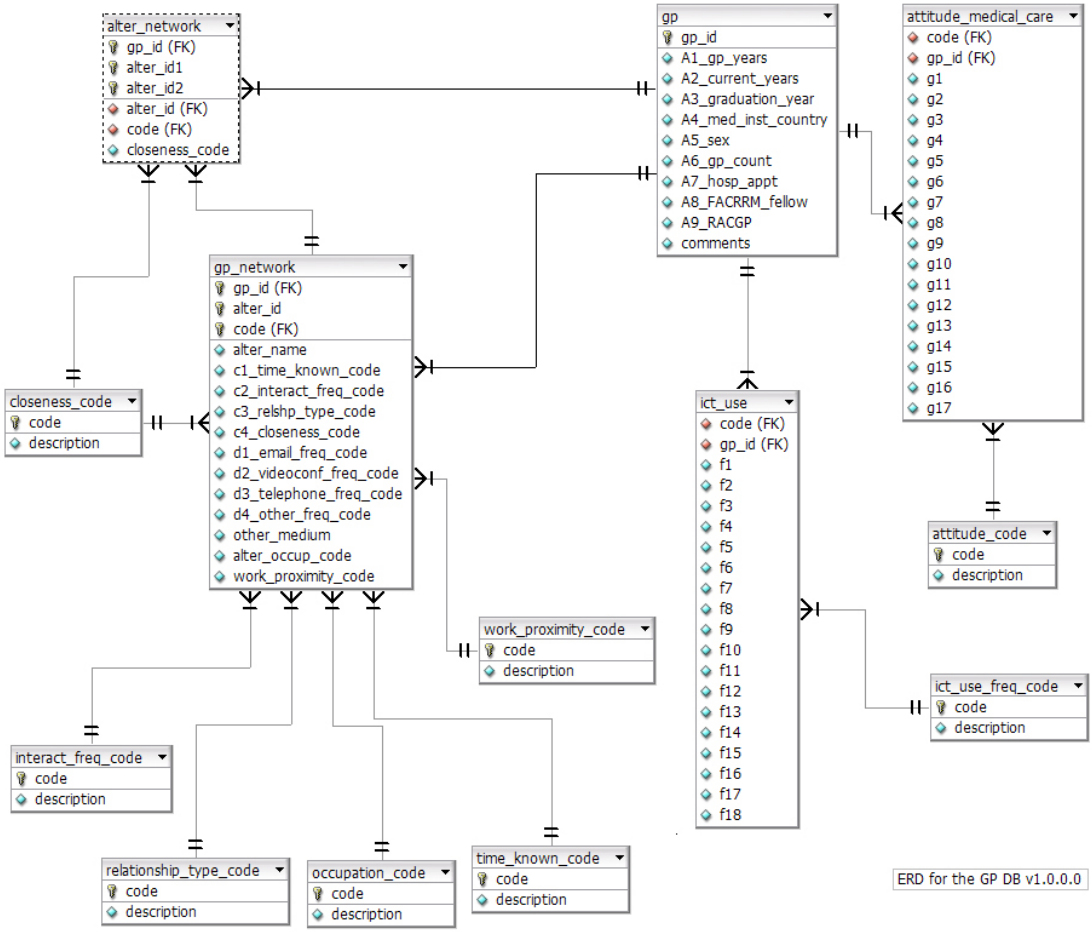
CONTACT SUMMARY SHEET	
Date and Time	02:30pm, Thursday 4th May 2006
Location of Interview	Sydney University, via Mobile phone (Number undisclosed)
Name of General Practice/Health Care Organisation	[redacted] Medical Centre, Wellington, NSW
Person interviewed	Dr. [redacted]
Job Title	General Practitioner in Wellington, NSW
Purpose	To obtain an overview of the workflow of general practice, refine the workflow model, discuss quality of care in general practice and also question the validity of the hypothesis
Description	[redacted] was born in 1948. He always wanted to do country general practice. Graduated in Sydney University. Wanted to be in rural general practice at the end of university years. Went to Hornsby High School. Embarked on GP training scenes. Trained in England as well for GPs. Worked in western part of NSW in August 1978 as Rural GP/Hospital doctor. In Bourke, he worked until 1983. Since then, he works in Wellington, in Central NSW. Have always done GP in hospital medicine and now has own general practice in a medical centre. He is also an emergency doctor who is on-call. He works with 2 rural registrars, one overseas trained doctor and another part-time doctor. Population in Wellington: approximately 5,500 in town and 9,500 as a whole.
Overview of General Practice activities	Activities and services are: Primary care consulting, referral for pathologies and radiology and all sorts of tests. In a sense, it is a normal general practice. Also liaises with independent living hospitals where patients or clients who reside in the hospitals are able to get themselves into the common dining rooms, bathroom, common rooms and so on. We visit them on a regular basis, we do house calls, but most of them are for terminal illnesses. I'm on a one in five on-call roster to hospital and if patients are needed to be admitted when I am on call, they would come into the hospital under my care and I look after them until they are discharged. There are some surgical procedures that we offer as well – some anaesthetic services for example. PROBLEMS: General problems that plague the rural practice are: workforce problems. There's always been a shortage of doctors in the current areas. This is not just GPs, but it is also a shortage of specialised services as well. Difficulties are that we are very busy but also we can't have patients necessarily have referral lines waiting for such specialised services. We look after patients from a diagnostic point of view.

	Doctor shortages don't impact my performance directly. I think my performance is ideal when we aren't very busy. Yet, I think performance also drops off when you're not very busy and I think there's an ideal working rate where your performance is best and there is a level above that where the amount of work you have to do within a short given number of hours and your performance becomes suboptimal.
Comments on Performance Measures	** See below (Performance Assessment for GPs)
The Consultation Process	The way I run my consulting is that I don't run any appointments. There are a large number of people who want to see me and there are quite a number of people waiting at the doorstep of my surgery as I walk into work. If I do make appointments, they are usually booked out. So it's quite difficult to get an appointment. When the patients do make an appointment with me, they would've made contact with the medical secretary and given they have a medical record, their medical record would be retrieved. Our office records are computerised and the front desk retrieves this medical record. The secretary then puts the hard copy of the record on my pigeon hole. I pick up this record in consecutive order and call the patient into the consulting room. I find on the computer via Medical Director the records of the patients and then start the consulting process with the patient.
Social Network (seeking information, advice and help)	"There is quite a lot of cross consulting or asking of second opinions with my colleagues. I might ask them for advice or ask them to see the patients or discuss the pathology results with them to get their point of view. Or I might ring a specialist for some verbal advice or just call them as a referral or ask them about a diagnosis or a clarification of the diagnosis. This is simple explanation of it really." With my own colleagues in the town, I do it face-to-face. For the specialist colleagues, I would ring by telephone. I haven't got into the habit of using email. What I may do, in a couple of occasions, is that I make a phone call after I send a fax to them so that they have more time to consider the matter to be discussed.
Who are the people involved in the practice whom you consider as important for the provision of medical practice	People who are important for the provision of medical practice or good quality care: "The secretarial staff is quite critical. Without them, with good and well mannered and professional staff such as these, the whole system falls down. They need to be experts in particular jobs such as reception, secretary. There is quite a lot of guidelines about the practice that need to be in place so that patients get good care. I think you have to have certain policies – such as those laid down by the RACGP. These guide us and check us on particular investigations." "Then I think the members of the practice itself need to have a very good practice arrangement with the specialists that they work with.

	And I think that is based on a mutual respect for each other. That you generally practice the respect of the quality of service they provide. Without mutual respect, the practice would fail." "Social networks are therefore quite important. You certainly cannot work alone in general practice. You are an organiser and gatekeeper in the flow of organisation and communication between them and your patients. As gatekeeper, you need to have very good network of contacts." "I don't feel isolation here in Wellington as opposed to my other fellow country practitioners. I work in a practice with other GPs and I work very closely with my specialist colleagues. And I do have a fairly intrinsic base understanding of the base hospital, so I don't feel excluded from the community of medical professionals. In my town, I know who is who as working colleagues and as friends and as very close acquaintances. "
ICT use	We have computers for admin and bookkeeping. We also have the medical directors. We have access to email and internet and these are used frequently. Emailing is made to colleagues and family. Internet services are used for searches – medical and non-medical. I don't use it for other things but other doctors use it for personal purposes such as net banking. Telephones and faxes are used quite frequently. I think a lot of the pathologist services tend to download most of the information on our email and directly on to our computer. The Health Commission invoices are all done electronically. Lot of information from health divisions come via fax and email. "I use computers lesser than my younger colleagues. My generation isn't that comfortable and quick to use computers."
Information Systems used	Medical Director (MD) is used as the primary software in this practice. "The practice can be made paperless although it is currently not. We are working towards it. My registrars are practically efficient computer-wise. Over the next 10 years, the practice will become paperless."
ICT Use and Task based activities	On what computers are good for and what they are bad for: "I think computers are important for searching. It can keep track of medication lists, medication interactions. It is much better at making certain about patient follow-ups, much more efficient at handling results, filing ledgers. I am not sure if it is more efficient in capturing what was actually going on in the medical consultation. I think computers can force the doctor to, and this is just a personal opinion, fill in the computer components of the patient record rather than free think themselves about what the patient is trying to tell them."
ICT Use and Social	"As a person who is 58, I have only just embraced the concept of

Networks	ICT being a social connection tool in the last five years. I realise that I can talk to my children who are now away from home via email if I want for an hour a day. I definitely think that email in particular has made a big difference in communicating information. So much so that the older generation like myself are much less likely to go to a text book to look up information rather than being more likely to go on to the internet to look up particular information." "I don't use ICT much for communicating with peers and colleagues. It's not the technology problem. I think I just haven't got used to using internet for that particular reason." Is ICT important for provision of quality care? "I think it's absolutely essential. I don't think you can practice good general practice anymore in the absence using of good ICT. Only 10 years ago, it was not probably true, but at least as long as the record was partly computerised, I think that really is a basic standard of general practice."
Performance Assessment for GPs	Is there a standard measure of GP performance? "I think the closest that there is to that is not so much an individual standard of practice. I mean the individual measure at the moment is just that you are able to accrue enough CME points in a triennium. Now that does not measure performance but that does indicate your intent to try and attend up-to-date educational things. But as far as a measure of standards, again, the closest I can think of is the FRACGP accreditation practice. With this, the practice has some accreditation. In many ways, they look at your medical records, they look at your administrative side, they look at the standards, for example, referrals, on OHS, etc. This is a very broad assessment of the practice. To pass this, the doctors have got to be practising fairly professional standards of practice otherwise the assessors would note this."
Other comments	On the importance of ICT use and SN for performance – "I think at the moment, ICT for me is more important for the running of my general practice rather than for maintaining my social contacts. As I become more aware and more comfortable with using ICT for social contacts, I may definitely use it in the years to come."

APPENDIX G: Entity Relationship Diagram for Survey Data



APPENDIX H: Using Perl to Populate and Extract Network Data

```
# Author:       Kenneth Chung
# Date:         24th November 2006
# Program:      populate.pl
# Usage:        populate.pl <debug_level>
#               where debug level 1=ON, 0=OFF
# Description:  populate.pl is a script that will populate the gpdb_v3 database with data as a
simulation of real
#               users.
# Version:      0.1
# Revision:

#!D:\Perl\bin\

use DBI;
use strict;
use warnings;
#use vars qw($Global1 @array $hash);
#package dbi;

$global::debug = 0;                                     # debug level: 1=ON, 0=OFF
$global::n = 10;                                        # The sample size (or number) of GPs to
be populated

#print "(Number of Argument(s) is(are): $#ARGV)\n";
if($#ARGV == 0 && $ARGV[0] == 1){                       # If there is only 1 argument of value 1
then
  $global::debug = 1;                                   # turn DEBUG info on.
  print "Yo Debug value is $global::debug\n";
}

############################
## GENERATE A RANDOM NUMBER BETWEEN A GIVEN MIN & A GIVEN MAX
############################
sub generate_rand{
  # Cases we can have, 0-7 for QoC Attitude statements, 1-2 for Yes/No or male/female
  my ($min, $max) = @_;
  # If min is greater than max, then "Houston! We have a problem! Abort this sub!"
  if ($min > $max){
    print "Aborting generate_rand subroutine: Min ($min) is greater than Max ($max?)\n";
    return;
  }

  my $range = $max; # - $min;
  $range++;          # This is needed cos' otherwise, it never prints the max. So we need to
increment by 1.
  #print "Min is $min, Max is $max and Range is $range\n";

  ## If min = max, then forget about generating a random number!
  if ($min == $max){
    my $random_number = $min;
    #print "$random_number\n";
    return $random_number;                      # The return function aborts and escapes the
subroutine.
  }

  my $random_number = int(rand($range));          #Note: int(rand(10)) returns value of 0-9
inclusive.

  ## We do not want 0 as a random number when minimum is 1, otherwise generate random number
between max and min.
  if ($random_number == 0 && $min == 1) {
    $random_number = 1;
    #print $random_number. "\n";
    return $random_number;
  }
  else {
    if ($random_number <= $min){
      while ($random_number <= $min){
        $random_number = int(rand($range));
          if ($random_number >= $min) {
            #print $random_number. "\n";
            return $random_number;
          }
      }
    }
    else {
      #print $random_number. "\n";
      return $random_number;
    }
  }
}

############################
## CONNECT TO THE DATABASE
```

```
##########################
sub connect_db{
  my $db = "gpdb_populate_v1";
  my $user = "root";
  my $passwd = "root";
  my $dbpath = "DBI:mysql:database=$db:host=localhost:3306";
  $global::dbh = DBI->connect($dbpath, "$user", "$passwd")  # I used $global to make the dbh
variable global and
       or die "Can't open database: $DBI::errstr\n";        # I don't know why but it works!
$global can be anything.
       print "Yea man! Successfully connected!", "\n";
}

##########################
## RETRIEVE SOMETHING
##########################
sub retrieve_db{
  my $sql = @_;
  my $sth = $global::dbh->prepare_cached("@_");
  $sth->execute
     or die "SQL Error: $DBI::errstr\n";
  my @row = $sth->fetchrow_array;
  return @row;
#  my $i = 0;
#  while ( my @row = $sth->fetchrow_array ) {
    #print "@row\n";                         # Give me the entire contents of the array
#    chomp(@row);                            # Remove all new line characters from every elemet
in array
    #print "Item $i in array is: $row[0], $row[9]\n"; # I also noted that
                                             # there is no difference between the scalar
operator $row[0]
                                             # and the array operator @row[0]
    #$i++;
#  }
  $sth->finish;                              # Hello SQL, I'm done retrieving you.
}

########################################
## PREPARE FOR INSERT INTO THE GP TABLE
########################################
sub prepare_n_insert_gp_table{
  my $count = 1;                             # A counter. I can probably just use $gp_id but am
lazy!
  my $gp_id = 1;                             # Being from this gp_id
  my ($a1_gp_years, $a2_current_years, $a3_grad_yr, $a4_med_inst_country, $a5_sex, $a6_gp_count,
$a7_hosp_appt,
  $a8_FACRRM, $a9_RACGP, $comments);

  while($count <= $global::n){
     $a1_gp_years = &generate_rand( 10, 40);
     $a2_current_years = &generate_rand( 1, $a1_gp_years);
     $a3_grad_yr = &generate_rand( 1942, (2006 - $a1_gp_years));
     $a4_med_inst_country = "University of Nowhere";
     $a5_sex = &generate_rand( 1, 2);
       if ($a5_sex == 1){
         $a5_sex = "Male";
       }
       else{
         $a5_sex = "Female";
       }
     $a6_gp_count = &generate_rand(1, 15);
     $a7_hosp_appt = &generate_rand( 1, 2);
       if ($a7_hosp_appt == 1){
         $a7_hosp_appt = "Yes";
       }
       else{
         $a7_hosp_appt = "No";
       }
     $a8_FACRRM = &generate_rand( 1, 2);
       if ($a8_FACRRM == 1){
         $a8_FACRRM = "Yes";
       }
       else{
         $a8_FACRRM = "No";
       }
     $a9_RACGP = &generate_rand( 1, 2);
       if ($a9_RACGP == 1){
         $a9_RACGP = "Yes";
       }
       else{
         $a9_RACGP = "No";
       }
     $comments = "Auto Populated";

     #  print "LOOK $gp_id $med_inst \n";
     #&insert_gp_table( $gp_id, 10, 20, 1955, $med_inst, "male", 10, "yes", "yes", "yes", "Auto
populated!" );
```

```
     &insert_gp_table( $gp_id, $a1_gp_years, $a2_current_years, $a3_grad_yr, $a4_med_inst_country,
$a5_sex,
     $a6_gp_count, $a7_hosp_appt, $a8_FACRRM, $a9_RACGP, $comments);
     if($global::debug == 1){
       print "INSERT INTO GP (", $gp_id,", ", $a1_gp_years, ", ", $a2_current_years, ",
",$a3_grad_yr,", ",
       $a4_med_inst_country, ", ", $a5_sex,", ",$a6_gp_count, ", ",$a7_hosp_appt, ", ",$a8_FACRRM,
", ",$a9_RACGP,
       ", ", $comments, " ) \n";
     }

     $gp_id++;
     $count++;
  }
}

############################
## INSERT INTO THE GP TABLE
############################
sub insert_gp_table{
  # This subroutine does the actual insert into the gp table. It accepts 11 arguments.
  # $global::dbh->do('INSERT INTO gp (gp_id, A1_gp_years, A4_med_inst_country) VALUES
  # (5, 30, "University of Germany, Germany")');
  # $global::dbh->do('INSERT INTO gp (gp_id, A4_med_inst_country) VALUES (?, ?)');
  # This is the most simple
  # INSERT statement. The dbh->do call
                                                                                  # prepares, and
executes.
  my ($gp_id, $A1, $A2, $A3, $A4, $A5, $A6, $A7, $A8, $A9, $comments) = @_;   # Arguments: 11
items to be inserted
  my ($insert_handle);

  $insert_handle = $global::dbh->prepare_cached('INSERT INTO gp VALUES
(?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?)');
  die "Couldn't prepare SQL statements; aborting" unless defined $insert_handle;

  $insert_handle->execute($gp_id, $A1, $A2, $A3, $A4, $A5, $A6, $A7, $A8, $A9, $comments) or
return 0;
  return 1;                       # Denotes successful insert. 0 is unsuccessful.
}

########################################
## PREPARE FOR INSERT INTO THE GP_NETWORK TABLE
########################################
sub prepare_n_insert_gp_network_table{
  # This sub
  #my $count = 1;
  my ($gp_id, $alter_id, $alter_name, $c1, $c2, $c3, $c4, $d1, $d2, $d3, $d4, $other, $alter_occup,
$work_prox);
  my $sth = $global::dbh->prepare_cached("SELECT gp_id FROM gp");
  $sth->execute or die "SQL Error: $DBI::errstr\n";
  while ( my @row = $sth->fetchrow_array ) { # For each GP_ID, generate the alters & gp network
    chomp(@row);                             # Remove all new line characters from every elemet in
array
    if($global::debug == 1){
      print "Reading GP table...";                       # Give me the entire contents of the
array
      print "Fetched gp_id: $row[0]\n";               # Give me the first element in the array
    }
    #print "Item $i in array is: $row[0], $row[9]\n"; # I also noted that
    $gp_id = $row[0];
    my $alter_count = &generate_rand( 1, 15);# Generate a random number of alters whom the GP
nominates
    if($global::debug == 1){
      print "Random Number of alters generated: $alter_count, for gp_id: $gp_id\n";
    }
    # For each alter, generate and insert the gp_network data
    for(my $alter_id=1; $alter_id<=$alter_count; $alter_id++){
      my $alter_name = "Auto O'Niel";
      my $c1 = &generate_rand( 0, 5);        # 0 here means not filled out in survey or blank.
      my $c2 = &generate_rand( 0, 5);        # 0 here means not filled out in survey or blank.
      my $c3 = &generate_rand( 0, 5);        # 0 here means not filled out in survey or blank.
      my $c4 = &generate_rand( 0, 4);        # 0 here means not filled out in survey or blank.
      my $d1 = &generate_rand( 0, 5);        # 0 here means not filled out in survey or blank.
      my $d2 = &generate_rand( 0, 5);        # 0 here means not filled out in survey or blank.
      my $d3 = &generate_rand( 0, 5);        # 0 here means not filled out in survey or blank.
      my $alter_occup = &generate_rand ( 1, 6);
      my $work_prox = &generate_rand ( 1, 6);
      my $d4 = 0;
      my $other = &generate_rand( 0, 2);     # 0 = use no other medium, 1 = Online Messaging, 2 =
Online forum
       if( $other != 0 ){                    # i.e. other medium is used, then fill out the
frequency table
         $d4 = &generate_rand( 0, 5);        # 0 here means not filled out in survey or blank.
       }

      if($global::debug == 1){
```

```
        print "INSERT INTO gp_network (", $gp_id,", ", $alter_id, ", ", $alter_name, ", ",$c1,", ",
        $c2, ", ", $c3, ", ",$c4, ", ",$d1, ", ",$d2, ", ",$d3, ", ", $d4, ", ", $other, ", ",
$alter_occup, ", ",
        $work_prox, ") \n";
        #print "INSERTING GP_ID: $gp_id, Alter_ID: $alter_id, Alter Name: $alter_name\n";
      }

     #&insert_gp_network_table( $gp_id, $alter_id, $alter_name, $c1, $c2, $c3, $c4, $d1, $d2, $d3,
$d4, $other,
     #$alter_occup, $work_prox);
    }
  }
}

############################
## INSERT INTO THE GP_NETWORK TABLE
############################
sub insert_gp_network_table{
  # This subroutine does the actual insert into the gp_network table. It accepts 11 arguments.
  # $global::dbh->do('INSERT INTO gp_network (gp_id, alter_id, alter_name, c1, c2, c3, c4, d1, d2,
d3, d4, other,
  # alter_occup, work_prox) VALUES
  # (5, 30, ...blah blah)');
  # $global::dbh->do('INSERT INTO gp_network (gp_id, alter_id...) VALUES (?, ?)'); # This is the
most simple
                                                                                  # INSERT
statement. The dbh->do call
                                                                                  # prepares, and
executes.
  my ($gp_id, $alter_id, $alter_name, $c1, $c2, $c3, $c4, $d1, $d2, $d3, $d4, $other,
  $alter_occup, $work_prox) = @_;   # Arguments: 14 items to be inserted
  my ($insert_handle);

  $insert_handle = $global::dbh->prepare_cached('INSERT INTO gp_network VALUES
  (?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?)');                                    # The ? var
is a life saver.
  die "Couldn't prepare SQL statements; aborting" unless defined $insert_handle;

  $insert_handle->execute
  ($gp_id, $alter_id, $alter_name, $c1, $c2, $c3, $c4, $d1, $d2, $d3, $d4, $other, $alter_occup,
$work_prox)
  or return 0;
  return 1;                     # Denotes successful insert. 0 is unsuccessful.
}


########################################
## PREPARE FOR INSERT INTO THE ALTER_NETWORK TABLE
########################################
sub prepare_n_insert_alter_network_table{
  my ($gp_id, $alter_id1, $alter_id2, $closeness_code);

  ## Fetch the number of DISTINCT/UNIQUE GP_IDs in the gp_network table to count number of GPs
available
  my $sth1 = $global::dbh->prepare_cached("SELECT COUNT(DISTINCT (gp_id)) FROM gp_network");
  $sth1->execute or die "SQL Error: $DBI::errstr\n";
  my @first_row = $sth1->fetchrow_array;
  my $gp_id_count = $first_row[0];           # The number of GP_IDs in the gp_network table
  if($global::debug == 1){
    print "Number of GP_ID in gp_network is: $gp_id_count\n";
  }

#  for(my $i=1; $i<=$gp_id_count; $i++){
  ## Fetch the gp_id and the number of alters for each gp_id
  my $sth = $global::dbh->prepare_cached("SELECT gp_id, COUNT(alter_id) FROM gp_network GROUP BY
gp_id");
  $sth->execute or die "SQL Error: $DBI::errstr\n";
  $alter_id1 = 1;

    while ( my @row = $sth->fetchrow_array ){ # For each GP_ID, generate the alters & gp network
      chomp(@row);                            # Remove all new line characters from every elemet
in array
      my $gp_id = $row[0];
      my $alter_count = $row[1];
      if($global::debug == 1){
        print "Reading gp_network table...";                        # Give me the entire contents
of the array
        print "Fetched gp_id: $gp_id, max alter_id: $alter_count\n";   # Give me the first element
in the array
      }

    # For each alter pair of each GP, generate alter pair closeness code and insert the
alter_network data
      for(my $alter_id2=1; $alter_id2<=$alter_count; $alter_id2++){
        my $closeness_code = &generate_rand( 0, 5);        # 0 here means not filled out in survey
or blank.
        if($global::debug == 1){
```

```
          print "INSERT INTO alter_table VALUES(",$gp_id, ", ", $alter_id1, ", ",$alter_id2, ",
",$closeness_code, ")\n";
        }
        #&insert_alter_network_table( $gp_id, $alter_id1, $alter_id2, $closeness_code);
      }
    $alter_id1++;
  #}
}
}

############################
## INSERT INTO THE ALTER NETWORK TABLE
############################
sub insert_alter_network_table{
  # This subroutine does the actual insert into the alter network table. It accepts 4 arguments.

  my ($gp_id, $alter_id1, $alter_id2, $closeness_code) = @_;   # Arguments: 4 items to be inserted
  my ($insert_handle);

  $insert_handle = $global::dbh->prepare_cached('INSERT INTO gp VALUES (?, ?, ?, ?)');
  die "Couldn't prepare SQL statements; aborting" unless defined $insert_handle;

  $insert_handle->execute($gp_id, $alter_id1, $alter_id2, $closeness_code) or return 0;
  return 1;                       # Denotes successful insert. 0 is unsuccessful.
}

############################
## DISCONNECT DATABASE
############################
sub disconnect_db{
  $global::dbh->disconnect;
}

############################
## MAIN MOTHER FUNCTION
############################
# THE ORDER OF THE INSERTIONS ARE VERY VERY IMPORTANT!
# ALWAYS DO:
#        0. Connect Database
#        1. Insert gp table (&prepare_n_insert_gp_table)
#        2. Insert into gp_network table (&prepare_n_insert_gp_network_table)
#        3. Insert into alter_network table
#        4. Insert into ict_use table
#        5. Insert into medical_attitude table
&connect_db;
#&retrieve_db;
#&prepare_n_insert_gp_table;
#&prepare_n_insert_gp_network_table;
&prepare_n_insert_alter_network_table;
&disconnect_db;



############################
#A routine to test random
############################
#while (){
#my $rand_num = &generate_rand( 2, (20-15));
#print "Random number is $rand_num \n";
##print "Random number is ",&generate_rand( 1, 1),"\n";
#sleep 1;
#}
```

```
# Author:       Kenneth Chung
# Date:         20th November 2006
# Program:      getnet.pl
# Usage:        getnet.pl <debug_level>
#               where debug level 1=ON, 0=OFF
# Description:  getnet.pl is a script that will retrieve basic network data from the database and
convert into a
#               UCINET/Netdraw friendly format (i.e. VNA) file. The vna files will then be used by
the make_em.bat script
#               for computing the ego measures. The script will also output a text file based on
the calculate_density
#               subroutine containting gp_id, density values.
# Version:      0.2
# Notes:        Variables to look out for when running the script:
#               1. $global::debug (1=ON, 0=OFF)
#               2. $DB variables like user, password, database name
#               3. Output files such as density and vna files
#               4. Ensure that the directores in 3 are already created
# Revision:     21/11/06:
#               1. Modified the make_vna routine to exclude ties with closeness = 5 or 0.
#               2. Also modified the calculate_density routine to reflect this.
#               3. Script execution found illegal division by zero where no of alter ties = 0 for
density calculation. Fixed.
#               09/02/07:
#               4. Modified the calculate density routine to incorporate symmetric ties (i.e.
2*t))

#!D:\Perl\bin\

### TO DO ###
#1. Check the populate_v2.pl file and include in the insert_alter_network routine a chance for
non-insertion
# when random closeness code is 0.- DONE!
#2. Code for density calculation - DONE!
#3. Insert data into the gp_network table - DONE!

use DBI;
use strict;
use warnings;

$global::debug = 0;                                          # debug level: 1=ON, 0=OFF
#$global::n = 10;                                            # The sample size (or number) of GPs to
be populated
#$global::row;                                               # var to hold the row from sql output
#$global::sth;                                               # var to hold the sql statement handler
#$global::file=;                                             # var to hold the output file name
#$global::query;                                             # var to hold SQL query


#print "(Number of Argument(s) is(are): $#ARGV)\n";
if($#ARGV == 0 && $ARGV[0] == 1){                            # If there is only 1 argument of value 1
then
  $global::debug = 1;                                        # turn DEBUG info on.
  #print "Yo Debug value is $global::debug\n";
}


############################
## CONNECT TO THE DATABASE
############################
sub connect_db{
  my $db = "gpdb_v3";
  my $user = "root";
  my $passwd = "root";
  my $dbpath = "DBI:mysql:database=$db:host=localhost:3306";
  $global::dbh = DBI->connect($dbpath, "$user", "$passwd")  # I used $global to make the dbh
variable global and
       or die "Can't open database: $DBI::errstr\n";        # I don't know why but it works!
$global can be anything.
       print "Yea man! Successfully connected!", "\n";
}

############################
## RETRIEVE THE GP & ALTER NETWORK & CLOSENESS VALUES
############################
sub retrieve_db{
  my $sql = @_;
  $global::sth = $global::dbh->prepare_cached("@_");
  $global::sth->execute
     or die "SQL Error: $DBI::errstr\n";
#  @global::row = $global::sth->fetchrow_array;
#  return @global::row;
#  my $i = 0;
#  while ( my @row = $sth->fetchrow_array ) {
#    print "@row\n";                          # Give me the entire contents of the array
#    chomp(@row);                             # Remove all new line characters from every elemet
in array
```

```
#    print "Item $i in array is: $row[0], $row[9]\n"; # I also noted that
                                                     # there is no difference between the scalar
operator $row[0]
                                                     # and the array operator @row[0]
    #$i++;
#  }
#  $global::sth->finish;                                  # Hello SQL, I'm done retrieving you.
}

##########################
## DISCONNECT DATABASE
##########################
sub disconnect_db{
  $global::dbh->disconnect;
}

##########################
## Make VNA file - including ego for calculating structural hole measures
## This method accepts an argument (the last gp_id in the alter_network table)
## to effectively limit the number of vna_files to make. i.e. if the argv is 5, then
## vna files for gp_id from 1 to 5 (inclusive) is made. The file name is gp_n.vna where n is the
gp_id.
## Call usage: &make_vna($last_gp_id)
##########################
sub make_vna{
  # DO A LOOP HERE TO GET MEASURES UNTIL LAST GP ID, which is also the file name.
  my ($last_gp_id) = @_;                 # We want the file name to be gp_id where id is the ID
  print "Last gp id was $last_gp_id but now changed to";
  print "$last_gp_id\n";

  for(my $current_gp_id=1; $current_gp_id<=$last_gp_id; $current_gp_id++){
    my $query="SELECT * FROM alter_network WHERE gp_id=$current_gp_id";
  #  my $query="SELECT * FROM alter_network WHERE gp_id=$id LIMIT 1";
    &retrieve_db("$query");
    my $file="D:\\PhD\\Data Collection\\gpdb_v3_output\\vna\\gp_$current_gp_id.vna";
    open(VNAFILE, ">$file") || die "Cannot open newfile: $!\n";
    print "*tie data \nfrom to closeness\n";
    print VNAFILE "*tie data\nfrom to closeness\n";
    while ( @global::row = $global::sth->fetchrow_array ) {
      chomp(@global::row);                               # Remove all new line characters from every
element in array
      ## The below if condition checks for whether closeness = 0 (meaning left blank) or 5
(meaning alters do not
      ## know each other. In these cases, discard entry as a tie in the vna file.
      if (($global::row[3]) != 5 && ($global::row[3]) != 0){
        print "$global::row[1] $global::row[2] $global::row[3]\n";
        print VNAFILE "$global::row[1] $global::row[2] $global::row[3]\n";
      }
    }
    $global::sth->finish;                                  # Do I need this here?

    ## Now, we need to retrive the GP ID (ego) and the alters and the closeness code for
structural hole measures
    ## and append it to the VNA file. The gp_id will be represented by node 99 to denote the ego
node!
    $query="SELECT gp_id, alter_id, c4_closeness_code FROM gp_network where
gp_id=$current_gp_id;";
    &retrieve_db("$query");
    while ( @global::row = $global::sth->fetchrow_array ) {
      chomp(@global::row);
      ## Here, even if closeness code is 0 (meaning User forgot to enter value or left blank), we
still consider
      ## the entry as a tie. The very fact that the gp has elicited the alter means there is a tie
at the very least.
      print "99 $global::row[1] $global::row[2]\n";
      print VNAFILE "99 $global::row[1] $global::row[2]\n";
    }

    $global::sth->finish;                                  # Hello SQL, I'm done retrieving you.
    close VNAFILE;
    &calculate_density($current_gp_id);
  }
}

##########################
## GET NUMBER OF GPs in ALTER NETWORK TABLE
##########################
sub get_last_gp_id_from_alter_table{
  $global::query="SELECT DISTINCT gp_id FROM alter_network ORDER BY gp_id DESC LIMIT 1";
  &retrieve_db("$global::query");
  my @row = $global::sth->fetchrow_array;
  chomp(@row);
  my $last_gp_id = $row[0];
#  print "GP Count is: $gp_count";
  $global::sth->finish;                                # Hello SQL, I'm done retrieving you.
  return $last_gp_id;
}
```

```
##########################
## GET DENSITY of GP NETWORK
## This subroutine gets the density measure for the GP network but exludes the GP (ego) node in
the calculation. This is
## as according to McCarty's paper on whether to include or exclude ego in the calculation. The
routine accepts an argument
## which is gp_id for retrieving the number of nodes(n), and number of ties(t). Density is then
calculated as t/n(n-1)
## preserving the directionality of the ties.
## Call usage: &calculate_density($gp_id)
##########################
sub calculate_density{
  my ($gp_id)=@_;
  # get the number of ties.
  print "GP id is now: $gp_id\n";
  ## We exclude ties of closeness code = 5 or 0
  my $query="SELECT COUNT(gp_id) as no_of_ties FROM alter_network WHERE gp_id=$gp_id AND
closeness_code<>5 AND closeness_code<>0";
  &retrieve_db("$query");
  my @ties = $global::sth->fetchrow_array;
  chomp(@ties);
  print "Number of ties are: @ties\n";

  # get the number of nodes.
  $query="SELECT COUNT(alter_id) as no_of_nodes FROM gp_network WHERE gp_id=$gp_id";
  &retrieve_db("$query");
  my @nodes = $global::sth->fetchrow_array;
  chomp(@nodes);
  print "Number of nodes are: @nodes\n";

  my $file="D:\\PhD\\Data Collection\\gpdb_v3_output\\density\\density.txt";
  open(DENSITYFILE, ">>$file") || die "Cannot open newfile: $!\n";
  if (($ties[0]) == 0){        ## Sometimes there are no alters or only one alter specified so
there are no ties
    my $density = "0.0000";
    print DENSITYFILE "$gp_id, $density\n";
    return $density;
  }
  else {
    my $density = sprintf "%.4f", (2*($ties[0]))/(($nodes[0])*($nodes[0] - 1));
    print "Density is $density\n";
    $global::sth->finish;                              # Hello SQL, I'm done retrieving you.
    print DENSITYFILE "$gp_id, $density\n";
    return $density;
  }
}



##########################
## MAIN MOTHER FUNCTION
##########################
&connect_db;
## Get the last gp id and from gp id =1 to gp id = last gp id, make the vna files
my $last_gp_id = &get_last_gp_id_from_alter_table;
#$last_gp_id = 500;                # For Testing
print "Last gp_id is: $last_gp_id\n";
system("del \"D:\\Phd\\Data Collection\\gpdb_v3_output\\density\\density.txt\"");
&make_vna($last_gp_id);
#&calculate_density(1);
#system("cd \"D:\\Phd\\Data Collection\\Simulation Outputs\"");
#system("\"c:\\Program Files\\Ucinet 6\\netdraw.exe\" batch batch.txt");
&disconnect_db;
```

APPENDIX I: Endorsement Letter for Survey

NORTHERN RIVERS
University Department of Rural Health

Dear Colleague,

I'm sure that you hate filling in surveys as much as I do, so I'd like to explain why I think you should consider doing this one.

One of the defining aspects of rural practice is that you work in areas that do not have the full range of clinicians to support you locally.

This professional isolation appears quite daunting to many incoming doctors, and hampers our ability to recruit and retain workforce.

Yet by working in these areas, we have each developed our own networks and our own ways of communicating with other service providers who may be quite geographically distant.

If the "who" and the "how" of what we do can be better defined, the information can be used in two ways: to help new colleagues commence rural practice with their networks already established, and to lobby governments for funding to support the infrastructure we need.

All the usual confidentiality rules will be adhered to, and the results of what is found will be communicated back to us.

So please take the time before you finish work today to describe what it is that works for you; and in doing so you might be helping to recruit your successor!

Kind regards,

Dr Sue Page
Director
Medical Education Collaborative

A joint venture of the University of Sydney and Southern Cross University supported by the Australian Government Department of Health and Ageing and the North Coast Area Health Service

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