MANAGING INTERNAL KNOWLEDGE SHARING:

A KNOWLEDGE LIFE CYCLE PERSPECTIVE

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To my parents

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Summary

As firms try to leverage their knowledge as a source of sustainable competitive advantage, many see the need to manage their knowledge effectively. One crucial aspect of knowledge management is how firms can effectively share knowledge internally. This thesis aims to provide new insights by adopting a knowledge life cycle perspective in examining firm internal knowledge sharing.

By analysing extant knowledge sharing literature, a theoretical framework incorporating the knowledge life cycle is developed to examine internal knowledge sharing. The stages of the knowledge life cycle are used as a method to meaningfully group knowledge characteristics, which are the independent variables of this study. The way firms manage internal knowledge sharing form the dependent variables.

The data for this study were collected from four IT-related firms located in Singapore and Malaysia. The four firms are highly knowledge-intensive with knowledge covering the stages of the knowledge life cycle. The research methodology is based on the case study approach where in-depth interviews with respondents from the firms were used as the main data collection method. Data are collected from the firms regarding the nature of their knowledge and the knowledge sharing approaches they use. The nature of a firm's knowledge is used to classify that knowledge into one of the three stages of the knowledge life cycle: Creation, Mobilisation and Diffusion, and Commoditisation. Knowledge sharing activities examined includes how the firms use their informal knowledge systems, information technology systems, and human resource management.

The results suggest that the underlying characteristics of knowledge being shared are the determinants of the knowledge sharing approaches adopted by the firms. Furthermore, the stages of a firm's knowledge, being used as a grouping of knowledge characteristics, should therefore determine distinct sets of knowledge sharing approaches. The results validate this claim. The findings of this study also provide a guiding framework for practitioners to make decisions about managing knowledge sharing based on the stage of their firm knowledge in the knowledge life cycle. These findings contribute new insights to the knowledge sharing discourse. The knowledge life cycle model for examining knowledge sharing is novel to known literature.

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Chapter 1

Introduction

1.1 Background and Motivation for this Study

In the past decade, organisational knowledge has emerged prominently as a source of competitive advantage in the modern economy. Scholars in the fields of strategic management and organisation theory researched extensively on the subject of organisational knowledge. Knowledge in an organisation, they argued convincingly, can be a valuable resource that is able to bring a sustainable competitive advantage to the organisation (Wernerfelt 1984, Grant 1991, Teece et al 1997, Peteraf 1993, Penrose 1995, Barney 1991, Lippman and Rumelt 1982). A lot of attention has been paid to the management of organisational knowledge (for review of literature, see Alavi and Leidner 2001, Huber 1991, Easterby-Smith et al 2000). Yet knowledge management presents difficulties to industrial practitioners (Ruggles 1998).

One issue in knowledge management is knowledge sharing. Organisations recognise that knowledge is a valuable resource, but in almost all instances, their organisational knowledge is not evenly distributed internally. Knowledge as a resource has to be shared within the firm in order for the appropriate individuals or groups within the firm to exploit this resource in order to generate value to the firm. Firms similarly encounter difficulties in knowledge sharing (Szulanski 1996, Kogut and Zander 1992).

On the one hand, we see the apparent importance of organisational knowledge sharing to a firm, and on the other, the attempts in literature to describe and explain the difficulties faced in knowledge sharing. Hence, the first motivation of this study is to further our understanding of how firms can manage knowledge sharing more effectively.

The second motivation for this study relates to the industrial context it examines. The profound economic impact of information technology on modern society has become irreversible. From individuals, organisations, and right up to whole communities and nations, none is spared from the changes brought about by the revolutionary 'knowledge economy'. Everyday lives of individuals are permanently altered through the Internet, and information technology pervades our communication, social interaction,

consumption, work and leisure. Business organisations are also critically affected by the new possibilities due to the advent of the Internet. New product development can be done faster, cheaper and better involving people located across the globe, customer databases can be easily managed to have a more focused approach towards selling, obtaining feedback and providing services, communication allows for reduced inventories, and the traditional rigid bureaucracy of many business organisations can be significantly streamlined. The remote interconnectivity and interactivity provided by the Internet helps to improve business efficiency and productivity (Litan 2001, Oliner and Sichel 2000). These fundamental changes in the new economy that combine information technology and new business practices go beyond the extraordinary failures of many dot.coms and the volatility of technology stock prices. National policies respond to this reality of the importance of knowledge, governments want to achieve the benefits of the new economy, characterised by rapid productivity growth, higher incomes for the citizens, low unemployment and manageable inflation rate. Countries all over the world want to replicate the phenomenal success of Silicon Valley (McGray 1999, Lee et al. 2000).

        One of the realities of the modern economy, fuelled by globalisation and liberalisation, is that firms operate in highly competitive environments. This has, to some degree, forced firms to focus on their most critical resources, which has led to the recognition of the importance of organisational knowledge. The information technology industry, which faces a rapid pace of technological innovation, is obviously one that exerts high competitive pressure on the firms that belong to it. Furthermore, the IT industry is one that epitomises competition on the basis of technological know-how. It is the highly competitive and knowledge intensive nature of the IT industry that motivates this study of knowledge sharing in the IT industry.

        The above rationales form the background and motivations for this study.

1.2 Thesis of Study

        The thesis of this study is that an effective management of how knowledge is shared in a firm should be determined by the nature of the firm's organisational knowledge. Furthermore, this thesis will argue that the stage of the firm's organisational knowledge in the knowledge life cycle, as a framework for organising characteristics of

firm knowledge, should determine how knowledge sharing is managed, adopting a perspective that treats organisational knowledge as dynamic. This is in contrast to the views taken by those who argue that barriers to knowledge sharing are primarily the motivational dispositions (Gupta and Govindarajan 2000), or network positions and structural linkages (Tsai 2001, Hansen 1999, 2002, Reagans and McEvily 2003) of the participants. Although Szulanski (1996) attributed the barriers of internal knowledge transfer to 'internal stickiness' that are largely knowledge-related, and Lam (1997) to the nature of knowledge causing it to be embedded in the knowledge source, they both treat these attributes of organisational knowledge as static.

1.3 Scope of Study

The main objectives of this study are:

a) To determine how IT-related firms manage their internal knowledge sharing.

b) To illustrate what factors determine the firms' approach to managing their internal knowledge sharing.

c) To understand how the firms' approaches to knowledge sharing differ with the stage in the knowledge lifecycle of their knowledge.

This study focuses on the firm-level knowledge sharing within IT related firms. Knowledge sharing is defined as the activity of finding out where knowledge can be found, and transferring the knowledge from the source to the recipient (Hansen 1999). The next section of this chapter provides a normative definition of organisational knowledge. However, for operational purposes to minimise confusion, organisational knowledge in this study can be limited to the firm's ability to leverage the relevant resources to provide an IT solution according to its client's requirements. Providing IT solutions to clients is the common activity that all the firms studied here engage in. Knowledge sharing is studied in the context of an IT firm carrying out projects to provide IT solutions to its clients. How knowledge sharing is managed in these IT firms is examined by looking at the various activities and approaches taken by a firm under the following three broad categories: informal knowledge systems, information technology systems, and human resources. We further narrow down the scope of this thesis by only considering internal knowledge sharing within firms that are single complete independent

operating units. This rules out multi-unit firms where knowledge sharing between the subunits is more akin to interaction with external parties for the firms examined here, and where conflicting organisational interests may come into question. Hence the knowledge sharing studied here takes place mostly between individuals or groups of individuals, possibly across functional delineation, within the firm, and where the organisational level interests can be reasonably assumed to be the same.

Data for this study were collected from three Singapore- and one Malaysia-based firms, all of which are involved in the information technology industry. The firms' knowledge covers the entire spectrum of stages in the knowledge life cycle. This affords the opportunity to analyse the differences in the approaches to managing knowledge sharing for firms with knowledge in different stages of the knowledge life cycle.

1.4 Definitions

A few key constructs are repeatedly referred to throughout this thesis. They are defined below:

- Firm - a collection of productive resources bound together by an administrative framework (Penrose 1995).

- Resources - the assets or inputs into a firm's productive processes (Wernerfelt 1984, Barney 1991, Grant 1991, Amit and Schoemaker 1993, Penrose 1995).

- Knowledge – in the business context, information that is relevant, actionable, and based at least partially on experience (Leonard and Sensiper 1998).

- Organisational Knowledge - an organisation's ability to leverage its resources to extract productive services (Penrose 1995)[1].

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[1] Following the resource-based view of the firm, the definition of the firm by Penrose (1995) as in her original formulation, the firm was intended to mean only industrial firms producing tangible physical products. In this research, the outcome of the firm's productive processes can be either products or services. This definition of organisational knowledge is used because the focus of this study is on the firm's perspective of knowledge. It takes into account the firm's perspective by associating the notion of knowledge to the firm's resources and their productive services, which are universal attributes that all firms possess. The inclusion of the extraction of productive services from resources as the outcome of exercising organisational knowledge can be used as a testing criterion of the definition. Furthermore, the definition of organisational knowledge as the ability to leverage firm resources suggests an action-related conception of knowledge. This serves to distinguish organisational knowledge from the data and information that a firm possesses. Data can be viewed as merely raw facts, and information is the relevant or meaningful data in a particular context. The distinction of knowledge from data or information lies in the associated actions or practices embedded in the notion of knowledge (Kogut and Zander 1992, Nonaka 1994).

- Knowledge Management – the approach to adding or creating value by leveraging the know-how, experience, and judgement inside and outside an organisation.

- Knowledge Sharing – the moving of knowledge from source to recipient and the incorporation of knowledge by recipient (adapted from Hansen 1999)

Chapter 2

Literature Review

2.1 Introduction

In this chapter, literature relevant to this study is reviewed. Research on the management of knowledge brings together diverse fields of study such as philosophy (epistemology), psychology, economics, and within management studies, topics such as competitive dynamics, organisational resources and capabilities, organisational learning, and technology and innovation management. There is a danger that such a varied background will bring confusion to the study of knowledge sharing. To reiterate, the objective of this thesis is to study knowledge sharing in IT firm with organisational knowledge across the stages of the knowledge lifecycle. This literature review will be structured to cover two broad themes: 1) knowledge as a resource to the firm, and 2) the different perspectives on knowledge sharing.

The first section on knowledge resource reviews briefly literature on the resource-based view of the firm, which introduces knowledge into the strategy discourse, and the concept of knowledge and the fundamental perspectives of looking at the concept. This section summarises the characteristics of knowledge that literature highlighted as important to management of knowledge. This literature can be considered as the foundation to knowledge management research.

The second section surveys literature that deals directly with the sharing of organisational knowledge. Knowledge sharing literature is grouped into two broad categories; namely those that posited that the issues in knowledge sharing are predominantly attributable to organisational and structural impediments, and those who advocate that certain nature of knowledge impedes its sharing. This thesis will adopt the second viewpoint, linking it back to characteristics of knowledge reviewed in the first section, and argue that there is a need for an alternative perspective on knowledge sharing within the firm that is dynamic, based on nature of knowledge, and orientated towards how knowledge sharing can be practically managed.

2.2 Literature on Knowledge Resource

In current literature on knowledge management, the importance of organisational knowledge as a strategic resource to a firm has become so widely accepted that it has turned into an implicit assumption of this body of research. This development began in strategy research, which highlighted knowledge as a strategic resource, and led to the recognition of characteristics of knowledge that make it such a resource. This is crucial because this thesis will argue that these characteristics of knowledge have an important effect on knowledge sharing. The ensuing section examines literature that brought knowledge as a resource into the strategy discourse.

2.2.1 Resource-Based View of the Firm

The field of strategic management research has been dominated from the 1960's by the Strengths, Weaknesses, Opportunities and Threats (SWOT) framework of analysis (Andrews 1980, Hofer and Schendel 1978). This organising framework suggests that a firm that is able to devise and implement strategies that match its internal strengths and weaknesses with the opportunities and threats that arise from its environment will enjoy sustained competitive advantages. However, strategy research has shown a tendency to be biased towards either focusing on the environmental opportunities and threats, or the firm's internal strengths and weaknesses. When the focus is on the firm's internal strengths and weaknesses, this perspective of the firm has been described as the resource-based view of the firm.

The resource-based approach to strategic management focuses on the unique attributes of the firm that generate performance and competitive advantage leading to economic rents (Conner 1991). In her 1959 work that explains the growth of firms, regarded by many as seminal to the resource-based perspective (Wernerfelt 1984, Grant 1991, Teece et al 1997, Peteraf 1993), Penrose (1995) defined the firm as a collection of productive resources bound together in an administrative framework. Together with the changes in the environment of the firm, the internal resources of the firm contribute to firm growth. The firm's resources have been defined as inputs into the production process (Penrose 1995, Grant 1991, Amit and Schoemaker 1993) or assets of the firm including machinery, capital, firm attributes, networks, information, organisational

processes, employment of skilled personnel, capabilities, knowledge etc (Wernerfelt 1984, Barney 1991).

Barney (1991) argued that the resource-based view of the firm makes two assumptions in its analysis of competitive advantage. Firstly, this view assumes that strategic resources of firms within an industry may be heterogeneous, and secondly, that these resources may be immobile across firms causing heterogeneity to be persistent. The existence of resource heterogeneity can be attributed to the firm's distinct historical inheritance (Penrose 1995). The persistence of resource heterogeneity across firms, on the other hand, owes to the imperfections in the resource markets such that not all resources can be bought and sold efficiently, and the different idiosyncratic choices that managers make about using and developing resources (Amit and Schoemaker 1993).

Resource heterogeneity is the fundamental basis for the assertion by the resource-based view of the firm that firm resources can account for the differential performance of firms (Lippman and Rumelt 1982). In general, the more contemporary literature on the resource-based view of the firm has been preoccupied with specifying the conditions under which firm resources are able to generate sustainable competitive advantage. Barney (1991) suggests that in order for a resource to have the potential to generate sustainable competitive advantage, (1) it must be valuable in that it exploits opportunities or neutralises threats the firm may face, (2) it must be rare among the firm's competition, (3) it must be imperfectly imitable due to any one or more of the following: (a) the unique historical conditions of the firm, (b) causal ambiguity between firm resource and sustained competitive advantage, (c) socially complex resource, and (4) it must not be substitutable (see also Grant 1991, Peteraf 1993). There are also writings of a more prescriptive nature that helped to bring the resource-based perspective to a wider audience by suggesting generic approaches to exploit strategic resources. These works typically include guidelines for identifying and assessing strategic resources within a firm as well as recommendations for exploiting, preserving and further developing these resources (see Grant 1991, Collis and Montgomery 1995). Table 2.1 presents an overview of the literature on the resource-based view of the firm.

Table 2.1: Literature on Resource-based View of the Firm

Author(s)	Key features of the work
Penrose 1995	The firm as a collection of resources. Growth of the firm is explained with reference not only to changes in the environment of the firm but to the internal resources of the firm as well. Heterogeneity across firms due to their historically inherited resources. Knowledge is the ability to extract productive services from available resources. Knowledge is also heterogeneous and highly immobile across firms.
Lippman and Rumelt 1982	Modelled the causal ambiguity in the creation of productive processes. This causal ambiguity can be viewed as the uncertainty to the level of firm efficiency as appears to external observers. This model generated stable inter-firm differences in profitability.
Wernerfelt 1984	Firms are viewed in terms of resources instead of products. Resource immobility introduced in the form of Resource Position Barriers. Identification of types of resources that can lead to high profits. Strategic exploitation and development of resources.
Barney 1991	The relationship between firm resources and sustained competitive advantage is examined. Assumptions of stable and heterogeneously distributed strategic resources across firms are made. Strategic resources that are valuable, rare, inimitable, and not substitutable are able to generate sustained competitive advantage.
Conner 1991	Comparison of the resource-based approach to strategic management to five schools of thought within industrial organisation economics, namely the neoclassical theory's perfect competition model, the Bain-type industrial organisation, the Schumpeterian response, the Chicago response and transaction cost theory. It was concluded that in comparison to its industrial organisation predecessors, resource-based theory comprises a new theory of the firm.
Grant 1991	Formulation of firm strategy by considering its resources and capabilities. The identification of firm resources. The identification and evaluation of firm capabilities. Evaluation of rent-earning potential of capabilities in terms of their sustainability and appropriability. Strategy formulation involves exploiting resources and capabilities, as well as identifying resource gaps and developing the resource base.

Table 2.1: Continued

Author(s)	Key features of the work
Peteraf 1993	Proposed a model that specifies the conditions that must be met for a firm to achieve sustained competitive advantage. These conditions are 1) heterogeneity of resources, 2) ex post limits to competition in the form of imperfect imitability and imperfect substitutability of resources, 3) imperfect mobility of resources, and 4) ex ante limits to competition where a firm is able to initially generate rents that are not offset by costs. Application of the model to single business strategy and corporate strategy.
Amit and Schoemaker 1993	Firms control heterogeneous resources and capabilities because of 1) imperfections in the resource market, and 2) discretionary managerial decisions about resource development and deployment. Asymmetry in firm resources and capabilities can be a source of sustainable economic rent. Environmental market conditions in the concept of Strategic Industry Factors are matched with internal resources in the notion of Strategic Assets.
Collis and Montgomery 1995	A firm's resources are competitively valuable when they are 1) inimitable, 2) durable, 3) appropriable to the firm, 4) not substitutable, and 5) competitively superior. Strategic implications to the firm are that it must invest in, upgrade and leverage its resources.

2.2.2 Characteristics of Knowledge as Resource

The notion of organisational knowledge has been closely linked to the resource-based view of the firm. Penrose (1995) defined knowledge of a firm as its ability to extract productive services from available resources. She characterised the growth of a firm as "essentially an evolutionary process and (is) based on the cumulative growth of collective knowledge." In this section, the different perspectives on knowledge are examined. It will be shown that some types of knowledge have characteristics that match the conditions required of resources in order for them to generate sustainable competitive advantage. The literature establishes organisational knowledge as strategic firm resource. This thesis will argue that, in addition to providing the conditions to generate sustainable competitive advantage, characteristics of knowledge also have an important impact on

how knowledge sharing should be managed in a firm. Hence, it is necessary to review what strategy literature has to offer as the originating field from which the importance of characteristics of knowledge first grew. We synthesise the various taxonomic dimensions proposed by strategy literature originally intended to further our understanding of a knowledge resource and its strategic significance, and present them in the following figure.

Tacit --Articulable Unteachable --Teachable Unarticulated --- Articulated
Not Observable in Use --- Observable in Use Non-transferable --- Transferable Non-replicable ---Replicable
Complex -- Simple
Embedded in a System --- Independent
Organisational --- Individual
Useful --- Not Useful
Rare -- Common
Imitable -- Inimitable Historically Unique ------------------------------- Not Historically Unique Causally Ambiguous ------------------------------- Causally Unambiguous Socially Complex -- Socially Simple
Substitutable --- Unsubstitutable

Figure 2.1: Taxonomic Dimensions of Organisational Knowledge (adapted from Barney 1991, Winter 1987, Kogut and Zander 1992, Brown and Duguid 1998)

Some of these dimensions are closely related to one another, for example, whether a knowledge resource is observable in use, or whether it is complex, is closely related to whether it is easily imitable. We focus our discussion primarily on two representative dimensions that are relatively independent and that have theoretical significance to knowledge sharing.

2.2.2.1 Individual vs. Organisational Knowledge

It is apparent to all of us that each individual person has some knowledge within him/herself that can be easily demonstrated through simple everyday activities. This type of knowledge is individual knowledge that can be found in the physical person. In contrast to the notion of individual knowledge is the subtler concept of organisational knowledge. It is less obvious because there is no physical entity that organisational knowledge can be attributed to. The basic building block of organisational knowledge is the individual knowledge of the organisation's members. There can be no organisational knowledge without the individuals within which knowledge is resident. Grant (1996b) quoted Simon (1991), who observed, "All learning takes place inside individual human heads; an organisation learns in only two ways: (a) by the learning of its members, or (b) by ingesting new members who have knowledge the organisation didn't previously have", as a warning against the over-emphasis of the organisation as an entity that produces, stores and applies knowledge to the detriment of the processes at the individual level where individuals engage in these knowledge activities.

Keeping in mind the importance of the individual-level processes of knowledge activities, it must be noted, however, that organisations are not merely the additive summation of a multiplicity of individuals as vessels of knowledge. Nonaka (1991) suggested that, "A company is not a machine but a living organism. Much like an individual, it can have a collective sense of identity and fundamental purpose". Nelson and Winter (1982) took a similar organic view of companies in 'An Evolutionary Theory of Economic Change'. They argued that as firms interact with their external economic environment, they would adapt and thus evolve by selection of applicable knowledge, and embedding it in organisational routines for future use. Implicit in this model of the firm is the notion that organisational knowledge as stored in routines is extrarational to the individuals in the firm, the firm itself acquires routines through learning, independent of the conscious reasoning of the individuals (Spender 1996). Kogut and Zander (1992) posit that organisational knowledge is created and applied in a particular context, which is social and provided by the organisation, and the knowledge thus created is not fully reducible to individuals because it is due to the combinative capabilities of the business organisation.

Organisational knowledge as a type, characterised above, can potentially bring about competitive advantage. It is likely to be imperfectly imitable by other organisations due to it being embedded in the unique social context of the organisation and hence has a unique history, is causally ambiguous with respect to its contribution to competitive advantage, and is socially complex. These same reasons that prevent imitation also highlight the implications that organisational, as opposed to individual, knowledge has on a firm's ability to share knowledge. Organisational knowledge therefore may not be easily replicated or shared even if it is internally within the same firm.

2.2.2.2 Tacit vs. Explicit Knowledge

Knowledge management literature has often emphasised an important property of how tacit or explicit a particular knowledge is. On one extreme of this continuum is explicit knowledge that is fully articulated, codified, structured and accessible to others through symbolic communication (Winter 1987, Leonard and Sensiper 1998). Examples of explicit knowledge are blueprints, formulas, and program codes (Teece 1998). On the other end is tacit knowledge, which is difficult to articulate in a way that is meaningful and complete (Teece 1998). Polanyi (1967) famously said, about tacit knowledge, "We know more than we can tell".

The tacitness of a piece of knowledge is attributed to the teaching and learning of the knowledge and to the limitations of verbal communication (Nelson and Winter 1982). The teaching and learning of tacit knowledge usually does not involve the verbalisation of the basis of the skill. Both the teacher and the student may not know the key principles involved in the skill. Verbal instruction comes in the form of correcting the performance of the skill. There is a heavy reliance on illustration by the instructor and imitation by the student.

Nonaka (1991) explained that the strength of Japanese innovation lies in their use of "the tacit and often highly subjective insights, intuitions, and hunches of individual employees and making those insights available for testing and use by the company as a whole". But the above is not easily achievable. While explicit or codified knowledge is easily transmittable in formal, systematic language, tacit knowledge has a personal quality, which makes it hard to formalise and communicate. Furthermore, tacit

knowledge is embedded in action, commitment and involvement in a specific context (Nonaka 1994).

It has appeared so far that tacit knowledge is only found in individuals. But organisational knowledge can also be tacit. This is due to the tacit knowledge that individuals hold, or due to the organisational knowledge arising from the relationships between individuals, or due to the differing levels of knowledge in the organisation that each individual possesses, such that the knowledge belonging to the organisation as an entity cannot be fully articulated (Winter 1987). Tacit organisational knowledge manifests itself most evidently in the collective and cooperative efforts of individuals as a result of social interaction and synergy (Brown and Duguid 1998).

While explicit knowledge can be easily transmitted at low costs, tacit knowledge is slow and costly to transfer (Teece 1998). On the other hand, the causal ambiguity and social complexity of tacit organisational knowledge makes it hard to be imitated. To the firm, tacit knowledge represents the conflicting problems of knowledge transfer for organic growth and of preventing imitation by others (Winter 1987, Kogut and Zander 1992). As far as internal knowledge sharing is concerned, explicit knowledge can be shared within the firm with relative ease, as compared to tacit knowledge, which will present a greater challenge to the firms that wish to share it internally.

Table 2.2 summarises the key characteristics of the different perspectives on knowledge discussed and their implications on knowledge sharing as well as on generating competitive advantage in the resource-based view.

Table 2.2: Characteristics of Knowledge

References	Perspective	Characteristics/Features	Implications
Grant 1996b, Simon 1991.	Individual knowledge	Individual as physical residence of knowledge. Building block of organisational knowledge. The focal point of knowledge processes.	Mobile across firms as individuals can be employed by other firms
Nelson and Winter 1982, Kogut and Zander 1992, Spender 1996, Brown and Duguid 1998.	Organisational knowledge	More than the sum of members' individual knowledge. Created in the context provided by the organisation. Created by the social interaction of individual members of organisation. Members have common underlying knowledge, sense making, meaning interpretation and worldview.	Possibly imperfectly imitable and difficult to transfer due to unique history, causal ambiguity and social complexity
Polanyi 1967, Nelson and Winter 1982, Winter 1987, Nonaka 1991, 1994, Spender 1996, Leonard and Sensiper 1998, Teece 1998.	Tacit Knowledge	"We know more than we can tell". Difficult to fully articulate. Tacitness is due to the manner knowledge is acquired as well as the limitations of verbal communication. Importance of apprenticeship: teach by showing, learn by doing. Embedded in action. Organisational knowledge often tacit due to social interaction and synergy. Slow and costly to transfer.	Imperfectly imitable and difficult to share due to causal ambiguity
Leonard and Sensiper 1998, Teece 1998.	Explicit knowledge	Articulated, codified and structured. Can be fully communicated to others. Examples: blueprints, formulas, and program codes	Easily replicable and transferred

2.3 Literature on Knowledge Sharing

Strategy research established organisational knowledge as a strategic resource of the firm. Knowledge management literature brought it forward by examining how to identify organisational knowledge that can generate competitive advantage, and how to develop organisational knowledge within the firm (Winter 1987, Prahalad and Hamel 1990, Grant 1991, Amit and Schoemaker 1993, Collis and Montgomery 1995, Zack 1999). In the numerous studies, knowledge sharing was identified as an integral part of knowledge development in a firm. As an example, Nonaka's (1994) model of organisational knowledge creation characterises knowledge creation as resulting from the conversion between tacit and explicit knowledge within the firm, taking place in processes called socialisation, combination, externalisation, and internalisation. The common mechanism underlying all the knowledge conversion processes is knowledge sharing. This line of enquiry proposed generic frameworks for organising a firm to better develop strategic organisational knowledge. In order to facilitate organisational knowledge creation/application and development, in which knowledge sharing is an essential process, some departure from the traditional M-form (multidivisional) organisational structure has been recommended. A hierarchical structure is thought to impede the focus on knowledge creation. Orientation around temporary teams or groups, more emphasis on lower level decision making and facilitating role of top management, and lateral communication are the attributes of the organisational structure that encourage knowledge creation (Nonaka 1991, 1994, Hedlund 1994, Grant 1996a, 1996b, Quinn et al 1996).

However, knowledge sharing as a process was examined more closely by scholars who studied the problems of knowledge transfer within as well as between firms in joint ventures, multinational companies, and transfers of best practices. The literature is reviewed in the following two sections, by grouping those who identified the problems of knowledge sharing as organisational and structural, and those who concluded that the problems lie with the inherent nature of the knowledge to be shared. Following the critique made of the extant literature in these two sections, in a third section, an alternative perspective is proposed to extend existing literature.

2.3.1 Organisational and Structural Impediments to Knowledge Sharing

This group of literature is grounded theoretically in communication and network theory. The scholars perceive the problems of knowledge sharing to be arising from organisational and structural impediments to communication in knowledge networks. Gupta and Govindarajan (2000) examined knowledge flows between subsidiaries of multinational corporations and argued that the determinants of knowledge transfer within multinational corporations are: 1) the value of the source's knowledge stock, 2) it's motivational disposition to share knowledge, 3) the richness of transmission channels, 4) the recipient's motivational disposition to acquire knowledge, and 5) its capacity to absorb the knowledge being shared. Although grounded basically in communication theory, Gupta and Govindarajan's (2000) work recognised in point 5) above that the nature of the underlying knowledge being transferred determines to some extent how much knowledge flows. The idea of overlapping knowledge being more easily absorbed was conceptualised by Cohen and Levinthal (1990) in the notion of "absorptive capacity", defined as an organisation's ability to recognise value of new information, assimilate and apply it.

Several studies also focused on knowledge transfer in multiunit companies, but with a focus on the firm's knowledge network. Hansen (1999) studied 120 new product development projects in a multiunit company to understand how the strength of inter-unit tie and complexity of knowledge to be shared affect the completion time of those projects. Knowledge sharing was defined as a two-part process involving the search for the appropriate knowledge, and the transfer of that knowledge from the source unit to the recipient unit. The main conclusion was that tie strength does not significantly affect efficiency of knowledge sharing. The project completion time of units with either strong or weak inter-unit ties is, however, contingent on the complexity of the knowledge to be transferred. Strong inter-unit ties are associated with faster project completion time when the knowledge transferred is highly complex, and weak ties are associated with faster project completion time when the knowledge transferred is not complex. It was argued that weak ties facilitate search for knowledge but impede transfer of complex knowledge.

Hansen (2002) furthered the analysis on his data, and found that network relations, measured by path lengths in the knowledge network, or extent of related

knowledge by themselves is not sufficient to explain the amount of knowledge that gets transferred and the time it takes to complete the project. It was shown that projects in a unit acquired more knowledge from other subunits and completed its projects in shorter times when the inter-unit path lengths were short and the knowledge transferred is related to the unit's knowledge. Again, a characteristic of knowledge showed a contingent effect on direct inter-unit relations in the knowledge network: transfer of tacit knowledge was shown to be facilitated by direct relations, but they had a negative impact when the knowledge to be transferred is codified.

In addition to Hansen's (1999, 2002) studies of tie strength and network relations, Reagans and McEvily (2003) further considered social cohesion and network range in informal knowledge networks and their effects on ease of knowledge transfer by collecting data from a contract R&D firm. They referred to cohesion as the extent to which a relationship is surrounded by strong third-party connections (network density), and range as the extent to which network connections span institutional, organisational, or social boundaries (network diversity). They argued that network structure in terms of cohesion and range offered a deeper understanding of knowledge transfer by clarifying the role of tie strength in knowledge transfer. The main conclusion was that cohesion and range ease knowledge transfer and that the extent to which they do so is over and above the positive effects of tie strength.

Another approach to studying knowledge sharing in a knowledge network is to look at a unit's position within its knowledge network. Tsai (2001) examined 60 subunits in two multiunit companies and argued that a unit's central network position provides better access to other unit's knowledge and enables it to achieve more innovations and produce better performance. His results, however, again showed that the above depends on the unit's absorptive capacity, a function of the unit's existing knowledge.

This group of literature made significant contributions to our understanding of knowledge sharing by adopting perspectives that emphasised the motivational, relational, or positional factors within the knowledge network and their effects on knowledge sharing. However, some issues can be raised about this body of work in relation to the intents of this thesis.

First, most of the studies surveyed in this section were carried out in large multi-unit companies (with the exception of Reagans and McEvily 2003). The knowledge network in question is a collection of these subunits linked by their knowledge relations. The intention of this thesis is to study internal knowledge sharing within a firm. The problem with multi-unit companies is that the subunits are essentially operated as independent businesses responsible for their own performance. In many ways, the knowledge sharing of more direct interest to this study is intra-unit and not inter-unit knowledge sharing. This critical distinction may lead to different focus when looking at knowledge sharing. For example, one might expect that motivational disposition may be less of an impediment to intra-unit knowledge sharing, as members within the same subunit are more likely to have aligned interests.

Second, the question of what constitutes effective knowledge sharing was not clearly and convincingly addressed. Tsai (2001) inferred knowledge transfer from the level of innovation and performance in a business unit. The network structure, in Tsai's (2001) case, the business unit's network position, was shown to have an effect on innovation and performance. It was assumed that knowledge transfer was the causal mechanism linking the network structure to innovation and profitability. What seems to be missing is the linkage between network position and knowledge transfer. Hansen (1999, 2002) made similar assumptions by arguing that tie strength and network relations have an effect on the completion time of new product development projects. Another approach was to use the amount of knowledge transfer as the dependent variable (Hansen 2002), or in Gupta and Govindarajan's (2000) terminology, the amount of knowledge inflows and outflows to and from a subunit. The implicit assumption appears to be that it is desirable to the organisation to have as large as possible the amount of knowledge transferred or that in the cases considered, the maximum desirable amount of knowledge to be transferred is known and has not been exceeded. Both assumptions are not likely to be valid, given that efforts to transfer knowledge represents a cost to the organisation, and an overload of knowledge may have negative impact.

Third, this body of work does not enlighten us about the knowledge sharing process itself. This is inherent in the research methodology common to all the studies surveyed here, that is one that uses quantitative data to show relationships between

constructs.   The understanding of the mechanism of knowledge sharing, consisting of how knowledge is transferred and why it is shared in a particular manner, is required to formulate a strategy to manage knowledge sharing in a firm.   In the studies mentioned, the mechanism of knowledge sharing is embedded in the assumptions, explicit or otherwise, that were made in their theoretical frameworks. Hence the recommendations on how to manage knowledge sharing tend to be re-statements of the desired outcome without being able to illustrate how to organise towards that end.   For example, Tsai (2001) is able to recommend that a subunit should try to occupy a central network position in order to be more innovative but is silent on how that subunit can organise itself to achieve network centrality.   Another example is Hansen's (1999) recommendation that subunits invest in improving tie strength with another subunit if the knowledge to be transferred is complex.   The unanswered question really is: How does a subunit organise itself to improve tie strength with another subunit?

Fourth, the properties of the knowledge being shared may have more significant effects on knowledge sharing than motivational factors or network structure.   As discussed earlier, the context of multi-unit companies may be the reason why these studies chose to focus on network structure's effects on knowledge sharing.   The studies themselves have acknowledged the contingent effects of certain properties of the knowledge content being shared.   Complexity of the shared knowledge (Hansen 1999), the subunit's absorptive capacity (Tsai 2001, Gupta and Govindarajan 2000), or the extent that subunits have common knowledge (Hansen 2002) were shown to mediate the effects of network structure on knowledge sharing.   The following section will review literature that focuses on effects of characteristics of knowledge on knowledge sharing.

2.3.2 Nature of Knowledge as Impediments to Knowledge Sharing

In this section, an extremely diverse body of work, in terms of methodology and research focus, is reviewed.   All of them arriving at the conclusion that some characteristics of the knowledge being transferred that are the most important factors impacting on effective knowledge sharing.

In an attempt to explain why firms exist, Kogut and Zander (1992) took the view that firms are repositories of capabilities, and that organisational knowledge is embedded in the organising principles that bind the people of an organisation.   In order for the firm

to grow, it needs to replicate its knowledge, but at the same time, efforts to make knowledge easily replicable expose the firm to the risks of being imitated. Kogut and Zander highlighted that the difficulty of replication and imitation lies in the characteristics of knowledge. They argued that the more resistant to codification, the more complex, and the more organisational the knowledge, the more difficult it is to replicate and imitate.

Szulanski (1996) analysed empirically the difficulties of internal transfer of best practice, what he termed internal stickiness, by looking at data obtained from 122 best practice transfer events in eight US companies. He considered a host of probable factors that can give rise to internal stickiness, including characteristics of knowledge like causal ambiguity and unprovenness, as well as other characteristics like motivation and perception of reliability of the source, motivation, absorptive capacity, and retentive capacity of the recipient, and favourable context, and ardour of relationship between the source and recipient. His results indicate that the lack of absorptive capacity of the recipient, causal ambiguity, and an arduous relationship between the source and the recipient are the three most important causes of internal stickiness. This is in contrast to prior research that emphasised mainly motivational factors that impede knowledge sharing. The most important contribution of this work is the empirically validated identification of origins of internal stickiness. Szulanski went on to use his results to suggest that firms will do better if they focus their resources on developing their internal learning capacities, build closer relationships between the relevant internal parties, and approach the understanding of organisational practices more systematically to reduce causal ambiguity.

Rivkin (2001) refined the enquiry on replication of knowledge and the effect of complexity of knowledge by running a simulation of knowledge replication and imitation processes. He demonstrated, based on the simulation results, that at moderate levels of complexity, knowledge can be more easily replicated than it can be imitated. Rivkin's logic was that at low levels of complexity, the imitator catches up very quickly with the replicator's knowledge advantage. At high levels of complexity, the success of acquiring the knowledge is sensitive to small initial errors such that the replicator's slightly superior knowledge does not offer an advantage over the imitator. At moderate levels of

complexity, it was argued that the replicator's imperfect knowledge offers sufficient guidance for it to make good decisions, giving advantage over the imitator.

Using the idea of embedded knowledge, Lam (1997) explored the difficulties of knowledge transfer and general collaboration in a cross-cultural high-tech venture. Based on a case study of the collaborative venture between a Japanese and British electronics firm, Lam illustrated that the Japanese partner operated using what she called an 'organisational model' while the British partner adopted the 'professional model'. The organisational model was seen to have engineers with 'knowledge of experience', which was highly tacit and acquired from long period of on-the-job training. Product development teams were organised with overlapping and flexible roles, and the knowledge structure is diffused and decentralised. Knowledge is stored in the team relationships and routines, coordinated and transferred via constant exchanges between members and networking. In stark contrast, the professional model was described as having engineers with 'knowledge of rationality' characterised by expertise based on theoretical knowledge acquired from formal training. Product development is organised in a sequential, task-specific, and hierarchical manner, with clear specialised roles and demarcation of functions. Knowledge resides in individual specialists in different functions, and is coordinated by the use of detailed documentation. In essence, knowledge is seen to be more embedded in the organisation of the Japanese partner. The differences contributed to poor project performance, compromised the technological relationship between the partners, and caused asymmetry of knowledge transfer.

Some concerns need to be raised about the literature reviewed in this section. First, the importance of characteristics of knowledge on knowledge sharing emerged from the above literature even though each study has its own perspective or emphasis on knowledge sharing. The properties of the knowledge being shared themselves have not received systematic treatment in terms of their effects on knowledge sharing. As we have seen, Rivkin (2001) only considered complexity of knowledge, Szulanski (1996) meanwhile, identified knowledge related factors out of many other probable factors, and Kogut and Zander's (1992) main concern was to illustrate the higher organising principles in firms that enable them to replicate knowledge without being imitated despite the characteristics of knowledge that make replication difficult. Lam's (1997) research is

interesting in that it offered a rich illustration of characteristics of knowledge and how these properties became a problem for knowledge sharing, but ended up with the conclusion that the difference in the partners' knowledge embeddedness was attributable primarily to the national culture and societal settings of the partners. The role of knowledge embeddedness on its own should have been given greater prominence as far as this thesis is concerned. It is speculated here that knowledge embeddedness might have been given more weight had Lam chosen a multiple-case instead of a single case study approach, controlling for the effects of national culture. For example, by studying a few cases of Japanese firms and how knowledge embeddedness differs in them, and how knowledge sharing is affected by it.

Second, all the works reviewed have a common approach of framing the issues of knowledge sharing in terms of barriers and impediments to knowledge sharing. This is unfortunate. Framed in the negative, the findings of these studies can possibly inform practitioners about what to avoid. But is merely removing barriers and impediments to knowledge sharing sufficient for practitioners to achieve effective knowledge sharing?

Third, following from the preceding comment, it is apparent that the literature only served to highlight the salient relationships between characteristics of knowledge and knowledge sharing according to the particular perspective adopted by the individual studies. This may be the theoretical intent of the different research, and that is fine in itself. However, together with the issues being framed as barriers and impediments to knowledge sharing, the literature is not able to provide a satisfactory framework to guide practitioners on how to manage knowledge sharing effectively. The researchers, as a whole, seem to have identified important issues in knowledge sharing but have not been able to integrate these issues and frame the problem in a manner that helps practitioners manage knowledge sharing.

Fourth, the possible variation of characteristics of knowledge across different context, or over time, was not addressed by extant knowledge sharing literature. Lam's (1997) work is particularly telling in this regard. She adopted a single-case case-study methodology, took a static view of the nature of knowledge in the partners of the venture, and concluded that the difference in knowledge embeddedness between the partners is due to national culture. A more dynamic perspective on the characteristics of knowledge

may lead to a conclusion that is centred more around the characteristics of knowledge themselves as determinant of knowledge sharing.

2.3.3 An Alternative Perspective on Knowledge Sharing

Existing literature on knowledge sharing has been reviewed in the previous two sections. We arrive at the conclusion that the characteristics of knowledge are powerful factors affecting effective knowledge sharing. However, a few weaknesses have been identified in the literature reviewed, and they are summarised as the following. There is a lack of a systematic approach to using characteristics of knowledge as a set of factors to study knowledge sharing. The problem of knowledge sharing is framed negatively in terms of barriers and impediments. Characteristics of knowledge are treated as static variables. There is no guidance for practitioners in terms of an integrated management approach on how to effectively organise knowledge sharing.

An alternative perspective on knowledge sharing based on the underlying nature of knowledge is presented in the following chapter to extend existing knowledge sharing literature and to address the issues identified above. Birkinshaw and Sheehan's (2002) Knowledge Life Cycle Model will be adapted from general knowledge management literature to be applied to the management of knowledge sharing specifically.

2.4 Conclusion

This chapter reviewed the extant knowledge sharing literature. Literature on knowledge resource covered the resource-based view of the firm, and characteristics of knowledge. Knowledge sharing literature with an emphasis on organisational and structural impediments is reviewed, followed by a survey of research on knowledge sharing emphasising nature of knowledge as impediments. Weaknesses were identified in the extant literature and an alternative perspective on knowledge sharing employing the knowledge life cycle model as an integrative framework for organising characteristics of knowledge is proposed to extend the existing literature.

Chapter 3

Theoretical Framework

3.1 Introduction

In this chapter, the theoretical framework used for this study will be outlined in detail. From the literature review in the previous chapter, weaknesses were identified. In this thesis, the knowledge life cycle model, developed by Birkinshaw and Sheehan (2002), will be adapted for examining knowledge sharing in the firms studied. We put forward arguments that the knowledge life cycle model adequately addresses the issues identified in the literature review.

3.2 Knowledge Life Cycle Model

Birkinshaw and Sheehan (2002) studied 16 large companies over a period of five years focusing on their knowledge management practices. The central idea in their work is that knowledge is not static, and hence the strategies employed by firms to manage knowledge cannot follow an undifferentiated solution. They argued that knowledge evolves over time, and that the characteristics of knowledge that changes over time can be used as a guide to formulating knowledge strategies for the firm.

Birkinshaw and Sheehan originally applied a dynamic approach to managing organisational knowledge by introducing the knowledge life cycle model. They argued that at different stages in the life cycle of the firm's knowledge, either in the creation, mobilisation, diffusion, or commoditisation stage, the firm has to decide upon the informal knowledge systems, information technology systems, human resources, and external relationships that best suit the characteristics of organisational knowledge at a particular stage in its cycle. Based on this knowledge life cycle model, Birkinshaw and Sheehan gave a rich description of how the informal knowledge systems, information technology systems, human resources, and external relationships differ across firms with organisational knowledge in the creation, mobilisation, diffusion, or commoditisation stage. These illustrations are clear proof that firms with knowledge in different stages of its life cycle need to adopt different knowledge management strategies.

Table 3.1: Summary of Birkinshaw and Sheehan's (2002) Research

Research Context	Using interviews for 16 case studies on knowledge management practices in large multinational companies
Independent Variables	Stages of the Knowledge Life Cycle: - Creation - Mobilisation - Diffusion - Commoditisation
Dependent Variables	Firm knowledge management practices in terms of tools and techniques used in the following categories: - Informal knowledge systems - Information technology systems - Human resources - External relationships
Conclusions	Implications of results on firm knowledge strategy: 1) A company can not realistically operate in all four stages of the knowledge life cycle 2) A fine balance has to be found between hoarding and sharing knowledge especially for firms that operate between the Mobilisation and Diffusion stages 3) Firms need to be aware and try to avoid the fact that as knowledge goes through its life cycle, the original idea may get corrupted along the way such that its original value is lost.

Birkinshaw and Sheehan's model can be adapted for this thesis due to the following reasons, which addresses the issues earlier in the literature review. The knowledge life cycle part of Birkinshaw and Sheehan's model provides an integrative framework to handle the various characteristics of knowledge. They argued that each stage of the knowledge life cycle is characterised by organisational knowledge exhibiting a common set of properties. And the knowledge life cycle model as a whole essentially describes the change of characteristics of knowledge over time. The life cycle model therefore provides a systematic and meaningful way of grouping characteristics of knowledge with which firms can easily identify their knowledge. The life cycle model is dynamic. In addition, Birkinshaw and Sheehan's model was built with an organising framework for knowledge management. This framework was originally intended to highlight aspects of characteristics of knowledge and their consequences on how knowledge should then be managed. However, knowledge sharing is a fundamental

process that underlies almost every aspect of knowledge activities in organisations (Nonaka 1994). We adopt this framework as the organising framework for managing specifically the internal sharing of knowledge. In section 3.2.2, extant literature on knowledge sharing will be integrated into this modified organising framework. This addresses the issue of managing knowledge sharing, as well as the issue of framing knowledge sharing in a positive manner. This framework is open-ended; hence it does not restrict the exploration of effective knowledge sharing.

The theoretical framework used in this thesis will be based upon the knowledge life cycle model. This model consists of two major components. The first component is the knowledge life cycle. The knowledge life cycle describes the proportion of a population that have access to a particular piece of knowledge over a duration of time or over the life of that knowledge. Figure 3.1 shows a graphical representation of the knowledge life cycle. The knowledge life cycle is used as an integrative tool to meaningfully organise the independent variables of this study: characteristics of knowledge. As the stage in the knowledge life cycle is defined by the characteristics of knowledge, the stage of a firm's knowledge in the life cycle is an exogenous factor that the firm cannot control. At any one time, a firm's knowledge typically falls into one stage, but sometimes it may belong to more stages.
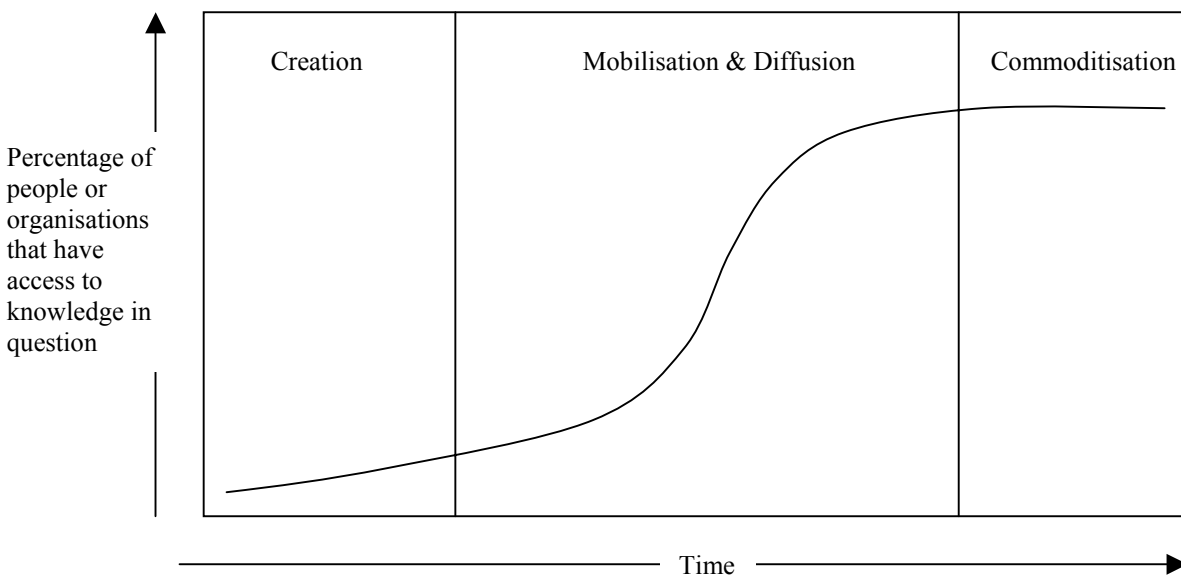

Figure 3.1: Knowledge Life Cycle (adapted from Birkinshaw and Sheehan 2002)

The second component of the knowledge life cycle model is the organising framework for managing knowledge sharing. This framework consists of three categories of knowledge management tools and techniques that a firm may employ to manage its knowledge sharing, and the categories are informal knowledge systems, information technology systems, and human resources[2]. The knowledge sharing activities and their management by the firm are the dependent variables of this study. These are endogenous factors that the firm have control over and expand efforts to decide. When all of these categories are illustrated in detail, one is then able to get a comprehensive description of the knowledge sharing activities of the firm. In the following two sub-sections of this chapter, the two components of the knowledge life cycle model will be developed in detail.

3.2.1 Knowledge Life Cycle

The knowledge life cycle depicts the temporal evolution of knowledge by tracking the percentage of a population that has access to that knowledge over a period of time, as illustrated in Figure 3.1. Birkinshaw and Sheehan (2002), in their original formulation, identified four distinct stages over the life cycle of a defined piece of knowledge, which they called Creation, Mobilisation, Diffusion, and Commoditisation, respectively. It is the defining characteristics of knowledge that differ from stage to stage that require distinct approaches for the organisational knowledge sharing to be adequately managed.

The representation of the diffusion of knowledge in a social system over time has been well established. The theoretical foundation of the knowledge life cycle shares a historical linkage to two families of models: 1) diffusion models, and 2) life cycle models (see Nieto et al 1998 for a comprehensive discussion of these families of models). Mansfield (1961) studied the rate of imitation of twelve innovations by firms in different industries and found that the number of firms adopting the innovations grows according to the logistic function, which is an S-shaped growth curve commonly found in the biological and social sciences. Others in the field of industrial economy have used the logistical growth function to model the diffusion process of various technologies and

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[2] In their original formulation, Birkinshaw and Sheehan (2002) included a fourth category called external relationships. This category is excluded in this thesis as only internal knowledge sharing is considered. Any effects of external knowledge sharing as far as it has an impact on internal knowledge sharing shall be sufficiently covered by the remaining three catagories.

processes in different markets and industries (Nieto et al 1998). Life cycle models are conceptually derived from diffusion models and are used to illustrate the evolution of industries, technologies, and products over time; and the most common are product life cycle models first established by Levitt (1965). Product life cycle models typically traces sales of product over time. The first three stages of the product life cycle, namely Introduction, Growth, and Maturity, excluding the Decline stage, also conform to the logistical growth function. The technology life cycle concept, defined by Ford and Ryan (1981), depicts the penetration of technology over time, and is also in the form of an S curve that resembles the logistical growth function from the Technology Development to Technology Maturity stages.

Nieto et al (1998) highlighted, however, that life cycle models have traditionally faced two main problems. Firstly, the definition of unit of analysis can be problematic as different life cycles can be developed for different but closely related units of analysis, for example, product form as opposed to product category. Secondly, life cycle models do not capture the causes that bring about the changes in the life cycle. Addressing these two issues as applicable to this thesis allows the opportunity to clarify how the knowledge life cycle will be used in the theoretical framework.

First, in the knowledge life cycle as applied in this theoretical framework, the unit of analysis shall be an acceptably defined body of knowledge. Knowledge in this context and from the perspective of a firm will be as the definition adopted for this thesis: an organisation's ability to leverage its resources to extract productive services. A simple example will be the knowledge life cycle of quality management as a body of knowledge. On this basis, this thesis will not distinguish between knowledge and technology life cycles, provided that the technology in question is actionable and allows the extraction of productive services by the firm.

The basic unit of analysis of this thesis is the firm. However, it would be argued that the concept of knowledge life cycle is strictly applicable only to an industry or a sector of an industry, but not to an individual business organisation. Indeed, one of the major conclusions of Birkinshaw and Sheehan's (2002) research was that firms should not, and most firms in fact do not, manage organisational knowledge that spans all stages of the knowledge life cycle. Hence the firm will view itself as having organisational

knowledge that fits into a certain stage or some stages of an industrial knowledge life cycle.

The second issue of causes of change in life cycle models is partly related to the unit of analysis. In strategic management research, where life cycle models are widely used, it is important to know the mechanism and causes of change. For example, knowing why and when a product crosses into different stages of its life cycle will allow a firm to apply the best strategies to adapt to the changes. And this is due to the fact that the unit of analysis is the product that spans the entire life cycle. In this thesis, the knowledge life cycle is used as a descriptive tool, and the stages of the knowledge life cycle are independent variables. We are not so interested in the transition from one stage to another. The unit of analysis, the firm in question, does not have knowledge that spans all stages of the knowledge life cycle. The key concern is not the detection of changes in knowledge life cycle stages. What is key is for the firm to identify to which stage or stages its organisational knowledge belong. Recognising the stage to which firm knowledge belongs means the characteristics of the firm's knowledge are matched, and subsequently the effects on knowledge sharing can be associated back to the characteristics of that stage.

An explanation is needed for the deviation from the original formulation of Birkinshaw and Sheehan's (2002) knowledge life cycle by combining the Mobilisation and Diffusion stages. The distinction of these two stages was relevant from the point of view of knowledge diffusion research due to the disparate proportions of population adopting the knowledge between the stages, as well as the distinct rates of adoption in the two stages. The rational for combining these two stages into one for this theoretical framework is that for both these stages, the underlying characteristics of knowledge, and hence the knowledge sharing activities of these two stages are not significantly distinguishable.

The following sections describe the three stages of the knowledge life cycle, both in terms of the evolution of the knowledge within each stage, and the characteristics of knowledge associated with each stage.

3.2.1.1 Creation

The creation of new knowledge in an organisation begins in the individual often as an idea that may not even be coherent. This may be a scientist in a research laboratory who found a new technique to detect a compound, for example. Knowledge in the creation stage starts out as a nebulous concept that even the creator does not fully understand. It is hence highly tacit in nature and the creator may not be able to fully articulate it until he or she develops the idea more fully. The future of this newly created knowledge in the organisation is wrought with uncertainty. This uncertainty arises from the fact that the applicability of the new knowledge in the context of its creation is at the point of time not fully determinable. Many of these new ideas do not get beyond the creation stage. The ability of the knowledge to survive to the next stage depends on a few developments. Firstly, the idea has to be made more coherent and less tacit, so that it generates sufficient interest among the individuals within an organisation that can sustain an idea's life span. Secondly, the usefulness of the new idea needs to be sufficiently demonstrated. This may involve testing of the idea to identify potential applications and to reduce the uncertainties of its applicability. Thirdly, the new knowledge needs to be aligned with the direction of the organisation; the organisation must have sufficient resources to further pursue the idea; and the organisation is satisfied with the potential return of developing the knowledge (Ford and Ryan 1981).

In the context of the IT industry, a firm with knowledge in the creation stage can be identified by its distinct organisational knowledge that enables it to provide IT solutions that are new to the market, offering functionalities that do not yet exist.

3.2.1.2 Mobilisation and Diffusion

Knowledge in the mobilisation stage is characterised by more extensive codification and wider acceptance. As the creator of new knowledge develops it further, the idea becomes more explicit and more easily codified. The critical process in the mobilisation stage is the internal diffusion of knowledge in the firm. For the firm that created the knowledge, this means diffusion of the knowledge from the smaller community where it was first created. For a firm that acquired a piece of knowledge in the mobilisation stage, it means diffusion of the knowledge from the individuals who initially gained the knowledge. This can take place in two modes as proposed by Nonaka

(1994), namely by Socialisation where tacit knowledge is shared and transferred, and by Externalisation where tacit knowledge is shared and becomes explicit. Nonaka's (1994) model of organisational knowledge creation process describes very well the mobilisation stage. He argues that in the organisational context, the social setting of individual knowledge enlargement, especially in the case of tacit knowledge, provides a shared experience for those members in the community. Through repeated and prolonged knowledge sharing interactions, the tacit knowledge may be converted into explicit concepts; this process is called conceptualisation. Crystallisation represents the stage in which the reality and applicability of the new concept is tested in some concrete form such as a product or a new system of approaches. Justification refers to the evaluation of the new knowledge with respect to the standards required by the organisation.

The crystallisation process involves further testing of the new knowledge and its validation. The justification process establishes a broader value of the new knowledge, and hence also its wider acceptance within the organisation.

A point to note is that the context of the knowledge sharing in this stage is more accurately described as a trusted community by which the new knowledge is more likely to be accepted, equivalent to the concept of 'community of practice' (Brown and Duguid 1998).

At this stage, the knowledge has taken on a nature that is more explicit than tacit, and more organisational or social than individual.

Knowledge in the diffusion stage has its validity, applicability, and value established and accepted in its community of practice. Broad diffusion of the idea beyond the community then takes place. The creator's idea can be diffused via a few mechanisms. A firm's competitors can imitate the idea. An innovative producer's goods can be reverse engineered. The creator of knowledge may sell it in the open market to interested buyers, or the knowledge may even be broadly diffused as the originator chooses to broadcast the knowledge freely. The knowledge at this stage becomes very well understood and established, fully developed and well tested. The knowledge gets adopted by many firms in the relevant market place. The main characteristic of knowledge in this stage is that the availability of this knowledge becomes unrestricted to any interested party.

The IT firm whose organisational knowledge falls into this stage is characterised by its ability to follow the trends set by technological leaders and provide IT solutions that are slightly improved and more customised to a relatively new market that is growing.

3.2.1.3 Commoditisation

In this final stage of its life cycle, the knowledge in question is so well established and widely diffused that it becomes common knowledge. The knowledge has been fully developed not only by the creator but has gone through modifications, refinements, and improvements by imitators, and competitors alike. The idea is so well understood and the form it takes has been so widely agreed that it has stabilised. This knowledge is available in the public domain to any one at negligible cost. At this stage, the knowledge is likely to be very explicit, and highly codified in textbooks and manuals or any other kinds of documents.

The IT firm whose organisational knowledge has reached the commoditisation stage will have developed capabilities that enables them to provide IT solutions that are highly reliable and very customised to user needs but are based on albeit not the most innovative technology.

The extent of the characteristics of knowledge, as found in knowledge sharing literature, in each of the above stages are summarised in Table 3.2.

Table 3.2: Characteristics of Knowledge in the Stages of Knowledge Life Cycle

Knowledge Stage / Characteristics of Knowledge	Creation	Mobilisation and Diffusion	Commoditisation
Tacit	High	High to moderate	Moderate to low
Codified	Low	Moderate to high	High
Individual	High	High to moderate	Moderate to low
Organisational	Low	Low to High	High
Embedded in System	Low to moderate	Moderate to high	High
Independent	High to moderate	Moderate to low	Low
Causally Ambiguous	High	Moderate	Low
Provenness	Low	Moderate to high	High
Complexity	Low to High	Low to High	Low to High

3.2.2 Organising Framework for Managing Knowledge Sharing

The management of knowledge sharing in an organisation is a multi-faceted activity. Many aspects of general management have an impact on knowledge sharing. This thesis adapts Birkinshaw and Sheehan's (2002) three categories of knowledge management tools and techniques to examine how knowledge sharing is managed in an organisation. These categories are 1) informal knowledge systems, 2) information technology systems, and 3) human resources. In each of the categories, extant literature on knowledge management, and especially literature on knowledge sharing, is synthesised to illustrate what are the elements making up the category. The theoretical impact of characteristics of knowledge on the choices that management is expected to make about these elements will also be discussed.

3.2.2.1 Informal Knowledge Systems

This section examines what are the informal systems that organisations can employ to manage knowledge sharing. The areas that will be discussed under this broad category include field of interaction, organisational hierarchy, teams and communities of practice, informal training, organisational culture, and top management role.

A good starting point of this discussion on informal knowledge systems is the concept of 'field of interaction' as proposed by Nonaka (1994). The field of interaction refers to the organisational and structural context in which knowledge sharing takes place. Knowledge sharing between individuals is the basis for organisational knowledge creation (Nonaka 1991, 1994, Hedlund 1994). The contextual issues related to knowledge sharing would be patterns of communication, and team structures (Nonaka 1991, 1994, Hedlund 1994, Grant 1996b, Quinn et al. 1996).

The starting point of organisational knowledge creation is knowledge sharing between individual members of the organisation (Nonaka 1991, 1994, Hedlund 1994). It is through the interaction of the knowledge and ideas of the different individuals that their knowledge acquires an organisational characteristic, and eventually becomes a piece of organisational knowledge. In order for knowledge sharing to take place, there must exist fields of interaction. A field of interaction is defined as a place in which individual perspectives are articulated, and conflicts resolved in the formation of higher-level concepts (Nonaka 1994). The vibrancy of a firm's internal knowledge acquisition activities depends directly on the amount and quality of its knowledge sharing processes. In general, communication theory suggests that due to the non-depleting nature of knowledge sharing, the potential benefits to a network grows exponentially as the amount of interconnected nodes increase numerically (Rogers and Agarwala-Rogers 1976). This is equivalent to the concept of network range or diversity, which Reagans and McEvily (2003) argued helped knowledge sharing by bridging structural holes in the knowledge network. They found that network range helped knowledge sharing regardless of whether the knowledge was tacit or explicit. Another feature across the linkages that has to be considered is the tie strength (Hansen 1999). In general, taking into account the issue of efficiency of transfer, strong ties are more efficient for transfer of tacit knowledge, and weak ties are more efficient for transfer of codified knowledge.

It has been argued that effective knowledge management should provide fields of interaction in which the communication network connects individuals laterally much more than vertically and the organisational hierarchy shifts focus more on to the middle and lower levels than on the top management (Hedlund 1994, Nonaka 1994, Grant 1996b). These are thought to better facilitate sharing of relevant knowledge than top-

down decision making and vertical communication flow prevalent in the multi-divisional form of organisation. The motivations for such emphases are, firstly, that there is a need for knowledge sharing among those with shared experiences and common practices, and secondly, that the rapidly shifting technological and economic landscapes had led to the dispersal of relevant knowledge to various levels of the firm.

At the sub-organisational level, the most discussed form of field of interaction is the team (Hedlund 1994, Nonaka 1994, Grant 1996b). A team is defined by the relationships of interdependence between the members that form it (Nonaka 1994). Due to the interdependence between members of a team, the potential for effective knowledge sharing is increased if there is a high level of both variety as well as overlap in the members' knowledge. The former widens the scope of the team's knowledge sources while the latter indicates common perspectives that enable tacit knowledge sharing. For example, in the development of new products, cross-functional teams have been observed to be a very effective structure to achieve high project performance (Griffin and Hauser 1996). Essentially, the mode of interaction of the knowledge that cross-functional team members bring to the team is parallel, with all the different functions having input simultaneously. This is in contrast to the traditional functional model where decision-making is sequential, making its way through the various departments or functions, one at a time. Glazer (1991) argued that the more knowledge-intensive a firm is, the more likely it will rely on decision-groups or teams and the use of parallel rather than sequential knowledge sharing. Lam (1997) has, however, argued that while a diffused, overlapping, and parallel knowledge structure in a team is more effective for sharing knowledge that is tacit and socially embedded, the task-specific, functionally delineated sequential structure is more effective for sharing codified knowledge.

Teams are temporary groupings of individuals formed usually for the purpose of developing products, delivering services, or designing some processes. These are knowledge creation activities. Hence knowledge requirements form an important consideration in the choice of team membership. Individual specialists meeting the knowledge requirements of the knowledge creation tasks should constitute the team, led by specialist coordinators (Grant 1996b). The knowledge requirements of the team may change. The rigidity and stability of a fixed group of team members can be sacrificed

when a firm realises that the most important criterion of whether the team is going to make sound decisions and produce good results is the quality of its combined knowledge. At different stages of the team's life, when different kinds of knowledge may be required that the team members may not already bring to the team, then those with the requisite knowledge must be brought in. The duty of those not needed can be relieved. The idea of primacy of specialist knowledge also compels the role of top management decision-making in teams to be re-examined. This results in the decentralisation of decision-making, away from top management, to whoever has the greater or more relevant knowledge. Teams must be empowered to make decisions about matters of which its members have a better knowledge.

Another possible field of interaction is the community of practice, defined as a group across which knowledge and sense making are shared, in which members have to work together for its dispositional knowledge to be put into practice (Brown and Duguid 1998). A community of practice is not confined in its knowledge sharing by the boundary of an organisation; it is often supra organisational. Such a community may include customers, suppliers, and distributors of the firm.

Informal knowledge sharing takes place in these fields of interaction. Organisations acquire much of their knowledge through direct experience. Frequently, through daily activities in which the organisation engages, experiential learning takes place unintentionally and unsystematically (Huber 1991). In addition to having training courses where explicit knowledge is transferred to the trainees, sharing of tacit knowledge require some forms other than classroom instruction. Tacit knowledge is most efficiently transferred between individuals through illustration by the instructor and imitation by the student (Nelson and Winter 1982, Lam 1997). Specialist knowledge can be transmitted to the newcomer by letting him or her be around when the experienced employees work. This is called 'legitimate peripheral participation' (Brown and Duguid 1998). So these types of on-the-job training take the form of apprenticeship, internship, and mentorship.

In addition to the field of interaction, there are some organisational conditions surrounding the fields of interaction that influence the effectiveness of knowledge sharing.

One approach is to focus on motivational factors to induce individuals in the firm to participate in knowledge sharing. This approach falls under the notion of organisational culture. Organisational culture can be defined as a complex set of values, beliefs, assumptions, and symbols that define the way in which a firm conducts its business (Barney 1986). Many have argued that organisational culture, in an implicit and unspoken form, is a powerful explanation for individual and group behaviours within an organisation (Polanyi 1958, Berger and Luckman 1966). The goal is to align a firm's culture to one that is consistent with knowledge sharing. But changing the values, symbols and beliefs that constitute organisational culture is not easily achievable (Smircich 1983). Organisational culture involves a very high degree of inter-personnel relations, and the factors determining these are myriad, complex and not well understood, it remains elusive to the influence of conscious management (Pan and Scarbrough 1999). Pan and Scarbrough (1999) suggested nonetheless that the essential issues involved in creating an organisational culture that encourages organisational members to share their knowledge are those of trust, risk-taking and initiative. The possible difficulty faced by management is that an individual might have the idea that personal knowledge is equivalent to power and might try to ensure his or her continued survival in the firm by hanging on to his or her knowledge and refusing to share it with others. The firm can try to realign the possibility of such divergence between individual and organisational objectives. The firm can make clear that it proactively values those who are willing to share their knowledge. It can motivate its members by rewarding those who take risks and initiatives in sharing and creating knowledge. Such mechanisms must be balanced against the caveat that they may politicise relations and further erode trust.

The persistence of the characteristic symbols, beliefs, and values of a firm's culture is also the partial reflection of the firm's unique history and inheritances, including the particular significance of leadership roles in influencing the early patterns of firm behaviours (Selznick 1957, Stichcombe 1965, Zucker 1977). Schein (1992) went so far as to suggest that the only thing of real importance that leaders do is to create and manage culture. Hence it is important that the firm's top management actively try to foster an organisational culture that encourages knowledge sharing.

3.2.2.2 Information Technology Systems

With the rapid development of information technology, especially the widespread digitisation of information and electronic inter-connectivity, the possibilities and usefulness of information technology systems has been profoundly increased. There exist in literature an extensive amount of work done on knowledge management that is related to the application of information technology in particular (see for example Alavi and Leidner 2001). These works have a heavy emphasis on the role of information technology as the infrastructural basis for managing information. It has been argued however that in order to leverage knowledge in a firm, emphasis should be placed on the social context in which it occurs and to the people that populate these communities. Finding ways to locate these communities, cultivating and supporting them would increase the ability of firms to use their existing knowledge and create new knowledge. On the other hand, use of information technology in itself would only strengthen the norms with which an organisation has always documented and shared information. In the absence of communities in which people already share their knowledge, in which there is already vibrant interaction, in which people already have clear ideas of what they and others need in terms of useful knowledge, information technology alone is not likely to bring about these conditions (McDermott 1999).

Despite not being able to create the desired level of knowledge sharing when knowledge sharing is absent, IT systems can enhance existing patterns of knowledge sharing within an organisation. This is the realistic power of an effective IT system. Hence, the warnings against emphasising too much on IT systems instead of the social and cultural aspects of knowledge management notwithstanding (Davenport and Prusak 1998, McDermott 1999), IT systems remain integral to the knowledge management initiatives of many firms as an important enabler. One example is a global database of a multinational corporation, with the databases of each of its offices worldwide electronically connected for access by one another (see for example Quinn et al. 1996, Pan and Scarbrough 1999).

Alavi and Leidner (2001), who surveyed knowledge management literature with an IT application focus, concluded that there are three common applications of IT systems for organisational knowledge management, namely: 1) the coding and sharing of

best practices, 2) the creation of corporate knowledge directories, and 3) the creation of knowledge networks.   IT systems realises the above applications and enhances knowledge sharing by extending the network reach of an individual. This may reap benefits from the effects of increased network range as argued by Reagans and McEvily (2003), but with diminished advantage as a result of weakened tie strength (Hansen 1999). Bridging of structural holes in the knowledge network is not the only function of these linkages provided by IT systems. Organisations are often unaware of the wealth of relevant knowledge within itself (O'Dell and Grayson 1998). An extended network range increases the possibilities of cross-pollination of scattered organisational knowledge, although the ties established via IT systems maybe weaker. Knowledge directories in a firm are an example of how knowledge content or access to knowledge within a firm can be organised to take advantage of the extended communication reach provided by IT systems. Beyond the reach provided by IT systems, the interactive feature of IT systems offered by tools like electronic bulletin boards, and discussion forums provide an efficient way for users to screen and establish the relevance of the sources' knowledge.

IT systems are however limited in its ability to convey knowledge as richly as compared to face-to-face interaction, although they are less prone to knowledge atrophy and personal filtering in the knowledge sharing process. They are therefore thought to be more effective for the sharing of codified knowledge (Hansen et al 1999, Birkinshaw and Sheehan 2002 and others).

3.2.2.3 Human Resources

Knowledge sharing is essentially an activity involving people, either as individuals or a group within an organisation. Human resource management offers a leverage on the people behind knowledge sharing, hence indirectly impacting knowledge sharing outcome in a firm. Minbaeva et al (2002) argued that absorptive capacity required for knowledge sharing is a function of both ability and motivation. They found that employee ability is positively related to a competence and performance appraisal system, and training provided. Motivation, on the other hand, relates positively to a merit-based promotion, performance-based compensation, and extensive internal communication. In terms of competence and performance appraisal system, merit-based promotion, and performance-based compensation, it is expected that these mechanisms

be used to align with the informal knowledge sharing systems and the information technology systems that the firm employs. For example, an employee will be positively appraised in a firm that advocates mentoring as a knowledge-sharing tool for spending time with new recruits assigned to him or her. Or an employee will receive higher compensation for diligence in documenting project parameters and solutions in a firm that wants to codify its knowledge for easier sharing.

Training methods should be differentiated to reflect the characteristics of the knowledge being transmitted as discussed in the earlier sections of this chapter. Mentoring and learning-by-doing involving small number of people are more appropriate for transfer of tacit or socially embedded knowledge, whereas for explicit and independent knowledge, formal training in the form of classroom instruction and involving large groups may be more efficient (Hansen et al 1999).

An additional factor that influences individual absorptive capacity is the employee's knowledge base prior to being hired for the job. Lam (1997) observed that those with 'knowledge of rationality' or knowledge based on theoretical knowledge and formal training were more suited to sharing explicit and independent knowledge while those with 'knowledge of experience' or knowledge based on practical know-how and job related problem solving skills are more suited to sharing tacit and socially embedded knowledge. Additionally, Hansen et al (1999) looked at consulting firms where the backgrounds of the recruits reflect different problem solving orientations. Fresh university graduates, they argued, are more suited to the reuse of codified knowledge and the implementation of known solutions. More experienced or MBA graduates were thought to handle ambiguity better and more suited to absorb novel, unproven, and complex knowledge.

3.3 Conclusion

In this chapter, the theoretical framework to be used in this thesis is developed and presented. The main challenge was to find a meaningful way to group characteristics of knowledge, which was shown by literature to have an important impact on knowledge sharing. The knowledge life cycle was found to serve the purpose of categorising properties of knowledge very well and at the same time offering a dynamic view of evolution of organisational knowledge in an industry. The theoretical framework consists

of two major components. The first component of the framework is the knowledge life cycle model seeks to describe the variation of knowledge in stages over time in terms of its adoption by a specified population. The three stages in the knowledge life cycle identified are Creation, Mobilisation and diffusion, and Commoditisation. Knowledge at each stage in the life cycle consists of attributes that impact on how the knowledge should be managed.

The second component of the framework is the organising framework for managing knowledge sharing. By looking at three categories of tools and techniques, namely the informal knowledge systems, information technology systems, and human resources management of a business organisation, its management of internal knowledge sharing can be characterised.

This theoretical framework provides a systematic approach to examine the impact of characteristics of knowledge on management of knowledge sharing. And the use of knowledge life cycle model for studying knowledge sharing is a novel contribution to the literature, to the best of my knowledge.

Chapter 4

Research Methodology

4.1 Introduction

This chapter sets out the methodological approach that is used in this study. The methods of collection of the required information and the plan for analysis of the collected data are presented.

A justification of the case study research methodology adopted is provided. The position in qualitative research of the methodology chosen for this study is explained. This is followed by a description of the design of the case study approach, and its implementation. The demographic data of the cases chosen are also presented. Finally, the analytical approaches that will be employed on the data are explained.

4.2 Case Study Methodology

4.2.1 Methodology Selection

The method of data collection of any study depends on the research questions that the study seeks to answer. The research objectives of this study are to determine what are the mechanisms employed by IT-related firms to manage their internal knowledge sharing and to understand how the firms' approaches to knowledge sharing differ with the stage in the knowledge lifecycle of their knowledge. The case-study approach has been chosen as the most suitable research methodology to answer the above research question.

The case study is defined as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident (Yin 1994). Yin (1994) specified three conditions that help to determine what research strategy to adopt. The conditions are, namely (a) the type of research question posed, (b) the extent of control an investigator has over actual behavioural events, and (c) the degree of focus on contemporary events.

In trying to find out about how knowledge sharing is managed by knowledge-intensive firms, the research interest lies firstly in illustrating the knowledge sharing activities carried out by these firms. In addition, the reasons why the firms carry out such approaches to the management of organisational knowledge sharing, especially those

reasons relating to the characteristics of the knowledge being shared, are also of interest. Control over the actual knowledge sharing events that are being studied is not required. Being able to find out the actual phenomenon of knowledge sharing taking place in its real-life context of the firms is more important than the need to manipulate the relevant factors to determine causal relations between variables. The management of knowledge sharing activities that is relevant to this study is an ongoing, contemporary phenomenon that takes place in actual firms, as opposed to some specific event that took place in the past. The explanatory mode of investigation, the non-requirement of control over the events and the phenomenon being a contemporary one favour the use of the case-study strategy.

4.2.2 Position In Qualitative Research

It has been argued that there are three possible positions to take when doing qualitative research, namely: 1) positivist, 2) interpretive, and 3) critical (Klein and Myers 1999). This thesis adopts the positivist position in using the case study approach. The methodological conventions of positivism evolved from the use of approaches in natural science enquiries by the social sciences. The positivist approach is characterised by the use of formal propositions, quantifiable measures of variables, hypotheses testing, and the drawing of inferences about a phenomenon from a representative sample to a stated population (Klein and Myers 1999). The above characteristics are applied strictly to research using quantitative approaches. The positivist approach to qualitative research applies the above rules less strictly. Yin's (1994) work on case study research is an example of the positivist approach. Yin relaxes, for example, the requirement to make statistical generalisation about a wider population from a sample, but instead emphasises 'theoretical generalisation' which draws conclusion about the underlying theory.

This thesis conforms to the positivist approach to case study consistent with that of Yin (1994) in the following ways. First, although no formal hypotheses are proposed, the theoretical framework, in clarifying the possible elements of management of knowledge sharing, synthesises existing literature and summarises the conclusions made about the effectiveness of a knowledge sharing technique in relation to the characteristics of the knowledge being shared. Second, the dependent variables of this study are the elements under the categories of informal knowledge systems, information technology

systems, and human resources. These are qualitative variables, which, although not quantifiable, are systematically presented in a structured theoretical framework. Third, since there are no formal hypotheses proposed, there can be no hypotheses testing. However, the results of the case studies can provide a basis to evaluate the conclusions from literature presented in the theoretical framework. Finally, this thesis emphasises theoretical and not statistical generalisation.

4.2.3 Case Study Design

This thesis adopts a case-study strategy using a multiple-case design with embedded units of analysis. First of all, a multiple-case design is employed to cover all the independent variables of the theoretical framework. The independent variable in question is the stage in the knowledge life cycle. As was argued earlier, each firm's organisational knowledge can be primarily classified into one stage in the knowledge life cycle, although more stages is also possible but rare. Hence, more than one case study is required in order to have every stage in the knowledge life cycle represented. Furthermore, a multiple-case design is chosen because the evidence provided from cross-case analyses affords more compelling support to the study's conclusions as compared to a single-case design. The strength of evidence in a multiple-case design will be discussed in detail in the data analysis methods section under cross-case analysis.

Much of the methodological foundation of this research can be found in the following works: Eisenhardt (1989), Strauss and Corbin (1990), Yin (1994). For examples of case study research on knowledge sharing, see Lam (1997).

4.2.4 Units of Analysis

The central unit of analysis of this study is the firm in question because ultimately, conclusions would be drawn regarding how the firm actually manages its knowledge sharing. However, not all the relevant activities that take place within the firm necessarily involve the entire firm. It would be expected that the unit of analysis changes in different instances when different activities are examined. For example, an examination of the role of top management would inevitably focus on the behaviours of particular leaders. An examination of team behaviours would have the project team or decision-making task force as the embedded unit of analysis and so on. Care is taken to

ensure that the language used will be explicit and specific so as to leave no doubt about the unit of analysis being referred to.

4.3 Data Collection

4.3.1 Sources of Information

In order to collect the necessary data for this study, three sources of information are considered. They are documents, the Internet, and interviews. Documents, and information obtained from the Internet are expected to provide descriptive information about the cases. The interviews provide the bulk of the substantive materials that are of theoretical interest.

Relevant documentary information refers to company brochures, internal publications, newsletters, annual reports, or external publications like newspaper or magazine articles, and advertisements. The use of this source of information is relatively less significant than the other two sources.

Since the cases are IT-related firms, they are expected to have some extent of web-presence in the form of web pages. These provide an alternative source of information similar to those obtained from documentary sources. The significance of this source of information is, however, dependent on the volume and richness of information that the firm posts on its website. Indeed, there is a big disparity in the usefulness of the information provided by the four case companies on their respective websites.

Personal interview is the main mode of data collection for this study, and the only one that the researcher can actively control. The procedures involved in conducting the interviews will be presented in details.

4.3.2 Selection of Cases

The first criterion for selection of cases for this study is to ensure that the phenomenon being studied, knowledge sharing, actually takes place in the firm. Hence, knowledge-intensive firms are required as case studies. Knowledge intensity of a business organisation can be defined as the extent that knowledge contributes to the value-adding process of providing services or products. The operationalisation of knowledge intensity is troublesome because of the difficulty in determining accurately the contribution of knowledge to the value of a firm's products or services. In addition, the concept of knowledge remains vague to the firm. The solution to this problem is to

examine firms in widely accepted knowledge intensive industries. Hence, in this study, IT-related firms are chosen based on their industry's widely acknowledged knowledge intensity. In each individual case, the type of major products and services of the firm are examined to ascertain that they are not capital- or material-intensive instead of knowledge intensive.

This study strives to achieve analytic generalisation, that is, the result should validate the underlying theory, instead of extending its validity to the population of interest.   In the case of statistical generalisation, probability sampling using a representative sampling plan would allow conclusions to be drawn about the target population to a certain degree of accuracy with a certain probability. The approach to selection of cases used here, however, is closer to non-probability sampling, in particular, purposive sampling. In fact, the use of the term 'sampling' in this study is misleading, as there is no intention of generalising to the population from which the 'sample' was drawn. The purposive-ness of the selection of cases is reflected in the second criterion of case selection, which is to ensure that all the independent variables of the theoretical framework are represented by at least one case study.   In this study, one firm has organisational knowledge that belongs mostly to the Creation stage, two firms the Mobilisation and Diffusion stage, and another the Commoditisation stage.

4.3.3 Procedures

All four cases in this study are found through the researcher's personal contacts. When a potential firm is identified, it is preliminarily assessed for suitability to this study by examining sources of information from documents and the Internet. If a firm is deemed suitable, a formal letter inviting the firm's participation in the study is sent to the contact person in that firm. Through discussions with the contact person, at least two interviewees from each firm would be chosen by the contact person. The main criterion for these choices would be based on the scope of responsibility of the respondents. Whenever possible, two levels of interviewees are chosen, of which one consists of at least one top management level personnel and another consists of at least one operational level employees. The rationale of interviewing these two levels of employees in a firm is to achieve a balanced perspective of what the actual knowledge sharing practice of that

firm is, without undue bias towards the direction of either the top level or the operational level employees' perceptions.

The interviews would last an average of about an hour each. Each interviewee is interviewed individually to rule out any effects due to group dynamics. The interview questions are structured based on the elements in the theoretical framework. They are however open-ended to allow the interviewee to express his perspective as freely and as unbiased by the researcher as possible. The interviewee is expected and encouraged to employ his own terminologies in describing his firm's behaviours. The researcher would ask to have ambiguous terms defined. The interviewee's permission is sought to allow the interview to be recorded on an audiotape. This is to facilitate the accurate recollection of data and an exact transcription.

All interviews would then be fully transcribed. The transcript is then content analysed according to categories as defined by the theoretical framework. This allows within-case analysis to be carried out.

4.4 Demographics

In total, four companies participated in this study. All of them are involved in the information technology industry. Three of the smaller firms are directly working in the field of Internet, mobile Internet or computer networks. The larger firm covers a broader scope as it does various types of consulting including technology consulting in Internet and wireless technologies. Three of them are based in Singapore while another operates in Kuala Lumpur, Malaysia. Two of the firms are young start-ups of less than a year; another was spun off for less than a year from a 4-year-old division of an organisation while the last firm is a well-established office of a multinational corporation for well over two decades. The number of employees in these firms ranges from 9 to 360. Their annual revenues range from S$300,000 to S$70 million.

A total of 10 respondents took part in the interviews. In all the firms, at least two respondents were interviewed. In the two cases when three respondents were interviewed for a firm, the third interviewee was an operational level staffs. In two cases, only senior management level interviewees were available, giving rise to possible top management bias in the data provided.

The confidentiality of the participating firms' identities is kept by disguising their names respectively as Digamma Sdn Bhd, Iota Pte Ltd, Kappa Pte Ltd, and Alpha Singapore. A brief description of each of these companies is given in the following section.

Case Study 1: Digamma Sdn Bhd

Digamma Sdn Bhd is a relatively small and young company based in Petaling Jaya, near Kuala Lumpur, the capital of Malaysia. There 9 people in total working in this firm, of whom 4 are partners, 2 are permanent staffs, 1 is a part-time staff, and 2 are interns from a local university. In terms of revenues, the firm has a turnover of between RM 50,000 to RM 100,000 (RM1 = S$0.45) per month. It is a young firm established by the 4 partners 10 months ago and only started its formal operations 4 months prior to the interviews. The respondents described the firm as being in the information technology industry, and its main activities as providing customised business solutions for the Internet and mobile communications to other companies in terms of services, as well as, building software products for their customers.

Case Study 2: Iota Pte Ltd

Iota Pte Ltd is a small and young start-up company based in Singapore. There are a total of 13 people working in the firm, of which 11 are full-time staffs and 2 are part-time employees. Iota had revenues of S$400,000 in the past fiscal year. The company has been established a year ago by a group of four electrical and electronics engineers who now form the top management of the firm. The respondents described the firm as being in the information technology industry, and its main activities as providing Internet and Enterprise Resource Planning (ERP) solutions. The firm provides operations solutions such as applications for human resource and office management, and financial accounting as well as front-end solutions like e-commerce solutions.

Case Study 3: Kappa Pte Ltd

Kappa Pte Ltd is a 9-month-old company based in Singapore. There are about 40 people working in the firm, of which 12 are co-founders. The firm secured orders worth around S$1million in the 9 months since it was established. The company was spun-off from a division of a government of Singapore statutory board in March 2000. The division was an industry-led effort managed by the Singapore government in the said

statutory board to serve the online needs of a consortium of Singapore-based firms. The entity had been in existence for about 4 years before being spun off into Kappa Pte Ltd, so Kappa's actual experience extends beyond the official 9 months of its existence. The respondents described the firm as being in the information technology industry, and its main activity as enabling e-businesses by providing Customer Relationships Management (CRM) tools to allow these businesses to service, retain and capture their customers. These CRM tools enable businesses to have functions like chatting, forums and clubs on their websites.

Case Study 4: Alpha Singapore

Alpha Singapore is a large global management and technology consulting firm with more than 65,000 employees in 46 countries. Alpha has had a presence in Singapore since 1975. Currently, the Singapore office employs around 360 people, generating an annual revenue of about US$40 million. Within the Singapore office as is the case with other offices worldwide, the employees are organised into market units which serve clients from different industries. The two respondents that were interviewed for this study belonged to the communications and high-tech market unit, whose clients include telecommunication companies, electronics manufacturing firms and media firms. Alpha is described as belonging to the consulting industry. It develops and delivers business solutions to meet the various needs of its clients. Instead of merely providing advice to its clients, the firm helps them to implement those solutions through the application of information technology.

The characteristics of the case firms are summarised in Table 4.1 and the details of all the respondents are also presented in Table 4.2.

Table 4.1: Characteristics of Case Study Firms

Firm	Digamma Sdn Bhd	Iota Pte Ltd	Kappa Pte Ltd	Alpha Singapore
Country	Malaysia	Singapore	Singapore	Singapore
Employees	9	13	40	360
Revenue	RM50,000 to RM100,000 (S$23,000 to S$45,000) per month	S$400,000 last year	S$1 million in the first 9 months	US$40 million (S$70 million) last year
History	10 months	1 year	9 months	26 years
Industry	Information technology	Information technology	Information technology	Consulting (Information technology)
Main Activities	Provide customised business solutions for the Internet and mobile communications to other companies in terms of services, in addition, build software products	Internet solution provider, e.g. operations solutions in terms of HR, office management, financial accounting and front-end solutions like e-commerce solutions	E-business enabler by providing Customer Relations Management (CRM) tools to allow businesses to service, retain and capture their customers	Develops and implement business solutions through management and technology consulting

Table 4.2: Characteristics of the Respondents

Firm	No.	Designation	Age	Years Within the Organisation	Total Years of Working Experience	Level of Education
Digamma	1	Managing Director	26	10	3	B. Sc in C.E.
	2	Director	27	10	3	B. Eng in M.E.
	3	Software Engineer	29	2 months	5 ½	B. Eng in E.E.
Iota	1	Technical Manager	27	1	3	B. Eng in E.E.
	2	Operations Manager	28	1	4 ½	B. Eng in E.E.
Kappa	1	President and Chief Operating Officer	33	8 months	9	Masters in Comp. Eng
	2	Chief Development Officer	34	9 months	8	Ph.D. in Comp. Sc.
	3	Technical Team Leader	28	9 months	3	Masters in Comp. Sc.
Alpha	1	Partner	44	7 ½	15	Masters in Comp. Sc.
	2	Senior Manager	32	10	10	B. Eng in E.E.

4.5 Data Analyses

The purpose of data analysis is to find the logical link between the data collected and the theoretical framework. In this research design, the development of the interview questions have followed, from the very beginning, the research objectives, through the literature review, and finally to the theoretical framework. The interview questions and hence the data collected from the interviews reflect the purpose of the study, following the structure of the theoretical framework. Yin (1994) suggested that relying on theoretical propositions is the first and more preferred general analytic strategy. As a result of the matching structure of the collected data to that of the theoretical propositions embedded in the theoretical framework, an analytic approach that compares directly the findings from the interview data with the associated theoretical elements of the theoretical framework would enable the validation of those proposed elements. The reliance on theoretical elements for data analysis can be applied to both within-case and cross-case analyses.

4.5.1 Within-case Analysis

Within-case analysis requires that an illustration of how knowledge sharing is managed to be prepared for each of the individual case firms. The completion of this illustration from the original raw interview transcripts goes through a process called content analysis (Holsti 1969, Weber 1990) or open coding (Strauss and Corbin 1990). This process essentially involves systematically going through the transcript and classifying the relevant unit of content into different categories. The unit of content can be a sentence or paragraph. The logical link to the theoretical elements of the theoretical framework can be found in the choice of these a priori categories. In this study, the categories are the theoretical elements. For example, organisational culture, as an element under Informal Knowledge Systems, is used as a category in content analysis. All relevant units of content having to do with organisational culture in the transcribed interview is classified under this category. The categories chosen are therefore structured exactly as the theoretical elements are structured, based on the theoretical framework. This process of classifying the interview material into the various a priori categories represents a possible weakness of this study, as due to resource constraints, only the researcher alone was involved in the content analysis. The potential problem arises from

the researcher's individual judgement used in classifying data into the different categories. Ideally, triangulation at the investigator level by using more than one evaluator to classify the data into the different categories would reduce the probability of bias.

After the interview transcripts for each firm has been content analysed and reorganised, an illustration of knowledge sharing management basis the theoretical framework is obtained for each individual firm. While open coding involves breaking down the interview data and grouping them into different categories, the illustration of knowledge sharing involves reconstructing the data according to the theoretical framework. This process of putting the data back together is also called axial coding (Strauss and Corbin 1990). For each category of data, a set of relationships links the subcategories within the category. Strauss and Corbin (1990) call this the paradigm model, in which the subcategories, namely, causal conditions, phenomenon, context, intervening conditions, action/interaction strategies, and consequences are used to systematically relate the categorised data. Although the categories are logically linked following the structure of the theoretical framework, the subcategories serve also to explicate other possible linkages between the categories.

The reconstructed results are compared to the theoretical propositions or conclusions embedded in the theoretical framework developed based on existing literature. In essence, the embedded theoretical propositions of the theoretical framework or its elements would be validated if it can predict the results of the case study. Validation of the theoretical framework can take two forms. A literal replication is where the result turns out just as the theoretical model predicted. A theoretical replication is where the result differs from the theoretical model but expectedly so and for known reasons. To strengthen the rigour of the data analysis, rival explanations can be used. Rival explanations take the form of rival theoretical propositions articulated in operational terms. The ability to rule out all rival propositions increases the validity of the conclusions made. Theoretical validation is uniquely important for case study research because the purpose of case study research is to achieve analytic generalisation of its conclusions. That is, the objective in case study research is to generalise the data to the underlying theory. This is crucially different from achieving statistical generalisation

where the objective is to draw conclusions about a universe based on a sample drawn from it.

4.5.2 Cross-case Analysis

The cross-case analysis carried out in this study will also rely on the structure of theoretical elements. Cross-case analysis enables one to derive the benefits of multiple-cases design. Cross-case analysis is similar to within-case analysis in that it tries to make conclusions about the underlying theory (analytic generalisation) but by extending the examination of data to more than a single case. Cross-case analysis provides more compelling evidence for literal replication. The more cases where literal replication is achieved, the stronger is the evidence for the theory. Differences in data across different cases afford opportunities for theoretical replication. Comparison between different firms and their known dissimilarities (independent variable: stage in knowledge life cycle) as well as their manifested behavioural differences (dependent variable: knowledge sharing) allows a deeper understanding of the theoretical relationship between those firm conditions and the firms' choices. Cross-case theoretical replication also strengthens the conclusions of a case-study research.

Cross-case analysis can be carried out at two separate levels. First, the elements of interest in the theoretical model are examined across the four cases and conclusions drawn about those particular elements. For example, the human resource management practice of providing training that a firm implements to facilitate knowledge sharing is a theoretical element that is studied, and this element is examined across the four separate cases. Second, at the individual firm level, each case exhibits some relationship patterns between those theoretical elements of interest. As an illustration, the tacitness of firm knowledge may affect various elements of the theoretical framework. These inter-elemental relationships are also analysed across the cases.

4.6 Conclusion

In this research, the case study approach had been chosen to investigate the phenomenon of knowledge sharing, and the justification for this methodological approach is outlined. Four Information Technology related companies from Singapore and Malaysia participated in this research. Interviews were used as the main method of gathering information from these four firms and the procedures for conducting them were

presented. The characteristics of the firms and the profiles of the respondents were also presented. The transcribed interviews were content analysed according to a priori categories based on the elements of the theoretical framework. Two types of analysis are carried out on the data. Within-case analysis looks at the validity of the theoretical framework in each case. Cross-case analysis examines the theoretical elements across cases on the one hand and compares the relationships between the elements of the theoretical model on the other. In both approaches, in keeping with case study strategy, the goal is to achieve an analytic generalisation of the results.

Chapter 5

Results and Analyses

5.1 Introduction

In this chapter, the empirical data collected from the firms about their knowledge sharing approaches will be presented and analysed. The first section examines the knowledge sharing for each stage of the knowledge life cycle. The second section examines the firms' management of knowledge sharing by analysing the differences across different stages of the knowledge life cycle.

5.2 Within-Stage Knowledge Sharing

In this section, an illustration of the knowledge sharing carried out by the firms will be provided for each of the knowledge stages. The illustration of the knowledge sharing carried out in the Creation, Mobilisation and Diffusion, and Commoditisation stages will draw from empirical evidence gathered from Kappa Pte Ltd, Digamma Sdn Bhd and Iota Pte Ltd, and Alpha Singapore, respectively.

5.2.1 Knowledge Sharing in the Creation Stage

To illustrate knowledge sharing in the Creation stage, Kappa Pte Ltd (hereafter referred to as Kappa) will provide the setting for how it manages its knowledge sharing. Kappa is an e-business enabler focusing on providing Customer Relationship Management (CRM) tools to businesses that have or wish to have a web presence. CRM tools, referred to also as community tools, allow a business to understand its customers more thoroughly such that it can better meet their needs. Kappa's CRM tools enable its clients to profile their customers with respect to the customers' declared attributes, for example their age, occupation and so on, the customers' behaviour on-line, and the customers' buying habits or transactional profile, in order to manage their relationships with these customers more effectively. Kappa's capabilities in CRM tools includes enabling businesses to have virtual community tools and services like chatting, forums, and clubs on their websites. Kappa offers these tools as an application service provider (ASP), which houses these applications in its server that its clients can access. It is also able to provide these CRM tools through other channels of delivery other than the

Internet, including on mobile communications devices, like mobile phone sets, and interactive television.

Kappa's organisational knowledge belongs primarily to the creation stage. It believes that it is an innovative company in terms of applying technology to provide solutions to its clients. Before being spun off from a government statutory board, Kappa was one of the first ASP providers of community tools in the region. Two examples of Kappa's pioneering efforts in the CRM field are, firstly, the application of voice recognition technology to CRM tools, and secondly, the delivery of CRM tools using interactive television as a platform. Both voice recognition and interactive television are areas where no other CRM players have entered and the markets for these solutions have yet to exist. Its Chief Development Officer summarised its organisational knowledge as follows,

"We are certainly an innovator, sometimes we think we are even too early for the market."

5.2.1.1 Informal Knowledge Systems

Informal knowledge sharing takes place throughout the entire firm, and mostly in the context of commercial projects aimed at delivering customised CRM tools to clients. Knowledge sharing occurs predominantly within and between the two main divisions of the firm: the business development division, which takes care of sales and marketing, and the technical development division.

For Kappa, its organisational knowledge has a major component that is embedded in the experience of its employees. Its Chief Development Officer expresses it this way,

"There are two aspects of knowledge, one is the know-how…what is inherent in the experience of the people, the skills. The other one is actually the IPR (Intellectual Property Rights)…what is actually [the] manifestation or [form of product] of that knowledge. "

As a result of the knowledge residing in individuals, face-to-face interaction between employees is the main form of knowledge sharing mechanism in Kappa. The wealth of individual knowledge can be tacit and cannot be expressed in codified forms very efficiently. Face-to-face interaction allows real-time interactive communication where doubts can be quickly cleared and ambiguity clarified. Face-to-face interaction emerges as the predominant form of informal knowledge sharing due to its efficiency of sharing individual knowledge. It is a conscious decision within the firm to encourage face-to-face interaction to achieve knowledge sharing and the firm tries to do this by keeping

employees within close proximity of each other. Kappa's President and Chief Operating Officer explains,

"We try to put people working in similar areas together, as close to each other as possible. We believe that you have to have some physical contact to have the kind of water cooler effect."

These inter-personal exchanges range from just "shouting across the aisle" to scheduled meetings as described by the Technical Team Leader,

"During the weekly meetings, because…[in] our technical team, each of us [is] running our different projects and in some cases using different technologies, so we try and share with each other, what are the problems we encountered you know, you can try this, what is the new area, what are the interesting things that you encounter, so we try and…help each other out."

The importance of location of staff to ad-hoc face-to-face knowledge sharing in Kappa was clearly highlighted when the opposite happened. As the number of people in the firm grew, Kappa has had to lease an additional office site, on the same street as the original office, to house the technical staff of about 15 people while the business development team remained. Within the respective offices, communication for knowledge sharing is frequent and effective, but the communication across technical and business teams have suffered. The Chief Development Officer explains,

"We used to be together, then the team grew too big and we had to look for another place. So after that happened, we find that actually the interaction dropped, so actually physical proximity is actually very important for communication."

Other forms of informal information exchanges supplement the face-to-face interactions between members of Kappa. The staff would forward interesting or relevant websites or articles to each other through e-mail, share program codes that they have written, and refer to project documentation of previous projects they have done. Hence, the communication pattern within Kappa can be characterised by widespread and active informal two-way knowledge sharing between every member.

The above forms of informal knowledge sharing usually take place in the context of a project team assembled to handle a client order. For Kappa, a project team consists largely of technical developers. The business development team that concluded the sale will have input to the project design in terms of relaying customer's requirements. The business development side also checks in during the project to ensure that customer requirements are met. The knowledge background of a team member forms the most

important criterion for his or her selection to the team by the project manager, as the Technical Team Leader puts it,

"It's mainly 2 things, one is capability, the other is availability. So let's say you have this project based on Java…and there is this guy who is good in it, we will try to get him. Of course if he is on a…higher priority project, then [we have] no choice, we go for the next better choice in that sense."

Capability is not perceived merely as a reflection of the member's ability to do the job, but also as his or her potential to be a source of knowledge for sharing, and an indication of absorptive capacity when knowledge is being shared.

Consistent with the transfer of tacit and socially embedded knowledge, informal knowledge sharing in terms of how new members learn takes two distinct forms in Kappa, depending on the function an individual belongs to. The technical function uses on-the-job training, while the business development division uses mostly mentoring. The Chief Development Officer explains,

"[For] technical staff actually…a lot can be gained by just being hands-on, you know, programming, developing and all that. That learning process gives them a lot of knowledge. But for the business part…we find that people pick up things faster when they have people to talk to, when they learn from someone, when they make joint calls together, so for example, when one of my BD (Business Development) managers…go out for a sales pitch for example, we find it very helpful if a junior staff tags along to learn…which is slightly different from [the] technical [side] because [for the] technical [side, it] is like throwing you into the water and hoping that you would swim at the end of it. For sales guy, we can't just expect to throw a junior sales guy to a company and let him pitch and hope that things will come out from it, so most of the time it's more of guided learning, but [for the] technical [side] it's slightly different…a lot is self learning with a little bit of guidance from the rest."

Kappa's organisational culture supports the knowledge sharing approaches that are prevalent in the firm. Its culture is described as open, with a lot of communication, and it is socially cohesive, with a family atmosphere. The organisational culture in Kappa is partly attributable to the role the 12 co-founders played in initially establishing a casual and cohesive culture. Tie strength manifested as social cohesion between members of the firm is thought to have a positive effect on knowledge sharing, as argued by Kappa's Chief Development Officer,

"Sometimes we organise outings and all that…I think a lot of times we learn things also through mutual understanding of each other, and that comes around only when you hang around with each other more."

Top management at Kappa does not leave organisational culture to evolve in the firm by chance. It sees one of the most important roles of top management as "putting in place a right culture". This involves flexibility in Kappa's processes and also trusting and empowering employees. The firm allows, among other things, employees to have flexible working hours and to telecommute, for which the President and Chief Operating Officer provides the underlying philosophy,

> "We try to make it so that the processes are actually flexible, that is the most important thing. People don't get held back, that is we have the culture that says we want people to be able to not be slowed down by artificial processes."

This flexibility is rooted in the need for creativity and requires the firm to trust its employees, from whom it expects accountability in return. The President and Chief Operating Officer describes the culture as,

> "One that people have the initiative, imagination to create something, one…where people…enjoy working in the environment like a family, one that you have the opportunity to express your talent with no restrain. Giving people the opportunity to do what they like to do, and trusting them that they would contribute to the company. "

Knowledge sharing is perceived to benefit from this culture that the top management fosters, and which is pervasive in Kappa, as the Technical Team Leader observed,

> "You don't have this bureaucratic thing where you are afraid of office politics and all that. Our bosses are quite open in nature, so it's like you can just point out things, you don't have to worry that there are implications or whatever, so it does help, at least [from] my personal viewpoint, from what I observe. It helps in sharing. Our hours can be quite long, especially in the technical side, so for this case…it makes it easier, it's not as tiring because imagine if you come [to the office] and you have to be rigid and you have to be careful, what other people would perceive of you doing, I think it's very tiring. So it's better if you can just be yourself and relax and just do your work."

5.2.1.2 Information Technology Systems

For Kappa, where face-to-face discussions are the most important form of knowledge sharing mechanism, the most important use of information technology system is to serve as a tool to maintain an employee's knowledge network within the firm. E-mail is the most common form of IT system used to supplement the face-to-face knowledge sharing, especially for codified knowledge. The President and Chief Operating Officer observed that in the technical team, for example,

"They share their own resources as well…if you look at the e-mail trail, it's like all kinds of [information], whether it's patch reports, or the latest tricks on doing something or very good resource Websites, that's where they share. "

The secondary function of IT systems is to code and share past experiences. One form of this is a document database stored in a common file server, and another is to use forum pages in the firm's Intranet to capture the discussions. The document depository in the common file server is used to store almost entirely codified knowledge. The two main divisions of Kappa, the business development team, and the technical team organise their database according to their own needs. The business development division will archive its financial models, proposals, templates for documents and so on, whereas the technical division stores its project documentation, including product architecture or design, and programme codes. Employees of Kappa can search the common file server in the relevant directories for the documents that they need. However, the preferred mode of gathering even codified knowledge appears to be the personal contact approach, as alluded to by the Technical Team Leader,

"[For programme] codes, we maintain a common depository, so there's where we try and sort of use common code, and there [are] 2 ways, one is using common [file server], that is the more formal direct way. The other way is just to pass [by someone] you know, I want to do this, this guy may have done something similar, so look for sample codes, just try [to] modify from there."

The information technology systems employed by Kappa for knowledge sharing do not appear to be critically important for the kind of knowledge sharing it emphasises, they only play a supporting role, and even then, they are only for sharing codified knowledge.

5.2.1.3 Human Resources

The knowledge base of Kappa's human resource reflects the company's knowledge needs in order to operate in the creation stage of the knowledge life cycle. This is especially evident in the members of the technical team that actually develops the technology used in Kappa's solutions. These computer engineers that Kappa employs have rigorous technical training, have deep expert experience, and have had exposure to cutting-edge technology by working in industry-leading organisations abroad. Kappa's previous link with the government meant that it benefited from government scholarship programs which sent many talented Singaporeans to top universities in the US and UK as scholars and who ended up in the previous government-led body, and now Kappa. These

scholars brought with them the benefit of first-rate education as well as industrial exposure from the industry leaders. Kappa's Chief Development Officer explains,

"And a lot of the technical staff that we have are actually NCB (National Computer Board) scholars that came out with us [from the government statutory board], so they are graduates from the Ivy League schools and all that, some of them have experience working in Microsoft HQ and…even NCSA."

Most of its engineers, even some of its non-technical employees, have advanced degrees, for example, the three respondents for this study have at least a Masters degree in Computer Science. And Kappa exhibits a willingness to hire high calibre people in order to handle the complex, rapidly changing knowledge that it works with, as evidenced by its President and Chief Operating Officer's declaration,

"We recruit as and when we need to, we will over-hire sometimes depending on the talent. For a position, we may over-hire, just because the guy is brilliant. [If] I've got an MBA draft pick number 1, even if I don't need it, I'll take it, that's how you hope it may grow."

As far as knowledge sharing is concerned, the knowledge base of Kappa's employees is a reflection of their absorptive capacity. The experience and highly technical knowledge that its recruits have is required in order for them to be able to absorb knowledge from the prevalent training method in Kappa: on-the-job training. Hence the new recruit is expected to bring with him or her the theoretical knowledge or 'knowledge of rationality', while the training will provide the 'knowledge of experience' adjusted to the context and specific requirements of the firm. The same is true for the mentoring scheme that applies for the business development recruits.

There is no empirical evidence to suggest that Kappa links knowledge sharing-based metrics to employees' performance-based compensation, or promotion. However, evidence from Kappa's informal knowledge sharing would suggest that organisational culture of the firm will predominate as the motivational factor contributing to its internal knowledge sharing.

5.2.1.4 Discussion

It is evident that the most important form of knowledge sharing in Kappa involves face-to-face exchange of information between individuals. This is consistent with the need to transfer tacit individual knowledge, which is expected to be dominant for firms with knowledge in the Creation stage. The widespread empirical evidence of inter-personal knowledge sharing in Kappa supports communication theory and network

research suggesting that network range eases the transfer of knowledge (Rogers and Agarwala-Rogers 1976, Reagans and McEvily 2003). Furthermore, the organisational culture in Kappa that encourages strong social ties between individuals was found to be helpful to inter-personal knowledge sharing, supporting Hansen's (1999) claims that strong ties are more efficient for transfer of tacit knowledge.

The informal training methods of on-the-job training and mentoring are also consistent with those that facilitate sharing of tacit individual knowledge by emphasising experiential learning (Huber 1991), and illustration and imitation (Nelson and Winter 1982, Lam 1997, Brown and Duguid 1998).

Organisational culture in Kappa supports knowledge sharing in general where it encourages trust, risk-taking and initiative (Pan and Scarbrough 1999). More specifically, Kappa's culture encourages strong inter-personal ties that facilitate transfer of tacit knowledge (Hansen 1999).

In contrast, Kappa's approach to using IT systems as a secondary tool for knowledge sharing confirms the relatively less critical importance of codified knowledge to a firm whose knowledge is in the Creation stage. In fact, as we saw, IT systems are used primarily to support the individual knowledge networks of Kappa's employees.

The way Kappa hires its employees and the way it provides training to employees reflect a human resource management approach that controls its employees' absorptive capacity to suit its knowledge sharing needs. With knowledge in the Creation stage, which is largely tacit, possibly complex, and very often unproven, the training Kappa provides will not be as structured and codified as classroom instruction. Hence it relies on hiring recruits with advanced professional training or 'knowledge of rationality'. On the other hand, it also hires based on 'knowledge of experience' not only to handle the specific knowledge needs of the firm but in order to acquire the individual absorptive capacity for the kind of training it provides. As we have already seen, the training provided by Kappa is informal and geared towards sharing of tacit knowledge. It is also noteworthy that Kappa's emphasis on hiring experienced people with advanced degrees supports Hansen et al's (1999) argument that such employees are better suited to handle the complexity and ambiguity of unproven knowledge, hallmarks of knowledge in the Creation stage.

In general, the empirical data from Kappa's management of knowledge sharing support the theoretical conclusions expressed in the theoretical framework. The results for knowledge sharing in the Creation stage are summarised in Table 5.1.

Table 5.1: Summary of Results: Creation Stage

Organising Framework for Managing Knowledge Sharing	Knowledge Sharing Approaches/ Elements Observed	Underlying Characteristics of Knowledge Shared
Informal Knowledge Systems		
Form of Knowledge Sharing	Face-to-face interaction (extensive)	Tacit, Individual
	Use of e-mail (supporting role)	Codified
Field of Interaction	Entire firm, across functions and within project teams	Tacit
Patterns of communication	Extensive (network range) and lateral	Tacit
Informal Training	On-the-job training	Tacit, Socially Embedded
	Mentoring	Tacit, Individual
Organisational Culture	Open, Trusting (supports tie strength and creativity)	Tacit, Unproven
	Strong social relations	Tacit
Top Management	Actively fosters culture by ensuring flexibility and trust	Tacit, Unproven
Information Technology Systems		
Coding and Sharing Knowledge	Common file server (supporting role)	Codified
Creation of Knowledge Networks	Supports human knowledge network	Codified
Human Resources		
Employee Absorptive Capacity	Hires recruits with advanced formal training	Theoretical, Codified
	Hires recruits with experience	Tacit, Individual
Training	Mostly Informal (On-the-job training and Mentoring)	Tacit, Socially Embedded, Individual

5.2.2 Knowledge Sharing in the Mobilisation and Diffusion Stage

To illustrate knowledge sharing in this stage of the knowledge life cycle, empirical evidence from Digamma Sdn Bhd and Iota Pte Ltd (hereafter referred to as Digamma and Iota respectively) will be used.

Digamma's current knowledge enables it to focus on developing customised software applications for the Internet as well as for wireless communications, serving mostly customers in the telecommunications industry. The firm's four founding partners' previous experience in the telecommunications industry explains the bias Digamma has for mobile communications in addition to the Internet business solutions it offers. An example of this is Digamma's recent use of a relatively new technology combining its know-how from Internet as well as the telecommunications industry. Digamma implemented a Wireless Application Protocol (WAP) gateway for an Internet retailer that enabled the retailer's subscribers to purchase its products through their mobile phone sets. However, within the Internet and mobile communications solutions provider space, Digamma does not consider itself as creating new markets by developing radically new knowledge. The reason is the lack of R&D or people with R&D experience looking at IT technology at a fundamental level that would enable the firm to operate at the forefront of technological development. Its technical knowledge for creating Internet and wireless communications applications is based on the experience of Digamma partners and employees from their education and work. The result is Digamma's reliance on downstream technology developments initiated by the established players in the business. Digamma has a declared strategy of being a technology follower as its Managing Director describes its source of knowledge,

"So we rely on the Internet as a source of…knowledge quite heavily, also we find that whatever we are doing, chances are somebody out there has already done it before and the information is actually available on the Internet."

Iota is a one-year-old start-up focusing on providing Internet and Enterprise Resource Planning (ERP) solutions to its clients. ERP applications attempt to integrate all departments and functions across a company onto a single computer system that can serve all those different departments' particular needs. Iota is also concentrating on serving the small and medium enterprises (SMEs) in Singapore. Iota's customers consist of local companies from various industries including life sciences, manufacturing, trading, and service industry. Iota's Operations Manager summarised the state of its technical knowledge,

"I don't think we have any cutting edge technology. Our technology basically is really very [much] based on the technological leaders like Microsoft or whatever, the giants, so we actually develop

[solutions] based on their platforms. So I would put it that we are very versatile as we are able to develop our [applications], customise our customers' needs according to our technology."

As in the case of Digamma, Iota's knowledge depends largely on the experience and technical training of individuals, especially the founding partners.

For both Digamma and Iota, their organisational knowledge belongs to the Mobilisation and Diffusion stage. This is evidenced by their technological knowledge that ranges from the relatively new to the more mainstream ones. Their strategy of working off the latest technological trends created by industry leaders also indicate knowledge belonging to this stage.

5.2.2.1 Informal Knowledge Systems

For both Digamma and Iota whose knowledge is in the Mobilisation and Diffusion stage, face-to-face inter-personal communication is also the most common form of knowledge sharing. These knowledge-sharing interactions relate mostly to solving technical problems arising from project work. Digamma's Director characterises the common scenario of knowledge sharing in the firm,

"Let's say a project is broken up into various parts, ok. Everybody has his or her own role in that particular part. Sooner or later of course one person will be bound to…basically come up to a problem, or basically a wall, which first of all, of course…being resourceful, of course [you will] try to find your own answers, but…you won't be able to find answers 100% of the time, ok. So one way is…you start asking your peers, asking those who are more knowledgeable in that kind of or that particular field. In that sense knowledge transfer happens from one person to another. Another way, probably like after you ask your peer…and then, if that guy can't find it, ok, or don't know it off-hand, he or she might start looking at information from outside, Internet or stuff like that. Of course once you find the answer, you have to go back to the person who has the problem, in that sense, it's like a double knowledge transfer, first, second layer, then to outside [of the firm], get the knowledge, then you transfer [back] down, in that sense, both persons also actually grow in it. Another thing is open discussion. Ok, this particular problem, we bring it out in the open, then we have frank discussions about it."

Iota goes further by making this inter-personal and interactive knowledge sharing more efficient through organising knowledge sharing sessions as described by its Operations Manager,

"We have a knowledge sharing session, every Wednesday, where…the manager will assign different engineers or whoever when there is an interesting topic so they will be tasked to do a presentation on it. So there is where we get knowledge sharing. So everybody have their [chance to] learn their own trade and then start sharing along. This will cut down the learning curve, learning time-span."

These modes of communication suggest that the individual and tacit component of the firm's knowledge requires a face-to-face and real-time interactive approach where questions and answers can facilitate knowledge sharing.

Informal sharing of codified knowledge also takes place via IT systems like the e-mail,

"What we try to do also because we surf the Internet quite a bit, and if we come across any article or any website that is interesting, basically we forward it to each other,"

as explained by Digamma's Managing Director; or in the case of Iota, using their own IT solution in the form of an Intranet, interesting findings in various publications are shared with all employees by broadcasting them on the company Website.

Although knowledge sharing described above happens throughout the firms, the most significant field of interaction for both Digamma and Iota is the project team. It is within the context of the project teams that most knowledge sharing occurs. In both firms, the project team is cross-functional involving the sales and marketing people, and the technical people. Team members, especially the technical software developers, are selected based on their individual knowledge, explained Iota's Technical Manager,

"Ok, basically they are a bunch of people who first of course has to know software in terms of web programming. The team will comprise of a system guy who will actually look into the software infrastructure for our customers. Let's say they do not have the kind of infrastructure set-up within their premises, we will go in and have this person who actually fulfil that aspect. When it comes to software development, we will have people for example multimedia people, we have web designer, that's a must. Of course software developers themselves, so these are the people that constitute a team."

The diversity of the team members' knowledge and the inter-personal knowledge sharing among them enables the team to come up with solutions that meet the customer's requirements.

The organisational culture in both Digamma and Iota is described as open and casual, and also members have cohesive social relations. Their organisational culture supports the inter-personal knowledge sharing that is prevalent in the firms. However, it is noteworthy that this organisational culture is attributed to the hierarchically flat organisational structure, and the small size of the firms. The flat organisation brings the top management close to the operational level employees and is especially important for knowledge sharing in these two firms because the top management were mostly the

founders with the defining knowledge of the firms. Small size does not only contribute to the culture, it is also directly facilitating this kind of informal knowledge sharing by providing physical proximity of the employees. Digamma and Iota also attribute partly their organisational culture to the attitudes initially instilled by the founding members of the firm. However, both the present top management of the firms do not view their organisational culture as something the management can easily control. But nonetheless, the cultural outcome of these two firms facilitates face-to-face inter-personal knowledge sharing.

Lastly, another form of informal knowledge sharing that takes place in Digamma and Iota is on-the-job training. Iota's Technical Manager illustrates,

"On-the-job training could be things like you are thrown this project, and you are supposed to use this [programming] language to get this thing out, so you go and find your way around. And if you encounter any problem, we have people who have this skill, or skill-set. You can consult them, so you pick-up this knowledge as you go along."

5.2.2.2 Information Technology Systems

For Digamma and Iota, their information technology system consists mainly of a simple common file server. Associated with every project taken up by these firms are a number of documentations such as the solution designs and source codes, as described by Digamma's Managing Director,

"For every project we do, the materials, all the designs, the actual source codes and everything, is always available as a reference. If it's a technology that is…new to us or anything like that, we will probably come up with additional documentation, basically some guidelines and some tips, what to do, what not to do."

These are made available as references to all the developers. Code sharing is especially important for speedy development in new projects, as well as a means of learning for the developers. Iota, for example, maintains a common file server, which houses the library in which all the previously developed modules for earlier projects are stored. When developers begin on building solutions in new projects, they are expected to make use of this database of modules, as Iota's Operations Manager demonstrated with an example,

"The software engineer is supposed to know which module to use in the library, so even if you ask a second person, they will still make use of, for example the login page, they will still use the login page that is in the library. They will not go and redevelop a login page unless it is really necessary."

The knowledge database includes, in addition to the project documentations, ad hoc additions by any member of the staff who finds something relevant and saves it in the file server. These two firms do not have a dedicated team that searches, sorts and files all the relevant information in the database.

In addition, Iota also uses some of its own IT tools to achieve better internal information flow, as the Operations Manager described,

"We actually developed a desk top [software] such that it will be the first page that everybody logs in [to] when he begins the day…so you are able to see what is happening around you, people around you, people who are absent for the day, and where is this person actually. So for example if this person is at customer base, customer site, he is supposed to update his presence on the web so I'm able to see: oh ok, this guy is actually at this customer's place. So when it happens that somebody calls in, and he is not in, when I leave a message, I actually key into a message box on the screen itself. There is no paper like I am going to paste a note at somebody's place. So actually I just prompt a box and just key in whatever information that I got from the telephone. So with such tools actually we improved or I'll say enhanced the information flow in our organisation."

In fact, in Iota, one of the most important roles of the top management in encouraging knowledge sharing was thought to be promoting the use of its IT system. The Operations Manager clarifies the role he plays in pushing for the use of the desktop software Iota developed in his own firm,

"I think we act as a policeman to drive certain policy. I mean we are doing pretty well on that, you know, for example myself, if I want to drive paperless [documentation], then actually we will…have a forum announcement, we will openly question the person: why is he not using the system? For example, like last week, somebody goes on leave, he actually did not update the system, so I actually openly questioned him, why didn't he update the system. You know so that I will get immediate effect, you know, and everybody is seeing that."

The importance of maintaining a comprehensive database of codified knowledge is important to firms with knowledge in the Mobilisation and Diffusion stage as the speed with which they are able to re-use established solutions become more important.

5.2.2.3 Human Resources

Digamma and Iota have an expectation that the employee they recruit have a certain level of relevant knowledge both in terms of theoretical knowledge as well as work experience. Iota's Technical Manager explains how relevant knowledge comes into consideration when he hires,

"You have read a lot on Linux, how good Linux can be. It is actually a cheap solution, so we cannot say: let's forgo Linux, we go hand-in-hand with [only] Microsoft. That is not the way to go, I think, when it comes to doing business. So we also recognise that Linux will eventually be a way but the learning curve for Linux is [steep]…you have to be a very tech-savvy person in order to acquire Linux skills. So we have recognised that fact and in terms of hiring people, we also look for people who have skills in Linux."

Recruits are expected to be able to contribute immediately after joining the firms based on their formal training and prior work experience. Digamma's Software Engineers explains this requirement in his firm,

"They [the management] are looking for very specific people. People that can straight away, when they come in, they can do stuff already."

However, reflecting the strategy of these firms which emphasises their ability to follow technological trends set by other industry leaders, and with these trends changing very rapidly, employees' prior experience can become obsolete. Digamma's Managing Director highlights the caveat attached to employees' prior experience,

"Whatever experience you have in this industry 4, 5 years ago, it is no longer relevant today. So in terms of experience, when we are looking for people, we can only expect that with the work that he is going to do…the best you can hope for is 2 or 3 years experience [still being relevant]. Usually the premium on the 2 or 3 years experience is quite high. And if you have someone who can learn quickly…[and] shorten the learning curve, you better take on the newer guy rather than somebody more experienced."

Hence, in addition to the moderate depth of knowledge base expected of candidates for recruitment, firms with knowledge in the Mobilisation and Diffusion stage value highly the characteristic of ability to learn and adapt quickly. Digamma's Director reiterates this point,

"We always believe that in this industry, things keep changing, so what is relevant or what is even cutting edge today might not be tomorrow. So the quality of the people or the level of the knowledge we want is more like resourcefulness, and nimble, in the sense [that one] can pick up things very fast and apply."

In Digamma and Iota, the main form of training is done on-the-job. This on-the-job training takes the form of consulting other colleagues, studying previous codes, searching on the Internet and looking at reference books. Digamma's software engineer explains,

"For me, I learn by going through [projects], because when I first came in, the project I did was actually almost completed already. It just needed a few more enhancements to complete the project. So I learn by looking at the previous code that has already been written. So from there I learn what to do."

This also reflects the fact that the employees at these firms are expected to have a moderate level of experience and working knowledge, providing them with the necessary absorptive capacity. Iota's Operations Manager puts it as follows,

"Because for example if he is employed as a software engineer, there should be a certain level of technical competency already. Right, if it's a new software, then you just throw the book at him and then he starts learning…once you are a programmer, you should be able to pick up any language and if you don't know, you will ask, there are people around you [who] should be able to share knowledge."

However, at Digamma and Iota, external courses are deemed to be useful, especially those conducted by firms with more advanced technology, which Digamma and Iota are using. Digamma's Director gives an example,

"We actually sent [an employee] to Oracle training for basically Oracle application development, Java and such. I myself have been to a Microsoft professional developers' conference. It's essentially introducing what are the latest technologies that come from Microsoft and how we can utilise that to actually build up our applications and such."

A cited example of such training by Iota happened to an employee who was hired to focus on wireless computing. Since Iota has no expertise in wireless applications involving, for example, WAP (Wireless Application Protocol), this particular employee was sent for training with Iota's WAP gateway vendor.

5.2.2.4 Discussion

As firms with knowledge in the Mobilisation and Diffusion stage, Digamma and Iota share knowledge internally mainly through face-to-face informal exchange of knowledge. This form of knowledge sharing covers the tacit and individual portion of these two firms' knowledge. In this particular regard, the empirical evidence from the cases of Digamma and Iota are very similar to that found in Kappa in the Creation stage. Data here also support arguments that network range and tie strength facilitate transfer of tacit knowledge. Additionally, organisational culture in Digamma and Iota also supports strong social ties among their members. What is different about the organisational culture in Digamma and Iota from Kappa is that there is a lesser degree of emphasis by the management that the manifested culture in these firms is the outcome that they consciously pursued. This suggests possibly that the management's focus on knowledge

sharing is dispersed to other forms of knowledge sharing like sharing of codified knowledge. Informal training method like on-the-job training remains prevalent, consistent with sharing of tacit knowledge.

Important differences begin to emerge when we examine how Digamma and Iota use their IT systems and manage their human resource. Guided by their imitative strategy that tracks technology trends, which is expected for firms with knowledge in the Mobilisation and Diffusion stage, explicit codified knowledge becomes important. In an imitative strategy, high premium is placed on the firm's ability to quickly adopt new technology and apply it effectively. Speed is compromised by re-working problems that already have a solution. Hence, we saw that IT systems, which are very efficient in capturing and storing codified knowledge for re-use, being emphasised in Digamma and Iota.

In order to handle the informal knowledge sharing and on-the-job training prevalent in Digamma and Iota, they hire recruits on the basis of their absorptive capacities. This absorptive capacity is measured in terms of the recruits' formal training and prior practical experience. However, the measures of education and experience are moderated by the firms in this knowledge stage having an imitative strategy that requires staff to adapt to rapid changes, making both prior training and experience obsolete in a short period of time. Hence Digamma and Iota employ staffs that have moderate levels of advanced training and experience. Finally, because Digamma and Iota's knowledge belongs to the Mobilisation and Diffusion stage, the most advanced knowledge on a certain technology lies outside the firms, external training then makes a lot of sense to them. This is especially true for the industry leaders whose products Digamma and Iota use or whose technology they adopt and to whom they send employees for formal training.

The results for knowledge sharing in the Mobilisation and Diffusion stage are summarised in Table 5.2.

Table 5.2: Summary of Results: Mobilisation and Diffusion Stage

Organising Framework for Managing Knowledge Sharing	Knowledge Sharing Approaches/ Elements Observed	Underlying Characteristics of Knowledge Shared
Informal Knowledge Systems		
Form of Knowledge Sharing	Face-to-face interaction (extensive)	Tacit, Individual
	Use of e-mail (supporting role)	Codified
Field of Interaction	Entire firm, across functions and within project teams	Tacit
Patterns of communication	Extensive (network range) and lateral	Tacit
Informal Training	On-the-job training	Tacit, Socially Embedded
Organisational Culture	Open, Casual (supports tie strength)	Tacit
	Strong social relations	Tacit
Top Management	Does not actively fosters culture	-
	Emphasises documentation	Codified
Information Technology Systems		
Coding and Sharing Knowledge	Common file server (moderately important due to speed and cost considerations)	Codified
Creation of Knowledge Networks	Supports human knowledge network	Codified
Human Resources		
Employee Absorptive Capacity	Hires recruits with moderate formal training (considerations of knowledge obsolescence)	Theoretical, Codified
	Hires recruits with moderate experience (considerations of knowledge obsolescence)	Tacit, Individual
Training	Informal (On-the-job training)	Tacit, Socially Embedded
	Formal (especially with industry leaders)	Codified, Proven

5.2.3 Knowledge Sharing in the Commoditisation Stage

As an illustration of knowledge sharing in the Commoditisation stage, empirical data will be drawn from how Alpha Singapore (hereafter referred to as Alpha) manages its knowledge sharing. Alpha calls itself a management- and technology-consulting

firm.   Through its consulting and technology services, which form its core business activities in Singapore, Alpha applies its knowledge to deliver IT-based solutions to its clients. The particular nature of the services it offers covers a very comprehensive range, including customer relationship management, finance and performance management, human performance, business intelligence, enterprise application integration, enterprise resource planning, Microsoft solutions, security, mobile solutions, strategy and business architecture, and supply chain management. Alpha is organised to handle a wide variety of industries through its five categories of market units. The industry groups broadly classify various client firms under products, communications and high tech, government, financial services, and resources.   The respondents of this study belong to the communications and high tech market unit. Communications and high tech includes firms involved in the communications, electronics and high technology, media and entertainment industries. In Singapore, in the telecommunications industry, which falls under the communications and high tech market unit, the two bigger of the three telecommunication firms are Alpha's clients.

Alpha is part of a global group of companies. Alpha in Singapore has knowledge that belongs primarily in the Commoditisation stage. However, as a global company, Alpha's knowledge spans the stages of the knowledge life cycle. From a technology point of view, Alpha operates a network of laboratories and technology centres around the world. These centres for strategic technology and centres of excellence for new technology basically carry out research and development to find applications for the newest technologies. Examples of these technologies are wireless communication, Internet and human interface technology. It is because of this specialisation of roles of different geographically based locations that differentiate the knowledge stage of different companies of the group in different countries. Alpha Singapore concentrates mostly on delivering proven and established solutions developed internally or adopted from elsewhere those has been very well documented and are also being offered by many of its competitors. It works with commoditised knowledge.

5.2.3.1 Informal Knowledge Systems

In general, informal knowledge sharing within Alpha does not appear to be significant compared to structured formal knowledge sharing through organised training

and use of its extensive IT-based knowledge database. Intra-firm face-to-face personal exchange of knowledge is conspicuously non-existent. This is partly due to the fact that projects, or what Alpha refers to as 'engagements', are handled by project teams usually at client's site. So the truly relevant field of interaction for members of Alpha is the project team. Some level of face-to-face inter-personal knowledge sharing takes place at the project team level. Having an expert with deep knowledge in a specific field joining a project team is a common way of transferring knowledge to the other members of the team. Alpha's Senior Manager explains,

"What skill sets do we have to put in for the client? …Internally, locally we'll try and look for [those skill sets] within the country, then maybe within the region, then globally. These skills are important. I mean if you do not have the right people, the right experience, [and] sad to say, doing 3G [third-generation wireless technology] for sure in Singapore, we don't have [the experience], all right, then we start approaching Europe. I'll look into Europe, North Asia, like Korea, [and] bring those people [with the knowledge] down, within the client engagement and slowly transition knowledge to the local people."

Otherwise, the team is very structured with clearly defined roles and scope of responsibilities and authority for each member, as explained by the Senior Manager,

"In a team when we go in and do an implementation project…there is usually a pyramid structure. [You have]…probably got a partner inside there, with probably several managers, several consultants and several analysts as well. Within the scope of their responsibility…if you are talking about day to day running of the project itself at the client site, probably the project manager will make those decisions. Day to day administration of a team within that project could be taken over by the consultant or analyst. The direction on how you want to go over to client in terms of strategy or some [major] development, that decision is probably made by the client-partner."

This kind of team structure suggests that the knowledge being shared is probably highly codifiable and not very socially embedded.

Other forms of informal knowledge sharing are related to the use of IT systems. Alpha's Partner gave an example,

"Just like anybody else, you have communities, you know, bulletin boards where people go in there and contribute little ideas here and there…and invite discussions."

Organisational culture in Alpha serves as a powerful informal tool to provide the motivational drive for consultants to contribute to its formal IT-based knowledge-sharing infrastructure. At the Alpha Singapore office, across all its market units, there is a competitive culture where consultants are eager to do a good job in their projects. And contributing information from their projects to the knowledge database raises the profile

of these consultants and gives them the visibility to differentiate themselves from their peers. Alpha's Partner expresses it in this way,

"So when you finish a project, if you have some interesting sexy stuff that you think others should be aware of, you publish it, put it into the knowledge database, and there are procedures to make sure that some of this publication is captured and [made] accessible globally. And a few people like to do that, especially if you are a young consultant. It gives you visibility. By now it is [a culture]. A lot of people would want to do it, especially those who are driven to success. They want to do it. And I think like some of our projects that we have done here, as soon as the information is published, within a couple of weeks, sometimes we get a call, like recently one of our manager got a call from another manager from Mexico City, you know, [or] one of our manager got an e-mail from a manager in Amsterdam…asking for advice on certain things…asking for inputs…so I think it works."

The recognition gained from others also provides motivation to these driven consultants as they get a sense achievement and pride from their work. The Senior Manager explains the role that the knowledge database plays in this,

"Whatever we do on any engagement…our deliverables or whatever we created gets pumped back into our knowledge database. I think from a standpoint of Asia [which] started [by] pulling a lot of stuffs from the US or Europe, [where] we used to go into the knowledge database and just pulling stuffs…we have gotten to a stage whereby we are slightly more matured and as a firm in this region, we probably have enough experience and we have pumped back enough experience back to the knowledge capital, which has been used by others [outside Asia]…At the end of the day, we would want to say that we contributed something as well. It goes a long way when somebody in the US calls you about your solutions: ok, you have done this, you know, can I fly one of you over to run this through with me? I mean that brings a lot of pride to the team…Everyone wants to feel that they have achieved something in every engagement, and the only way you are going to get that recognised globally now is through this infrastructure…Now, whatever I do, when I pump [the information] back in there, the eyeballs which hit what I have done is just tremendous."

5.2.3.2 Information Technology Systems

Alpha has an elaborate, very well developed, efficient and voluminous IT system to support its knowledge sharing. It consists of knowledge databases spread across the globe that are electronically linked to form a globally accessible network for all Alpha personnel.

The knowledge database in Alpha serves the primary function of coding and sharing of best practices. The content on the knowledge database can be classified into three categories. The first kind of documentation is called business integration methodologies. These are the globally standardised methods used by Alpha consultants

to approach client projects. They contain the details on how to deal with every stage of a project, from start to end, including strategy formulation, system software design and installation, testing and so forth. Because these methodologies are standardised, they facilitate the integration of Alpha employees from other offices who join a project team, in Singapore, for instance. The second kind of documentation captures the actual experiences of teams that have handled client projects. These documentations describe the type of project, the scope of work, the estimate of the effort required, the critical success factors, issues to consider, common problems and difficulties, and the codes delivered to the clients. Thirdly, the knowledge database also contains the technologies and business thinking developed by the various technology and solution centres, and institutes operated by Alpha worldwide, as well as relevant information from industry journals, news wire reports, and research results from external institutions. In addition to being a knowledge database, the network also supports communities, with bulletin boards where Alpha staffs can share knowledge informally. Alpha Singapore maintains its own server with the local contributions connected to the global network. This local server is managed by a full-time dedicated team of administrators who search, organise, categorise, and archive all the information that goes into the knowledge database.

For a firm with knowledge in the Commoditisation stage, codified knowledge can be conveniently stored and accessed via an electronic system. The knowledge database is the first place that Alpha consultants will search before the start of a new project, even at the stage where the Partner is trying to sell a job to a client, as he explained,

"We go into our knowledge database, [and] we can find the information we have. That's the first thing we do, because it is electronically available."

One of the major reasons why the knowledge database is of such importance to Alpha consultants everywhere is the relevance of the material it stores. The occurrence of relevant or useful material is due largely to the sheer critical volume of information stored in the network. It is simply huge. The Alpha Partner described,

"It is just amazing how much information you have…you could almost say that we would seldom have to do something from scratch. …If someone has to develop a business case, you know, to deploy a new service, whatever that service is, he can always go to the … knowledge database, and if you just source around hard enough, you probably can find [that] somebody has developed a business case or financial

model for something very similar… you just need to change the parameters, so that actually helps us in the execution of the job."

The project completion time can be drastically improved if a match is found within the knowledge database for a new project, as Alpha's senior manager explained,

"If there is an exact match for the client, with what we have done…and we put it up on the knowledge database, whatever we have done is an exact match for another client, you could do the job [in]maybe half the time, and that makes a difference."

Furthermore, the detailed project documentations maintained in the knowledge database are also thought to be extremely accurate for the estimation of effort required on the part of Alpha in new matching projects as they were drawn from actual project situations. This helps to improve planning and reliability of project delivery, and reduce costs.

Because of the access provided by the knowledge database to all Alpha employees, it serves as a corporate knowledge directory in which employees can easily contact those who have expert knowledge in a particular area, which is clearly documented in the project the person or team has completed. And in this way, the knowledge database helps Alpha consultants build their knowledge network.

As discussed earlier, the IT systems employed by Alpha is important not only as a direct means of knowledge sharing, the efficiency with which the knowledge contribution of Alpha employees can be transmitted to the entire global firm also acts as a strong incentive for fostering a strong knowledge sharing culture.

5.2.3.3 Human Resources

The profile of employees hired by Alpha suggests very strongly that they are hired to take advantage of the knowledge sharing capabilities provided by Alpha's elaborate knowledge database as well as its structured training programmes. The typical hire by Alpha is a university graduate fresh out from school without any prior working experience who is able to demonstrate a certain level of analytical skills and capacity to learn new things very quickly, even those knowledge that is not in the field in which the graduate was formally trained. Alpha hires many fresh graduates who are not from the fields of computer science or computer engineering. Alpha's senior manager provides a metaphor for its hiring practices,

"Our organisation is slightly different. We hire a lot of fresh grad, like myself, I've been here since I graduated. The model we take after is very different. The model we take would be something like: we

measure an individual's potential to succeed in the organisation. Because, I mean, look at the fresh grad, you know, if you find him in an engagement, he definitely does not have the experience to do something like that. What we do is we measure his potential, it's like looking at an unpolished diamond, right, it's a diamond, you know that this is a diamond you'd pick it up."

Although making up only a small minority of the employees at Alpha, there are also occasions when Alpha hires experienced people from the industries outside the firm, and these are based on the skills and knowledge the firm needs. The senior manager explains,

"We'll say, ok, for FY2002, this is where I see the next big area of work is in. From there, we project how many managers or how many partners or how many consultants or analysts are required for that year. Do we need to hire from outside expertise to bring in to supplement the increasing demand in networks for example? If we don't have [the skills] at the point of time, are we going to hire people from outside to come into our firm just to make up the skills?"

Alpha's preference for fresh graduates is a departure from the definition of absorptive capacity, which places the highest requirement on prior knowledge of the recipient for the efficient sharing of knowledge. The knowledge content that the candidate possesses is not an important consideration because Alpha has already a knowledge database that stores a large amount of codified working knowledge. The IT systems functions as a delivery mechanism for Alpha's stored knowledge to be transferred from the organisation to the individual who apply it. So instead, Alpha focuses on hiring fresh graduates who are judged on their ability to fit into the requirements of being able to use its IT systems effectively. Hence, Alpha does not view personnel recruitment so much as a direct acquisition of the candidate's existing knowledge for the firm but more as a means to the better use of the large amount of knowledge within the firm.

Another reason fresh graduates are hired into Alpha is because Alpha provides a very structured training programme for its recruits. Alpha makes available very elaborate training programs for its employees to develop its human resources. From the new analysts to the partners, there is a training curriculum for all levels of staffs. A new analyst, for example, will undergo a standard basic training curriculum. Alpha runs a fully operational, purpose-built campus-like training facility in the US where employees from all over the world go to attend training either as trainees or instructors. According to the employees' needs, the training will progress towards electives, workshops, conferences, and seminars. Employees will go for some kind of training or another every

year.   Alpha's senior manager characterises the elaborateness of the training Alpha provides for its staffs,

> "There is in-house training, there is joint vendor training. There are conferences which we go for. Workshops which we go for, specific to clients. I mean, whatever you can imagine, we probably have it."

In terms of human resource management, Alpha's case also illustrates the interesting phenomenon where performance or perception of performance is linked to its knowledge sharing tools. We have seen how many consultants use the firm's knowledge database as an avenue to showcase their ability in a competitive internal environment. The recognition gained for their performance will lead to rewards in terms of salary increment, bonuses, promotion or sense of achievement. These outcomes provide the motivational drive for consultants to contribute more effectively to the knowledge database, thereby reinforcing the knowledge database's effectiveness to the firm.

5.2.3.4 Discussion

For Alpha, whose knowledge for the most part falls into the Commoditisation stage of the knowledge life cycle, the most important form of knowledge sharing is done through its IT system. Knowledge is shared by employees contributing to its knowledge database, and drawing previously documented knowledge from that knowledge database. This is expected of a firm with commoditised knowledge as knowledge in this stage is characterised as being so well understood that it often exists in the codified form. And Alpha stores a large amount of codified knowledge in its much valued knowledge database.   In contrast, informal and personal forms of knowledge sharing are less significant in Alpha as the tacit component of knowledge is less important to Alpha. From the point of view of cost and efficiency of knowledge sharing, Alpha's emphasis on relying on its IT system instead of inter-personal relations for knowledge sharing validates Hansen's (1999), and Reagans and McEvily's (2003) argument that weak ties are more efficient for transferring codified knowledge.

Furthermore, the importance of the IT-based knowledge database to Alpha can be analysed from the perspective that it provides the following characteristics in Alpha's IT solutions, which are critical to a firm whose knowledge is in the Commoditisation stage: low cost, high speed, customisation, and high reliability. The knowledge database helps achieve lower cost by reducing the need to re-invent existing solutions as re-use

manpower costs much less than creative manpower. Doing away with spending time on re-working problems that have ready solutions cuts down the project completion time. Having an existing proven base solution helps concentrate the project team on customising the solution to customer's needs. IT systems are a mechanism for transferring codified knowledge that is better at preventing knowledge atrophy and personal knowledge filtering than human based approaches, hence ensuring reliability of solutions generated by project teams.

The only significant field of interaction in Alpha, the project team, is structured very hierarchically, with clearly defined roles for the members, and sometimes using individuals with specific expert knowledge. This partially supports Lam's (1997) proposition that the task-specific, functionally delineated sequential structure of a project team is more effective for sharing codified knowledge.

The fact that Alpha has a huge knowledge database of codified knowledge has a significant impact on its human resource management. The availability of the knowledge database reduces the consideration given to a recruit's existing personal knowledge base. This is because IT systems, as an extremely efficient knowledge sharing mechanism for codified knowledge, moderate the role that prior individual knowledge plays in a recruit's absorptive capacity. In addition to that, Alpha's structured formal training programmes are also very effective at sharing codified knowledge. Together with the cost consideration, which is important to Alpha whose knowledge is in the Commoditisation stage, it is therefore clear why Alpha prefers to hire mostly fresh graduates. Alpha's extensive hiring of fresh graduates lends very strong empirical support to Hansen et al's (1999) contention that fresh university graduates are more suited to the reuse of codified knowledge and the implementation of known solutions

Finally, it is noteworthy that Alpha's knowledge database as a knowledge sharing tool is linked to employees' performance. This is possible because Alpha's knowledge database acts as a platform on which consultants gain recognition for their good performance. This motivates them to continue to share knowledge in this mode. This partially supports Minbaeva et al (2002) who argued that motivation for knowledge sharing relates positively to performance-based compensation.

The results for knowledge sharing in the Commoditisation stage are summarised in Table 5.3.

Table 5.3: Summary of Results: Commoditisation Stage

Organising Framework for Managing Knowledge Sharing	Knowledge Sharing Approaches/ Elements Observed	Underlying Characteristics of Knowledge Shared
Informal Knowledge Systems		
Form of Knowledge Sharing	Face-to-face interaction (restricted to within project teams)	Tacit, Individual
	Use of IT systems (supporting role)	Codified
Field of Interaction	Project teams	Tacit, Codified
Patterns of communication	Limited (narrow network range)	Tacit
	Hierarchical (From team structure)	Codified, Individual
Informal Training	Insignificant	-
Organisational Culture	Competitive (supports use of knowledge database)	Codified, Independent
Top Management	Supports culture by conferring recognition via knowledge database	Codified, Independent
Information Technology Systems		
Coding and Sharing Knowledge	Elaborate knowledge database	Codified, Independent
Creation of Knowledge Networks	Knowledge database functions as knowledge network	Codified, Independent
Human Resources		
Employee Absorptive Capacity	Hires fresh graduates (to be trained)	Codified, Proven
Training	Formal, structured training programmes	Codified, Independent, Proven
Motivation	Performance based recognition/reward (supports use of knowledge database)	Codified, Independent

5.3 Knowledge Sharing Over the Knowledge Life Cycle

In the preceding sections of this chapter, results and analyses have been presented for the individual stages of the knowledge life cycle. In the following sections, the results will be analysed across the different stages of the life cycle. The first section that follows will examine each category of knowledge sharing management and discuss the similarities and differences across stages. The second section summarises the overall

results and their theoretical implications on the knowledge life cycle perspective on managing knowledge sharing.

5.3.1 Comparison By Categories

The empirical results across stages of the knowledge life cycle of each category of the organising framework for managing knowledge sharing will be discussed in the following sub-sections.

5.3.1.1 Informal Knowledge Systems

The results from the case firms showed that the form of knowledge sharing predominant in a particular stage of the firm's knowledge is determined by the extent to which its knowledge is tacit or codified. Informal knowledge sharing, in the form of face-to-face inter-personal interactions either as ad-hoc discussions or informal training methods like on-the-job training or mentoring schemes, is especially affected by the relative significance of tacit knowledge and individual knowledge in the firm. Informal knowledge sharing was most important in the Creation stage, less so in the Mobilisation and Diffusion stage, and almost insignificant in the Commoditisation stage. Hence, the results of this study validates the hypotheses that informal knowledge sharing will be more prevalent in the Creation stage because of the higher proportion of tacit and individual knowledge in this stage. Furthermore, the corresponding decrease in importance of informal knowledge sharing across the Mobilisation and Diffusion stage, and the Commoditisation stage provides strong support for tacit and individual knowledge as the deciding factors for firm's use of informal knowledge sharing.

In terms of patterns of communication, its effects on knowledge sharing based on the evidence from the cases in this study are not as clear. Theory suggests that lateral patterns of communication encourage knowledge sharing in general. In the Creation stage, and the Mobilisation and Diffusion stage, physical proximity of members of the firms allowed for lateral communication, which facilitated informal knowledge sharing of tacit knowledge. On the other hand, in the Commoditisation stage, the relative lack of lateral communication in Alpha, inferred from the fact that teams are often situated at clients' sites, although negatively impacting informal knowledge sharing, seems to have no impact on the more formal sharing of codified knowledge.

As far as organisational hierarchy is concerned, we observed that flat organisations facilitated the informal sharing of the tacit component of knowledge in these firms with knowledge in the Creation, and the Mobilisation and Diffusion stages. Conversely, Alpha, which shares its largely codified knowledge of the Commoditisation stage through its knowledge database, employs a very hierarchical team structure to handle its projects.

Organisational culture is very evidently a powerful informal tool for encouraging knowledge sharing across all stages of the knowledge life cycle. However, different cultures foster different kinds of behaviour that helps foster different forms of knowledge sharing. In the Creation stage, an open and trusting organisational culture encourages strong personal ties between members of the firm that makes transfer of tacit knowledge more efficient. On the other hand, a competitive culture in a firm with knowledge in the Commoditisation stage that recognises members who contribute to its knowledge database encourages other members to codify knowledge and share knowledge through the firm's IT systems.

Top management has, to some extent, an effect on knowledge sharing across all stages of the knowledge life cycle. Top management's influence is manifested through the firm's organisational culture. Top management encourages an open and trusting culture by the examples of their own actions in interactions with other staffs, especially in flat organisations, or through the values and attitudes instilled by founders of the firm. Top management can also encourage a competitive culture where employees are rewarded for exhibiting certain knowledge sharing behaviour.

5.3.1.2 Information Technology Systems

The use of IT systems is clearly dictated by the need of a firm to handle its codified knowledge. As the results of this study show, the use of IT systems as a means to code and share knowledge is increasingly important as firm knowledge moves through the stages of the knowledge life cycle. This is consistent with the fact that codified knowledge becomes the increasingly predominant form of organisational knowledge as one moves from the Creation stage to the Mobilisation and Diffusion stage, and finally to the Commoditisation stage.

We have also observed that the use of IT systems is also related to cost considerations. In the Mobilisation and Diffusion stage, and more so in the Commoditisation stage, the efficiency of IT systems to enable a firm to complete projects and provide IT solutions at a cheaper cost and faster speed is critical to the firms when they compete in their environments within these stages of the knowledge life cycle.

IT systems support a firm's knowledge network in different capacities depending on the knowledge stage of the firm. In the Creation stage, IT systems play a supporting role in maintaining employees' knowledge networks. The main interactions in these employees' knowledge networks involve face-to-face discussions or meetings. IT systems supplement these face-to-face interactions by serving as an efficient conduit for transferring codified knowledge for example data, charts and programme codes. In the Mobilisation and Diffusion stage, codified knowledge becomes more important, hence the approach to using IT systems to support employees' knowledge network becomes more structured. Finally, in the Commoditisation stage, because most of the firm's knowledge can be codified, the IT systems become the employees' knowledge network.

5.3.1.3 Human Resources

In the different stages of the knowledge life cycle, a firm needs to manage knowledge sharing by looking at the different absorptive capacities of its human resource. To raise the level of absorptive capacities of a firm's existing human resource, it can provide training for its employees. In the Creation stage, the need to share tacit knowledge results in the adoption of informal non-classroom type of training. Tacit and individual knowledge may be more efficiently shared via mentoring. Tacit and socially embedded knowledge may be efficiently transferred by observation and practice via on-the-job training. In the Commoditisation stage, the need to transfer largely codified and well-established knowledge can utilise formal training methods. The transfer of independent codified knowledge can exploit the broader coverage of classroom instruction.

The different requirements of absorptive capacity of the knowledge stages affect the hiring approaches used. The Creation stage requires that the firm hires recruits with rigorous theoretical knowledge and deep experience to deal with the unproven and complex knowledge inherent in this stage of the knowledge life cycle. From an

absorptive capacity point of view, a recruit's deep experience provides the common knowledge that eases knowledge sharing of tacit knowledge using informal training methods. The recruit's formal training makes up for what the firm provide: structured training. In the Mobilisation and Diffusion stage, the requirements for experience is moderated and formal training requirements are less stringent as the firm emphasises a recruit's ability to learn quickly and adapt to rapid changes. In the Commoditisation stage, the availability of IT systems to store and transfer codified knowledge, and the use of structured formal training programmes allow the firm to hire fresh graduates with little prior experience.

Table 5.4: Summary of Generalised Results: Across the Knowledge Life Cycle

	Creation Stage	Mobilisation and Diffusion Stage	Commoditisation Stage
Informal Knowledge Systems			
Form of Knowledge Sharing	Face-to-face interaction (very significant)	Face-to-face interaction (significant)	Face-to-face interaction (moderate to insignificant)
Field of Interaction	Entire firm, across functions and within project teams	Entire firm, across functions and within project teams	Restricted to project teams
Patterns of communication	Extensive network range and lateral	Extensive to moderate network range and lateral	Moderate to narrow network range and hierarchical
Informal Training	Experiential learning (significant)	Experiential learning (significant to moderate)	Experiential learning (Moderate to insignificant)
Organisational Culture	Supports strong ties and creativity	Supports strong ties and moderately supports use of IT systems	Supports use of IT systems
Information Technology Systems			
Coding and Sharing Knowledge	Simple to moderate IT systems used in supporting role	Simple to moderate IT systems used moderately	Moderate to elaborate IT systems used extensively
Creation of Knowledge Networks	Supports human knowledge network	Supports human knowledge network	Functions as knowledge network
Human Resources			
Employee Absorptive Capacity	Hires recruits with advanced formal training	Hires recruits with moderate formal training	-
	Hires recruits with experience	Hires recruits with moderate experience	Hires fresh graduates
Training	Mostly Informal (experiential learning)	Informal (experiential learning) and formal (courses)	Formal, structured training programmes

By analytically generalising the empirical results discussed in sections 5.3.1.1, 5.3.1.2, and 5.3.1.3, a summary of generalised results is shown in Table 5.4. Analytic generalisation is achieved by using an observation to explicate the underlying theoretical relationships between the observed variables. In this study, an analytic generalisation would involve using an observed knowledge sharing behaviour in a case to explicate the effects that the underlying characteristics of that knowledge have on how it is being shared. This is in contrast to statistical generalisation where the observation made is generalised to a larger population.

5.3.2 Managing Knowledge Sharing: Comparison Between Stages

The management of knowledge sharing in a particular stage of the knowledge life cycle, taken as a whole, when compared across the other stages, leads to the following two conclusions that support the thesis of this study.

First, the results from this study clearly show that the determinant of knowledge sharing approach used by a firm is the underlying nature of the firm's knowledge. Across all the stages, empirical data show that the characteristics of organisational knowledge are a sufficient factor to explain the choice or manifestation of knowledge sharing approaches in a firm (see Tables 5.1, 5.2, and 5.3 on pgs. 63, 72, and 81 respectively). Furthermore, the evidence laid out in the preceding sections of this chapter also validate almost all the theoretical predictions of relationship between characteristics of knowledge and choice of knowledge sharing approach as summarised from extant knowledge sharing literature. The results also illustrate that the most important characteristic of knowledge in a firm that determines the knowledge sharing approach lies on the spectrum between tacit versus codified knowledge. Other characteristics like individual versus organisational knowledge, social embeddedness, complexity, provenness of knowledge also showed an effect on the relevant elements of management of knowledge sharing.

Second, Table 5.4 shows that for each stage of the knowledge life cycle, there is a distinct set of knowledge sharing approaches that should be adopted. The most significant conclusion arising from this result is that it validates the knowledge life cycle perspective of managing internal knowledge sharing. Because the knowledge sharing approaches are demonstrably different in significant ways for the different stages of the

knowledge life cycle, therefore the stage of a firm's knowledge in the knowledge life cycle can be used to determine the knowledge sharing approaches that the firm should adopt. The use of the knowledge life cycle perspective is justified because the argument was made that stages of the knowledge life cycle are a meaningful way to group characteristics of firm knowledge. Empirical evidence also shows that characteristics of firm knowledge determine knowledge sharing approach. Hence distinct knowledge sharing approaches by stage demonstrates that stages of the knowledge life cycle are also a meaningful way to group knowledge sharing approaches, which is the premise of the knowledge life cycle perspective. This will also have an impact on the managerial implications of the results.

5.4 Conclusion

In this chapter, the empirical data from the case studies have been presented. The results were presented firstly as knowledge sharing within each stage of the knowledge life cycle. This is followed by within-stage analyses where the results showing the relationships between characteristics of knowledge and the knowledge sharing approaches used mostly validated theory from literature. Cross-stage analyses were also presented. The results presented supported the thesis of this study.

Chapter 6

Conclusions

6.1 Introduction

This chapter summarises the results of this study and highlights its conclusions. The theoretical and managerial implications of these results will also be presented. The arguments will be put forth to support the contributions made by this study. This will be followed by a discussion on the limitations of the research findings, as well as recommendations for further research.

6.2 Research Findings

Motivated by the increasingly wide acceptance that knowledge can be a source of sustainable competitive advantage to firms, many firms see the need to manage their knowledge effectively. One fundamental aspect of knowledge management is how firms can effectively share knowledge internally within themselves. Internal knowledge sharing has been found to be difficult. Combined with the known knowledge intensity of the IT industry, this study set out to answer these research questions:

a) How do IT-related firms manage their internal knowledge sharing?
b) What factors determine the firms' approaches to managing their internal knowledge sharing?
c) How do the firms' approaches to knowledge sharing differ with the stage in the knowledge lifecycle of their knowledge?

By analysing extant knowledge sharing literature, a theoretical framework incorporating the knowledge life cycle is developed to examine internal knowledge sharing. Empirical data is collected using a multiple case study approach based on the theoretical framework to answer the research questions above. The research findings are summarised below.

Internal Knowledge Sharing in the Case Firms

The case study approach used in this research provided rich empirical data to illustrate how IT-related firms manage their internal knowledge sharing. Based on the structure of the theoretical framework, the knowledge sharing approaches of IT firms in each stage of the knowledge life cycle are summarised in Table 6.1.

Table 6.1: Knowledge Sharing in the Stages of the Knowledge Life Cycle

	Creation Stage	Mobilisation and Diffusion Stage	Commoditisation Stage
Informal Knowledge Systems			
Form of Knowledge Sharing	Face-to-face interaction (extensive)	Face-to-face interaction (extensive)	Face-to-face interaction (restricted to within project teams)
	Use of e-mail (supporting role)	Use of e-mail (supporting role)	Use of IT systems (supporting role)
Field of Interaction	Entire firm, across functions and within project teams	Entire firm, across functions and within project teams	Project teams
Patterns of communication	Extensive (network range) and lateral	Extensive (network range) and lateral	Limited (narrow network range) and hierarchical (from team structure)
Informal Training	On-the-job training and Mentoring	On-the-job training	Insignificant
Organisational Culture	Open, Trusting (supports tie strength and creativity) with strong social relations	Open, Casual (supports tie strength) with strong social relations	Competitive (supports use of knowledge database)
Top Management	Actively fosters culture by ensuring flexibility and trust	Does not actively fosters culture but emphasises documentation	Supports culture by conferring recognition via knowledge database
Information Technology Systems			
Coding and Sharing Knowledge	Common file server (supporting role)	Common file server (moderately important due to speed and cost considerations)	Elaborate knowledge database
Creation of Knowledge Networks	Supports human knowledge network	Supports human knowledge network	Knowledge database functions as knowledge network
Human Resources			
Employee Absorptive Capacity	Hires recruits with advanced formal training and experience	Hires recruits with moderate formal training and moderate experience (considerations of knowledge obsolescence)	Hires fresh graduates (to be trained)
Training	Mostly Informal (On-the-job training and mentoring)	Informal (On-the-job training) and formal (especially with industry leaders)	Formal, structured training programmes
Motivation	-	-	Performance based recognition/reward (supports use of knowledge database)

Determinants of Internal Knowledge Sharing Approaches

The results of this research shows that it is the underlying characteristics of the knowledge being shared that determines how the knowledge is being shared (see Tables 5.1, 5.2, and 5.3 on pgs. 63, 72, and 81 respectively). In general, the results obtained here validate existing literature's hypotheses about the effects of particular characteristics of knowledge and its sharing mechanism, for example, that codified knowledge is more efficiently shared through IT systems. The most significant characteristics found in this research that affect how knowledge is shared in a firm are the extent to which the knowledge is tacit and, conversely, the extent to which it is explicit or codified.

Differences in Internal Knowledge Sharing Approaches Between Knowledge Stages

Specifically, through the knowledge life cycle, from Creation stage, through Mobilisation and Diffusion, to Commoditisation stage, we can conclude the following about each element of how knowledge sharing is managed from the results.

As far as informal knowledge systems are concerned, face-to-face interaction becomes less significant through the cycle, as the field of interaction narrows from the entire firm to be more team focused while network range reduces and communication patterns change from lateral to hierarchical. Informal training emphasises less experiential training through the cycle. The nature of firm's culture shifts from one that supports strong ties and creativity to one that increasingly support the use of IT systems.

Consistent with this change in organisational culture, the Information Technology systems' role changes from simple structures that supplement informal knowledge sharing to elaborate systems that are used extensively for coding and sharing knowledge. In Information Technology systems' capacity to create knowledge network, it changes from one that supports human knowledge network to one where the IT system form the core of the knowledge network.

In managing human resources for knowledge sharing, firms through the cycle tune their employee absorptive capacity by hiring from recruits with advanced formal training to recruits whose specialisation becomes less relevant to the firm. In the same vein, through the cycle, recruits' experience becomes less significant as more fresh graduates are hired. Training programs as a means to develop human resources changes

form one that is mostly informal, emphasising experiential learning to one that is formal and structured.

Table 6.2: Summary of Generalised Results: Across the Knowledge Life Cycle

	Creation Stage	Mobilisation and Diffusion Stage	Commoditisation Stage
Informal Knowledge Systems			
Form of Knowledge Sharing	Face-to-face interaction (very significant)	Face-to-face interaction (significant)	Face-to-face interaction (moderate to insignificant)
Field of Interaction	Entire firm, across functions and within project teams	Entire firm, across functions and within project teams	Restricted to project teams
Patterns of communication	Extensive network range and lateral	Extensive to moderate network range and lateral	Moderate to narrow network range and hierarchical
Informal Training	Experiential learning (significant)	Experiential learning (significant to moderate)	Experiential learning (Moderate to insignificant)
Organisational Culture	Supports strong ties and creativity	Supports strong ties and moderately supports use of IT systems	Supports use of IT systems
Information Technology Systems			
Coding and Sharing Knowledge	Simple to moderate IT systems used in supporting role	Simple to moderate IT systems used moderately	Moderate to elaborate IT systems used extensively
Creation of Knowledge Networks	Supports human knowledge network	Supports human knowledge network	Functions as knowledge network
Human Resources			
Employee Absorptive Capacity	Hires recruits with advanced formal training	Hires recruits with moderate formal training	-
	Hires recruits with experience	Hires recruits with moderate experience	Hires fresh graduates
Training	Mostly Informal (experiential learning)	Informal (experiential learning) and formal (courses)	Formal, structured training programmes

The results from this study clearly show that for each stage of the knowledge life cycle, a distinct set of approaches to managing knowledge sharing emerges (see Table 6.2). This outcome is important because it justifies the claim that knowledge sharing should be managed by a firm according to its knowledge stage in the knowledge life cycle. The premise for adopting the knowledge life cycle model as the theoretical framework for this study had been that the stages in the knowledge life cycle offer an

intuitive and meaningful way of bundling characteristics of knowledge to be treated as independent variables. And since the use of individual elements of knowledge sharing approaches had been shown to be sufficiently explained by the underlying characteristics of knowledge in the cases. Therefore, empirical evidence showing significant difference of knowledge sharing approaches between the stages validates the argument that a firm's knowledge stage in the knowledge life cycle is a meaningful way of bundling knowledge sharing approaches. In other words, a firm's knowledge stage in the knowledge life cycle can also be used to guide how its internal knowledge sharing should be managed.

6.3 Theoretical Implications

The majority of theoretical implications arising from the results of this study are associated with the role of characteristics of knowledge and their effects on knowledge sharing.

The results of this research established that the characteristics of knowledge being shared are the best determinants of how the knowledge should be shared. It was found that different characteristics of knowledge have an effect on different elements of knowledge sharing approach and to different extents. The results here suggest that the key characteristics of knowledge that determine the use of informal knowledge systems and information technology systems in a firm are tacitness and codifiability of knowledge.

The conclusions above contrast with a body of research that considered organisational and structural impediments to communication in knowledge networks as the main problems of effective knowledge sharing. These works posited that the extent of motivation (Gupta and Govindarajan's 2000), strong ties (Hansen 1999), network relations (Hansen 2000), social cohesion and network range (Reagans and McEvily 2003), and network centrality (Tsai 2001) determines effective knowledge sharing. The results of this study showed that it is the characteristic of the knowledge being transferred that determines the effectiveness of a particular knowledge sharing approach. These organisational and structural conditions are intermediate outcomes that do not by themselves determine the appropriate knowledge sharing approach to be used. An illustration is that the effectiveness of a knowledge sharing approach like using an IT-

based knowledge database can be low even if motivation to share is high, or network range in extensive, if the knowledge to be transferred is tacit.

The theoretical framework employed in this research incorporated the knowledge life cycle as a systematic approach to organising characteristics of knowledge as independent variables. No prior known research on knowledge sharing has focused as systematically on characteristics of knowledge using a structured framework to examine knowledge sharing as has this study. For example, Szulanski's (1996) concept of 'internal stickiness' highlighted the difficulties of transferring internal best practices. He argued that the lack of absorptive capacity of the recipient, causal ambiguity, and an arduous relationship between the source and the recipient are the three most important causes of internal stickiness. The results of this study extended our understanding of the effects of characteristics of knowledge on effective management of knowledge sharing beyond the limited scope of Szulanski's (1996) causes of internal stickiness.

The findings of this research also extend the conclusions of Lam's (1997) study on the concept of 'knowledge embeddedness' as an impediment to knowledge sharing. In effect, Lam's (1997) case study is a contrast between knowledge sharing approaches used to share embedded knowledge and independent knowledge, where the concepts of embedded knowledge and independent knowledge each embodies some underlying characteristics of knowledge. The use of the knowledge life cycle model in the theoretical framework broadened the scope of this study compared to Lam's (1997). The use of the stages of knowledge life cycle covered a broader range of characteristics of knowledge and the use of informal knowledge systems, information technology systems, and human resource management includes a more comprehensive range of knowledge sharing approaches for analysis. Lam's (1997) single-case study approach also missed out the opportunity to compare across cases with differing characteristics of knowledge, so instead, she attributed the differences of knowledge sharing approaches to national culture. In this study however, the multiple case study approach required by the knowledge life cycle perspective highlighted the role of characteristics of knowledge in differentiating knowledge sharing approaches across stages.

The use of the knowledge life cycle model in this research incorporated a dynamic dimension to the study of knowledge sharing. As a piece of knowledge evolves

through its life cycle, it exhibits different characteristics. Our results have shown that characteristics of knowledge determine knowledge sharing approaches. Hence knowledge in distinct stages will require distinct approaches to manage it is shared, which the results also validate. Therefore, this research established the principle that for a firm that can determine the stage of its knowledge at any one time, it can use its knowledge stage as a guide to decide a set of approach to manage its knowledge sharing. Most literature on knowledge sharing treats firm knowledge as a static entity.

6.4 Managerial Implications

The results of this research highlights to industrial practitioners that the underlying characteristics of their firm's knowledge are the determinants of the effectiveness of their choice of knowledge sharing approach. Hence, in order to choose the most effective knowledge sharing approaches to be applied in their firm, managers need to first understand what are the underlying characteristics of their firm's knowledge. Practitioners who are able to understand the characteristics of their firm are half way through the path to effective knowledge sharing.

However, the underlying characteristics of firm knowledge may not be easily identifiable. The knowledge life cycle model used in this study provides a useful framework to guide managers to make decisions about knowledge sharing approaches that will be effective for their organisation. The results of this study established the principle that for a firm that can determine the stage of its knowledge at any one time, it can use its knowledge stage as a guide to decide a set of approach to manage its knowledge sharing. The fundamental premise of the knowledge life cycle model is that knowledge in a particular stage in the life cycle is associated with a common set of characteristics. At the same time, the stage of knowledge is also associated with distinct indicators that are more easily identifiable than the characteristics of knowledge. Some indicators might be newness of technology, number of competitors, and number of users or customers.

The generalised results of this research can serve as a guide for managers to select the knowledge sharing approaches that are most likely to be effective for their organisations based on the stage that their knowledge belongs to (see Table 6.2 on pg. 91). The set of approaches under each knowledge stage can be viewed as a generic

strategy for managing knowledge sharing for knowledge belonging to that particular stage. This dynamic framework for managing firm knowledge sharing will be much more adaptive to the realistic needs of practitioners than recommendations based on static analysis of firm knowledge which usually claim to be universally applicable.

6.5 Contributions

The main research contribution of this thesis is the introduction of a knowledge life cycle perspective to the study of internal knowledge sharing, which is novel to the literature.

The theoretical framework employed in this research incorporated the knowledge life cycle as a systematic approach to organising characteristics of knowledge as independent variables. Stages in the knowledge life cycle are used to provide intuitive and meaningful grouping of the characteristics of knowledge. Furthermore, the knowledge life cycle model provides a dynamic perspective to the study of knowledge sharing.

The use of the organising framework for managing knowledge sharing adapted from general knowledge management (Birkinshaw and Sheehan 2002) which included the categories of informal knowledge systems, information technology systems, and human resource management widened the scope of knowledge sharing approaches studied. This extended the analysis of the effects of characteristics of knowledge on knowledge sharing. This is in contrast with most knowledge sharing literature that usually studies knowledge sharing without considering the sharing process. The empirical data from the case studies also provided a rich description of actual knowledge sharing choices that real managers make.

The results of this thesis highlight the importance of the underlying characteristics of knowledge in determining the effectiveness of knowledge sharing approach, in contrast to literature that focuses on barriers to knowledge sharing.

The contribution of this dissertation of managerial interest is the development of a guiding framework for managing internal knowledge sharing. Managers are able to apply a generic strategy for managing knowledge sharing based on the stage of their firm knowledge in the knowledge life cycle. The generic strategy consists of generalised

results of this study that provide a guideline on the particular elements of knowledge sharing approach to be used under each stage.

6.6 Recommendations for Further Research

Some areas of further research related to this study are suggested in this section. Firstly, there is a need to address the limitation of this research based on the case study approach. The conclusions for this study have been drawn based on analytic generalisation of observed empirical data to the underlying theory. In the three stages of knowledge life cycle studied here, only results from the Mobilisation and Diffusion stage were drawn from more than one case study firm. Because there are two cases to compare within this stage, there is an internal literal replication that strengthens the results from this stage. Although conclusions can still be drawn about a stage with only evidence drawn from a single case using theoretical replication (against known theory and cross-stage), it is probably recommendable to extend the multiple case requirement to every stage. To further test the generalised theoretical conclusions drawn from this study, each conclusion can be empirically tested on a large sample of firms. This strengthens the robustness of the conclusions.

Another limitation of this study is that some firm characteristics like financial strength, firm size and age may have an impact on their knowledge sharing approaches that obscure the effects of characteristics of knowledge. These effects were controlled by theoretical replication in this study. However, that increases the risk of researcher bias and inconsistency of interpretation. It is therefore recommended that the choice of case studies should try to control for these firm characteristics.

This research has devised a generic framework for firms to manage knowledge sharing internally based on the stage of their knowledge. The results also highlight to managers the importance of characteristics of knowledge in determining effectiveness of knowledge sharing approaches. However, these generalised conclusions can only serve as a guide on the choice of knowledge sharing approaches made by managers. The particular forms or manifestations of the knowledge sharing approaches to be used still depend on the contextual and practical conditions in the firms. It would be interesting to study how effective the guiding framework based on the conclusions of this study can be in practical application.

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