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**An Integration of Information Technology, Culture of Knowledge
Transfer and Innovative Work Environment in Support of
Organisational Knowledge Creation Activities**

Firas Mohammad Khalaf Alkhaldi

A thesis submitted to the University of Huddersfield in partial fulfilment of the
requirements for the degree of Doctor of Philosophy

**The University of Huddersfield
Huddersfield University Business School**

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ABSTRACT

Knowledge management and knowledge creation is recognized to be of supreme importance to the competitive advantage of organisations as well as a major agent of change in the new era of the knowledge economy. This study empirically examines knowledge creation activities in the context of the banking industry. It extends the work of Nonaka and Takeuchi (1995) and others on the theory of organisation knowledge creation by introducing the information technology infrastructure as an enabler of knowledge creation condition (ITISKCFs), accompanied by the culture and infrastructure of knowledge transfer. The research questions asked are: 'What are the characteristics of an IT infrastructure that enhance the knowledge enabling conditions, whether IT infrastructure capability can be define for knowledge creation? and 'What are the shared effects of the culture (CKT) and the infrastructure of knowledge transfer (IKT) when combined with IT infrastructure on knowledge creation activities?' A positivistic approach is adapted using quantitative data. A survey aimed at the middle managers of the financial services industry population was conducted in an effort to investigate the knowledge creation activities and to examine the relationship of knowledge enabling factors to the time spent on knowledge creation activities. Theoretical developments on organisational knowledge creation and knowledge enablers are presented and discussed. A conceptual framework is developed based on the theory and hypotheses which were generated. Variables of the research model are operationalised using confirmatory factor analysis (CFA) and the data are analysed using structural equation modelling (SEM). The results of the data analysis suggested that ITISKCFs support the activities of tacit to tacit, explicit to tacit and explicit to explicit knowledge transfer, thus leading to the creation sympathised, systemic and operational knowledge. While ITISKCFs fail to support the activities of tacit to explicit transfer and, hence, failing to support the creation of conceptual knowledge. CKT is a significant enabler of the activities aimed at explicit to explicit and explicit to tacit knowledge transfer. IKT have failed to support the activity of tacit to tacit, tacit to explicit transfer, and only one element of IKT (IKT-K&S) was a significant enabler of explicit to tacit, thus unable to support the creation of sympathised, conceptual knowledge and partially supported operational knowledge. While CKT fail to support the tacit to tacit transfer and, hence, the creation of sympathised knowledge, it was the only enabler of the conceptual knowledge; however, the statistical test suggested a significant but weak relationship.

Dedicated to:

My Wife and My Parents

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List of Abbreviation (theory)

| | |
|----------|---|
| CK | Conceptual knowledge |
| CKT | Culture of knowledge transfer |
| IKT | Infrastructure for knowledge transfer |
| IKT-CB | Infrastructure for knowledge transfer – creative behaviour |
| IKT-I | Infrastructure for knowledge transfer – integration |
| IKT-IS | Infrastructure for knowledge transfer – information systems |
| IKT-K&S | Infrastructure for knowledge transfer – knowledge and skills |
| ITI-A | Information technology infrastructure – autonomy |
| ITI-F | Information technology infrastructure – fluctuation |
| ITI-R | Information technology infrastructure – redundancy |
| ITI-RV | Information technology infrastructure – requisite variety |
| ITISKCFs | Information technology infrastructure that support the knowledge creation factors |
| KECC | Knowledge creation enabling environment |
| OK | Operational knowledge |
| OKC | Organisational knowledge creation |
| OK-rwk | Operational knowledge – real world knowledge |
| Ok-vwk | Operational knowledge – virtual world knowledge |
| PCKT | Policy - culture of knowledge transfer |
| SCKT | Socialisation - culture of knowledge transfer |
| SK | Sympathised knowledge |

| | |
|------|-----------------------------------|
| SKA | Sympathised knowledge acquisition |
| SKT | Sympathised knowledge transfer |
| SyK | Systemic knowledge |
| SyKA | Systemic knowledge accumulation |
| SyKD | Systemic knowledge dissemination |
| SyKP | Systemic knowledge processing |

List of Abbreviation (statistics)

| | |
|------------------|---|
| AFM | Absolute fit measures |
| CFA | Confirmatory factor analysis |
| CFI | Comparative fit index |
| CFI ^r | Robust comparative fit index |
| EFA | Explanatory factor analysis |
| GFI | Goodness of fit index |
| IFI | Incremental fit index |
| IFM | Incremental fit measures |
| PFM | Parsimonious fit measures |
| RMSEA | Root mean square error of approximation |
| S-B χ^2 | Scaled Chi Square |
| SCs | Standardised coefficients |
| SEM | Structural equation modelling |
| TLI | Tucker- Lewis index |
| χ^2 | Chi Square |

Chapter One

Introduction/Overview

1.0 Background to the study

The theme of organisational knowledge creation is relatively new; it draws on the enormous literature on management, sociology, innovation and learning. Today's economy has evolved from a managed economy into an entrepreneurial economy (Audretsch and Thurik, 1997); it is generally referred to as a knowledge-based economy (Quinn, 1992; Drucker, 1993; Nonaka and Takeuchi, 1995). Organisations realised that knowledge is the key asset for competitiveness and they have to deal with this emphasis on knowledge in their business. In the knowledge-based economy knowledge is considered a primary factor which leads to competitive advantage. One way of doing this is through the management of knowledge. In other words, it is to deal astutely with knowledge, which has been stressed by Senge (1990), Drucker (1993), Toffler and Toffler (1993), Nonaka and Takeuchi (1995) and Leonard-Barton (1995).

Peter Drucker observes fundamental changes in knowledge during the twentieth century.

- There was the industrial revolution where knowledge was being applied to tools, processes and products.

- Next, there was the productivity revolution when people like Taylor and Ford began to apply knowledge to human labour.

➤ The revolution we see before us now is the management revolution in which knowledge is being applied to knowledge itself.

This is by no means suggesting that traditional production factors of land and labour have disappeared; they have merely changed position (Beijerse, 1999). Provided that there is knowledge, Drucker argues, the other production factors will be easily obtained. Drucker (1993) indicated that the most essential challenge of the knowledge-based economy is to find a methodology, a discipline or a process with which information could be made productive.

In classical economies theorists have focused on land, labour and financial assets as their core production factors while, conventionally, organisations are viewed as production entities, where their function is to deal only with the relationship between input and outputs. The transaction-cost theory views the firm as an information processing machine, in which organisational members act as processing systems that extract meaning from information inputs and store these meaning for later use when deciding a new course of action. The introduction of the resource-based approach to the firm's competitive strategy (Prahalad and Hamel, 1990; Barney, 1991; Black & Boal, 1994; Collis & Montgomery, 1995; and Stalk et. al., 1992) has emerged as a new approach that is designed to assist the firm to compete effectively in this ever-changing and turbulent environment. The new resource-based theory of the firm recognises knowledge as a new reproducible production factor and views core-competency and capabilities as the core sources of sustainable competitive advantage (Prahalad and Hamel, 1990; Stalk et al., 1992). Prahalad and Hamel (1990, p. 82) defined core-competency as "*the collective learning in the organisation, especially*

how to coordinate diverse production skills and integrate multiple streams of technologies". Stalk et al., (1992) view capabilities as the general skills which convert the organisational core business processes into strategic capabilities and, hence, lead to competitive advantage. According to this view, the firm's sustainable competitiveness success lies within the boundaries of the firm through emphasising the behavioural aspects of the firm's strategy.

The realisation of the firm's key role as knowledge creator rather than knowledge applicator has led to the emergence of the knowledge-based view of the firm. According to Nonaka et al., (2000a), this new view of the firm is the most recent development in the theories of the firm. The knowledge-based view of the firm views a firm as a knowledge creating entity; the main thesis of this view is built on the argument that knowledge and capabilities to create and utilise such knowledge are the foremost important sources of sustainable competitive advantage (Teece et al, 1990, Nelson, 1991; Nonaka, 1991, 1994; Nonaka and Takeuchi, 1995; Leonard-Barton, 1995; Henderson and Cockburn, 1994; Spender, 1996; Grant, 1996).

A knowledge-based organisation, through utilising its knowledge assets (knowledge and skills) will attain a competitive advantage, by innovating, improving a process/product/services, or knowing how to do things more effectively and efficiently in a way that is hard for competitors to imitate based on their existing superior knowledge and their ability to create knowledge continuously. The climax of the knowledge-based view of the firm has led to the recognition of the significance of knowledge management in the organisation and, more specifically, to the organisational knowledge creation for sustainable competitive advantage. The

recognition of knowledge as the focal assets to the organisation success, which is increasingly dependent on its ability to create, gather, store and disseminate knowledge.

1.1 Knowledge and organisation

There is an increasing emphasis on the knowledge-based economy (Quinn, 1992; Drucker, 1993; Nonaka and Takeuchi, 1995; Leonard, 1995). This unending stream of knowledge that sustains the markets in perpetual motion calls for companies to execute continuous improvements and continuous innovation, while simultaneously limiting imitation. As a consequence of changing into a knowledge-based economy, organisations need to develop the essential competencies to be able effectively to take part in a working life that is primarily based on knowledge productivity (Kessels, 2001). Certain organisations have more information than others and turning this into knowledge gives them an advantage in ascertaining market inefficiencies, putting them in a superior position to innovate. Kuznets (1966, p. 6) asserts “*an increase in the stock of useful knowledge and the extension of its application are of the essence of modern economic growth*”. We are entering the knowledge society (Drucker 1993; Bell, 1973; Toffler 1990) in which the ownership of knowledge and information, as a source of competitive advantage, is becoming increasingly important. Sveiby (1997) argues that organisations are increasingly acknowledging that the keystone for their competitive advantage is their knowledge base. Nonaka (1991) asserts that the successful organisations are those that continually create new knowledge, disseminate it extensively all over the organisation and rapidly embody it in new process and products. For organisations to maintain a competitive advantage continuous innovation is needed. Innovation, as defined by Drucker (1993, P. 173), is the

function of knowledge to create new knowledge. Therefore, some management theorists argued that knowledge assets are as imperative for competitive advantage, if not more than physical and capital assets. Developing and managing human intellect and skills, more than managing and developing physical and capital assets, will be the dominant concern for managers in successful companies (Quinn, 1992, p.439).

In a global economy, knowledge may be a firm's finest competitive advantage (Davenport and Prusak, 1998). That competitive advantage flows from the creation, ownership, and fortification and utilisation of difficult-to-imitate knowledge assets (Teece, 2000). Some researchers and practitioners even declare knowledge as the only source of competitive advantage (see Zoonky, 1999). In a turbulent environment where every thing is changing rapidly, technology changes on a daily base, products disappear and reappear in relatively no time; continuous innovation is required to keep up with these changes. For such innovation to be sustained, knowledge is required.

Management philosophers today consider knowledge and the ability to create knowledge to be the ultimate source of a firm's sustainable competitive advantage (Nonaka et. al, 2000a). Organisations recognise the importance of knowledge as a key factor for prosperity and growth. Organisations deployed their own resources, human, financial and technological, to track, access, import and ultimately create knowledge. To conclude, knowledge is viewed by organisations as a source of competitive advantage, a corporate asset and/or agent of change. This research focuses on the knowledge creation activities and empirically examines the processes and factors involved in the management of knowledge creation.

1.1.1 Knowledge intensive organisation

The knowledge-based view of the firm (Quinn, 1992; Nonaka et. al., 2000a) positions knowledge as a key competitive resource of the organisation (Teece 2000; Drucker, 1993). Knowledge can be described either as explicit or tacit (Polanyi, 1966, Nonaka, 1991). As an explicit, when it can be made public and embedded in paper or standard operating procedures, it can be transmitted in a formal and systematic language. Knowledge can be described as tacit when it is internal to individual, a group and an organisation. Tacit knowledge is personal and context specific and, hence, it is hard to articulate and it is not easily transferable. Knowledge centric organisations are institutions that advance the development of specialised knowledge while concurrently creating co-ordination mechanism (i.e. co-operation among knowledge worker) to bring expertise together for the purpose of transforming inputs into outputs (Roberts, 1998). The transformation into knowledge economy and growth of knowledge intensive organisations has been recognised by many management philosophers (Toffler 1990; Drucker 1993; Audretsch and Thurik, 1997). In particular, Miles (2000) indicated that knowledge intensive business services have been the fastest growing share services sector. He asserted that knowledge intensive business services employ high shares of “knowledge workers” of many types. Mainly, the core role of “knowledge workers” is collecting, assembling, organising and translating knowledge resources from producers of knowledge elsewhere. In the late 1990s organisations in many economic sectors are exploring and developing management approaches and techniques to take advantage of their knowledge base and how the concept of knowledge management could deliver benefits to them. Financial services institutions are considered as knowledge and information based (Abell and Oxbrow, 2001) where key business essentials, such as client relationship,

continuous innovation, cost efficiency, risk management, global reach, employee satisfaction, bank reputations and business intelligence depend upon strong knowledge performance capabilities (Moss and Thompson, 1998). According to Abell and Oxbrow (1998) in banks the most fundamental key business imperative is risk management. Through organisational knowledge, banks can manage the complexity inherited in the trade-off between the risk and return for the benefit of their stakeholders (Marshall et. al., 1997). Recent development of information technology and the emergence of globalisation have dramatically changed the market and put more strains on the financial institutions or, more specifically, banks rely more on knowledge to advance their positions in a turbulent and volatile market and to increase their degree of competitiveness. Knowledge management development in financial institutions has been facilitated by such net technology as the internet, the intranet and the extranet which can provide a wide variety of information resources such as facilitating access to expertise and technical support, online data bases of different types. In particular, NatWest, a UK based bank, has developed a number of KM initiatives which focus primarily on culture, supported by technology. For instance, NatWest's main focus of their KM current initiative is through centralised training and development facility known as the new learning organisation (NLO), which is an intranet based capability providing services for five NatWest business units (Abell and Oxbrow 1998). As indicated earlier, the financial services industry is highly depended on information and knowledge, where the main driver for their interest in KM are information based, highly regulated, risk management, competitiveness and fast time reaction. In the light of the previous discussion, the financial services industry was seen as an appropriate business environment that is

particularly suitable to test for the research model and the knowledge creation process.

1.2 Significance of the study

This study investigates the relationship between the knowledge creation enabling environment (KCEE) and the organisational knowledge creation activities in financial organisations operating in a volatile and turbulent environment. KCEE is defined as an integration of the knowledge enabling factors; information technology infrastructure that support the knowledge creation enabling factors (ITISKCFs), the culture (CKT) and the infrastructure of knowledge transfer (IKT) that encourages and contributes to the advancement of organisational knowledge creation activities. The volatile and turbulent environment, however, calls for a new organisational knowledge creation model. The main purpose of this study is to establish the characteristics of IT and to provide a design guideline for IT environments that will enable the knowledge creation conditions to support successfully the organisational knowledge creation activities. The new perspective on IT proposed in this study is a model that shows how organisational members use IT to extend their knowledge sharing and exchanging of ideas and creating new knowledge. This new perspective differs from the previous views of IT as a way to replace management by automation, or to provide timely and relevant information to managers. Drawing on the organisational knowledge creation theories (Nonaka and Takeuchi, 1995, Leonard-Barton, 1995, Choo, 1998; Von Krogh 1998, Nonaka et. al., 2000b) and the accumulated IT studies on knowledge management and learning organisation the model developed in this study will show how support of the knowledge enabling

conditions through IT infrastructure, combined with a special type of organisational culture (the culture of knowledge transfer) and the innovative work environment (infrastructure for knowledge transfer), can help the organisational members to create and share knowledge to advance their organisation's competitive status. So the major focus of this study is about the IT enabled transformation; in other words, how an IT infrastructure can be designed in a way that will make the knowledge enabling condition more effective.

The results of this study are expected to help organisations to design an IT infrastructure that will enhance and advance the organisational knowledge creation activities and, hence, improve their innovativeness and performance. Also, the developed model in this study is expected to contribute to further our understanding of IT enabled organisational knowledge creation and organisational learning.

1.3 Questions of the study

The advancement of information technology applications has given us the ability to develop and design information systems for managers so they can deliver well-timed and pertinent information from the organisation's database. However, little is known about how an information technology infrastructure can be designed that supports the organisational knowledge creation enabling factors (ITISKCFs). The main objective of this study is to define the information technology characteristics that enhance the ITISKCFs for the design of organisations to support the knowledge creating activities. Therefore the main question in this thesis is:

What are the characteristics of an information technology infrastructure (ITI) that enhance the knowledge enabling factors' capability for organisational knowledge creation activities?

In order to answer this question, a model of ITI capability has to be defined for the knowledge enabling factors. According to Zoonky (1999), ITI can be defined in different ways, but one of the challenging tasks for an organisation is to identify which dimension/s of ITI capability is pertinent for a certain context. This study is aimed at identifying the ITI dimensions that are appropriate for the organisational knowledge creation context.

The second issue is to see whether the ITI defined dimension, when merged with other organisational variables, is an essential and decisive condition for the organisational knowledge creation (OKC) activities. This leads us to ask the following questions.

1. How do the ITI defined dimensions interact with other organisational variables? Or more precisely:
2. Does the ITI capability affect the time spent on organisational knowledge creation activities?

3. How does the culture of knowledge transfer (CKT) and infrastructure for knowledge transfer (IKT) play a role when integrated with the ITI capabilities has on the time spent on OKC?

4. Can ITI, CKT and IKT be defined to the knowledge creation-enabling environment (KCEE)?

A number of factors that affect the organisational capability to create knowledge, among them CKT and IKT are often cited as the most important. This leads us to ask the following question.

How does the KCEE affect the time spent on OKC?

1.4 Objectives of the study

The objective of this research is to expand and enhance our understanding of the enabling conditions, factors and processes that support knowledge creation. Generally, researchers who use knowledge management frameworks have focused on the transfer of knowledge rather than its creation (see for example; Inkpen, 1996; Mowery et. al., 1996; Gilbert and Cordey-Hayes, 1996; Chen, 1997; Lam, 1997; Carayannis et. al., 2000). This research identifies from the previous literature the importance of knowledge transfer, but adds an important focus on the actual creation of knowledge. While knowledge transfer and other processes, most especially those related to communications, are important elements of the overall model, the most

important focus of the research is the activities of knowledge creation. The specific objectives of this thesis are:

- to extend the theory of organisational knowledge creation by introducing ITI capability as a promoter of knowledge enabling conditions
- to extend the theory of organisational knowledge creation by adding the knowledge-enabling environment through integrating the culture and the infrastructure of knowledge transfer to ITI capability
- to extend the theory of organisational knowledge creation in the context of the services industry, more specifically, in the context of the UK banking industry.

The lack of empirical foundation of knowledge on the relationship between the knowledge-enabling conditions and the organisational knowledge creation and innovativeness has led to another objective being established.

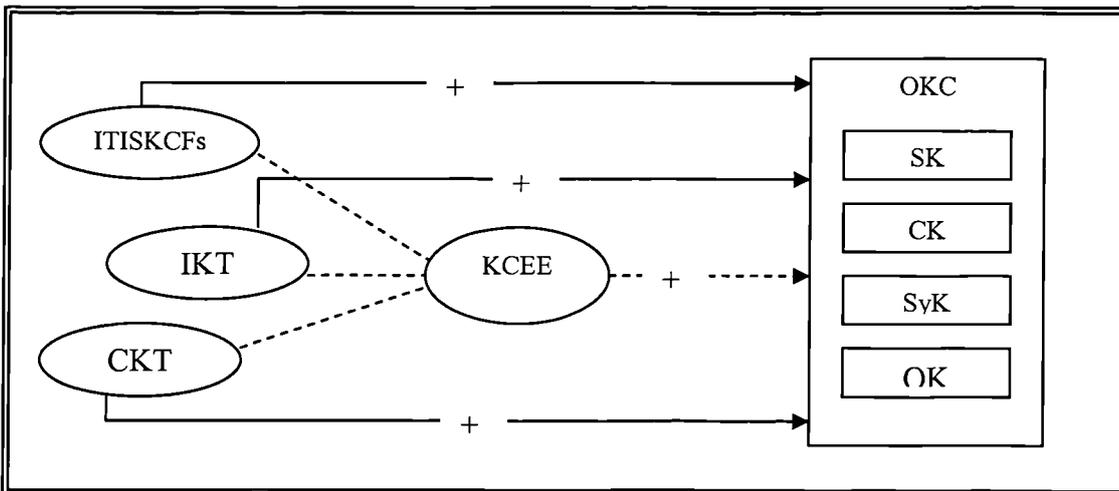
- the creation of a conceptual framework to enable organisations to understand better the relationship between the knowledge creation-enabling factors and the time spent on organisational knowledge creation.

1.5 Overview model of the research and the major propositions

It was seen as appropriate to introduce an overview version of the research model (see figure 1.1) at this early stage. The objective here is to give the reader a general idea

of the research theme since the full detailed model will come into view at a latter stage or, more precisely, at the end of chapter three.

Figure 1.1 Overview of the research model



Information technology that supports knowledge creation factors (ITISKCFs); infrastructure for knowledge transfer (IKT); culture of knowledge transfer (CKT), knowledge creation enabling environment (KCEE); organisational knowledge creation (OKC); sympathised knowledge (SK); conceptual knowledge (CK); systemic knowledge (SyK) and operational knowledge (OK)

The overview model consists of one general dependent construct that represents the organisational knowledge creation (OKC) activities which, in return, consist of four sub-constructs that represent the type of knowledge that emerges for OKC activities. These types of knowledge are termed as sympathised knowledge (SK), conceptual knowledge (CK), systemic knowledge (SyK), and operational knowledge (OK) creation activities. Each one of the OKC sub-constructs is represented by a first order hypothesised latent variable. The overview model also includes four independent constructs which are the hypothesised knowledge creation enablers: the information technology that supports the knowledge creation factors (ITISKCFs); the infrastructure for knowledge transfer (IKT); the culture of knowledge transfer (CKT);

the knowledge creation enabling environment (KCEE), where the first three independent constructs represents first order latent variables and the last (KCEE) represents a second order latent variable (completely latent). KECC can be seen as an integration of the previous three latent constructs. The bold arrows represent the direct hypothesised relationship and the dotted arrows represents a shared effect of the three enablers through KCEE on OKC. The sign represent a hypothesised direct of the relationship between the independent and the dependent constructs. More details of the research model development are provided in chapter three.

The major proposition of the research

Four major propositions were developed to satisfy the objectives of this research. These propositions were designed to test the autonomous and the shared effect that the knowledge enabling factors have on the time spent on the four types of organisational knowledge: sympathised knowledge, conceptual knowledge, systemic knowledge and operational knowledge, hypothesised by (Nonaka et al., 1991, 1994; Nonaka and Takeuchi, 1995; Nonaka et al., 2000b).

Propositions one to three are designed to test the autonomous effect of ITISKCFs, IKT and CKT on the organisational knowledge creation activities. The fourth proposition is designed to test the shared effect of ITISKCFs, IKT and CKT all represented by the knowledge-enabling environment¹ (KCEE) on the organisational knowledge creation activities. The major propositions of this study are as follows (details on the development of the research hypotheses are provided in chapter three):

¹ Information technology that supports knowledge creation factors (ITISKCFs); infrastructure for knowledge transfer (IKT); culture of knowledge transfer (CKT), and the knowledge creation enabling environment (KCEE)

P1: There is a direct positive relationship between ITISKCFs and the time spent on organisational knowledge creation activities (SK, CK, SyK, and OK).

P2: There is a direct positive relationship between IKT and the time spent on organisational knowledge creation activities (SK, CK, SyK, and OK).

P3: There is a direct positive relationship between CKT and the time spent on organisational knowledge creation activities (SK, CK, SyK, and OK).

P4: There is a direct positive relationship between KCEE and the time spent on organisational knowledge creation activities (SK, CK, SyK, and OK).

1.6 Organisation of the study

The rest of the study is organised in the following way. The investigation of the processes and structures of knowledge creation begins in chapter two, which provides a review of the literature relating to knowledge creation; Specifically, knowledge management, management of innovation and organisational learning literature as it places knowledge creation within it and demonstrates the gap in the literature that will be explored by this research.

Chapter three develops the research model of knowledge creation, starting with Nonaka and Takeuchi's (1995) model as a preliminary framework of the organisational knowledge creation theory then develops a more comprehensive model by redefining the pre-existing knowledge enabling conditions and integrating them with new enablers. The new enablers of knowledge, and Nonaka and Takeuchi's

(1995) organisational knowledge creation theory, are explained and then the knowledge conversion processes and five enabling conditions that they propose in their theory are described. In operationalising the developed model, seven general propositions are made regarding the new model of organisational knowledge creation and sixteen specific hypotheses are proposed for testing.

Chapter four describes the methodology and the method used to explore the phenomenon of knowledge creation in the financial services industry. The literature on knowledge creation was first used to explore the phenomenon of interest and develop hypotheses concerning the enabling conditions of the knowledge creation process. A survey design and analysis were employed to test the specific hypotheses that were proposed and the criteria for the evaluation of the method of data collected and analysis are elucidated. The measures used in the survey are also explained.

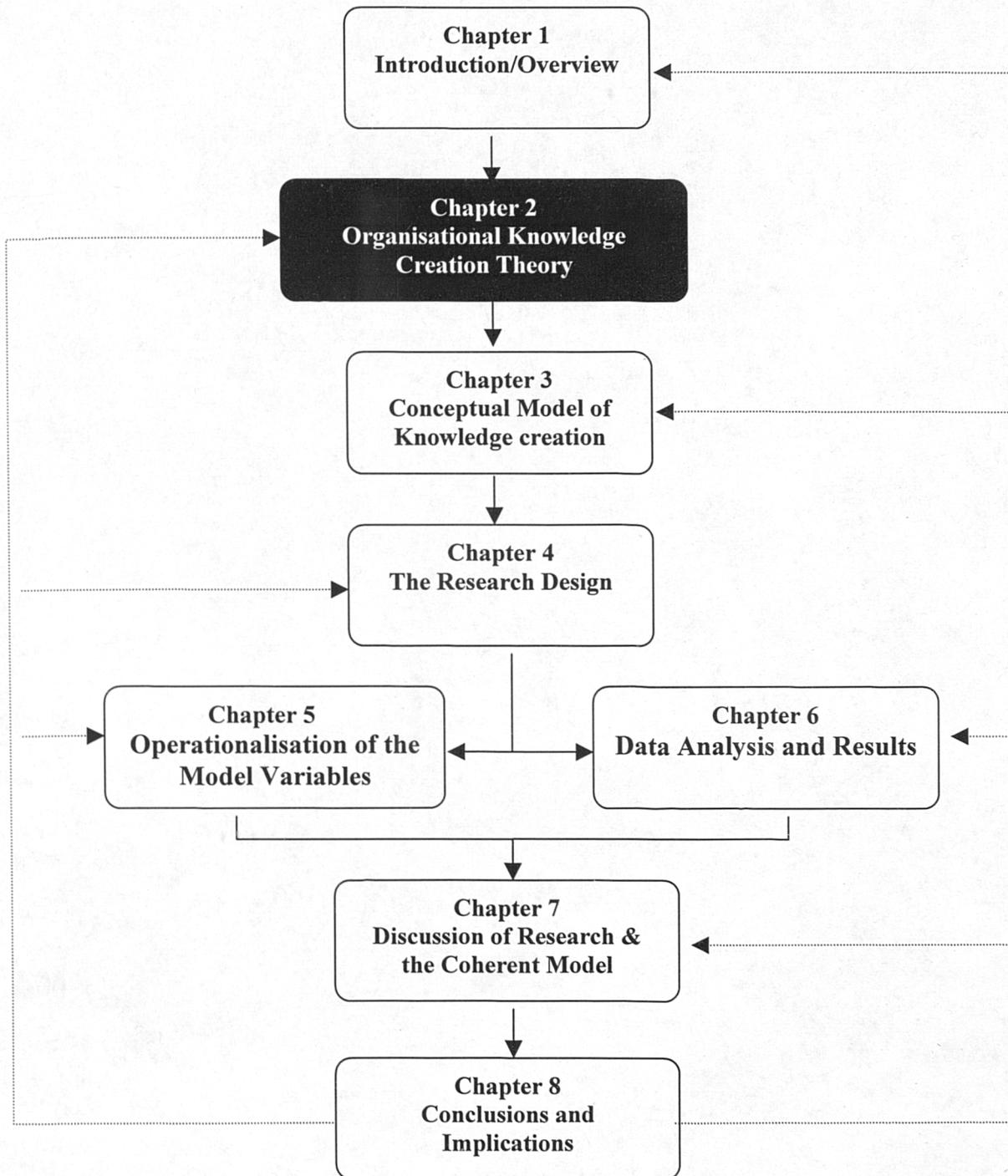
Chapter five describes the operationalisation strategy and measurement of the model's variables. A number of statistical techniques, such as factor analysis (explanatory and confirmatory) and the summated scale, are used in operationalising the variables. Chapter six draws on the findings of the previous chapter and utilises the structural equation modeling (SEM) for the data analysis and reports the statistical results of the testing of the specific hypotheses. This is followed by chapter seven where a major aspect of the chapter is discussion of the results. The chapter also integrates the findings of the two previous chapters into a coherent model of organisational knowledge creation.

Chapter eight starts with a summary of the main findings. Then the expected contributions to knowledge are proposed, followed by a discussion of managerial implications of the findings, limitations of the research and suggestions for future research.

Chapter Two

Organisational Knowledge Creation Theory

Figure 2.1 Chapter two in the context of the thesis



Chapter Two

Organisational Knowledge Creation Theory

2.0 Introduction

According to Beijerse (1999) western economies are becoming more and more knowledge-intensive. Organisations are more strongly dependent on the creation, generation, distribution and use of knowledge than ever before. Drucker (1993) clearly indicated this in his conclusions when he analysed this knowledge-based economy; his arrangement is fervently supportive of the value of knowledge and he indicated that the most important, if it is not the 'only' source of wealth in the contemporary post-capitalist society, is knowledge and information (Drucker, 1993). In classical economic theories, knowledge was viewed as outside to the economic process. These views were recently changed and new knowledge is not only seen as a key asset in companies leading to a better degree of competitiveness (Toffler 1990; Quinn, 1992; Sveiby, 1997; Davenport and Prusak, 1998); it is becoming the most important determinant of economic growth (Beijerse, 1999). In the classical theories of economic growth, technological development was seen as something that went on in an autonomous way, outside economic processes. Economic growth was justified only by the growth of the quantity of labour power and by the quality of labour power, paying no attention to the role played by knowledge in all this.

Knowledge creation as a subset of a larger concept of knowledge management are recognised as imperative enablers leading to organisational performance which, ultimately, leads to organisational success and must be anticipated and proactively

managed. Management philosophers and practitioners have recently pointed out that managing all of the activities of knowledge creation, sharing, diffusion and leveraging is vital to organizational success. In some organisations, as in the case of Dow Chemical, knowledge management concepts have been advantageously employed. On the other hand, the centre of attention is often related to the collection and proficient management of explicit knowledge as in the western organisational context (Nonaka and Takeuchi, 1995). For example, Dow Chemical exploited the knowledge management concepts, in order to save and make millions of dollars on patent costs, through utilising patents that were initially 'forgotten', discarding other patents that they could not use or sell but for which they had to pay patent costs and selling off unused and internally non-useful patents. According to Mullin, (1996) over a period of ten years this process saved Dow Chemical no less than 40 million US dollars.

The following review is an attempt to address the major theme of the literature that informs the research. The literature starts by exploring the meaning of the concept of knowledge which is an essential aspect of organisational knowledge creation. Knowledge is defined and aspects related to it that have been discussed and proposed by other researchers are explored. Organisational knowledge creation is then placed within the overall context of knowledge management. It is shown that knowledge management may be delineated generally by at least four domains, each of which is exceedingly interconnected. This chapter reviews the pertinent knowledge management research findings and the major contributions of researchers to further our understanding of the organisational knowledge creation theory. Then, the existing frameworks that model the knowledge creation process are reviewed. Finally, the

research is summarised and a conclusion regarding the gap in the literature which this research attempts to fill, is given.

2.1 Defining knowledge from different management literature

Knowledge and information

Before delving into knowledge from the management literature perspective, knowledge and information are often used interchangeably; to isolate any misunderstanding a clear distinction between the two is needed. Nonaka (1994) defines information as a flow of messages and meaning, while knowledge is creation and organisation by the very flow of information. Nonaka and Takeuchi (1995) described the similarity and differences between the two concepts; knowledge, unlike information, is about beliefs and commitment and is about action, where knowledge is a product of a particular instance and perspective. Knowledge, like information, is about meaning, which is context-specific and relational. Sanchez (2001) defined information as the meaning that is attributed to some data¹, in which comparing data with other data derives meaning, where knowledge is “*a set of beliefs about casual relationships in the world and an organisation*” (Sanchez, 2001, p.5). Boisot and Griffith (2001) defined information as the meaning that is related to an observer’s prior expectation when it is extracted from incoming data, where knowledge is the individual interpretation of the meaning of information that modifies the individual beliefs that reside in him. Knapp (1998, p. 4) sees knowledge as “*information in action, where information is mindfully applied for a specific purpose and/or during a*

¹ Data are defined by Davenport and Prusak (1998, p. 2), as “*a set of discrete, objective facts about events*”.

specific task". Davenport and Prusak (1998, 3) defined information as "*data that makes the difference*"; in other words, information viewed as a message is meant to shape up the individual that gets it, to make some difference in his prospect and insight and it only becomes knowledge when it conveys meaning for the receiver. Bailey and Clarke (2000) defined "knowledge" as "usable ideas", ideas which are current, relevant and actionable. Moving beyond the distinction between knowledge and information, knowledge can be looked at from different perspectives in the management literature, which can be viewed under the following headings.

Knowledge in the innovation management

Sanchez et al., (1996, p.9) defined knowledge as a "*set of beliefs held by an individual about causal relationships among phenomena*". Expanding their definition to the organisation, knowledge was seen as a shared set of beliefs held by individuals within a group about causal relationships among phenomena (Sanchez et al., 1996). Libeskind (1996, p. 94) defined knowledge as "*information whose validity has been established through tests of proof*". Knowledge was viewed by Johannessen et. al., (1997) as systematising and structuring information for a specific purpose. Johannessen et. al., (1999) viewed knowledge upon which action is based and it is the value added. In the knowledge-based company the value added occurs as a results of integration of ideas between the organisational members. This view supports Howells (1996), where he opines that the value added in the knowledge-based organisation for the customers comes from the communication among the members of the organisation. This is the main core in the knowledge-based theory of the firm (Grant, 1996). This is also emphasized as the resource based view (Reed & DeFillippi, 1990;

Barney, 1991; Stalk et. al., 1992; Black & Boal, 1994; Collis & Montgomery, 1995) and the new growth theory (Scott, 1989).

Knowledge in organisational learning and strategic management

Prahalad and Hamel (1990) considered knowledge to be the basic ingredient of the learning organisation, and the logical characteristic of the core competence. Nonaka and Takeuchi (1995) defined knowledge as “*a dynamic human process of justifying personal belief towards the “truth”*”. Cohen and Levinthal (1990) regarded knowledge as the basic element of the learning organisation and it is the core characteristic of “absorptive capacity”, where the ability of the organisation is to pick up new ideas and to make use of them. Accumulating knowledge will facilitate the organisational ability to create new knowledge (Cohen and Levinthal, 1990). Through knowledge accumulation, the organisation simply comprehends their objectives regarding new knowledge and, hence, is in a superior position to assess the consequence of the knowledge that they plan to acquire. Leonard-Barton (1995) asserted that knowledge accumulations for an organization could occur only by combining people’s diverse individualities within a specific set of activities. This view takes for granted that interactive learning could take place in the organisational system.

2.2 Contributions to further the understanding of general concept of knowledge

More recently, there has been a broader focus that embraces more delicate types of knowledge (such as sympathised knowledge ‘the tacit to tacit transfer’) and the entire

process of knowledge creation, as opposed to simply managing knowledge product. Researchers have established some features of distinctions in the investigation of knowledge over several years, where the most significant distinction is between tacit and explicit knowledge forms. There is a broad consensus among management philosophers that tacit knowledge is intuitive, subjective and hard to codify and transfer, whereas explicit knowledge is seen as objective and easy to codify and transfer. Polanyi (1966) classified knowledge into two dimensions, tacit and focal, where tacit is used as a tool to handle or improve what is in focus and focal knowledge is about the object in focus. Nonaka and Takeuchi, (1995) proposed two forms of knowledge: explicit objective and tacit subjective. Explicit knowledge is formal and systematic and, thus, it can be easy to communicate and share. Tacit knowledge consists of mental models and perspectives that cannot easily be articulated and shared. They asserted that knowledge first begins with the individual, which is consistent with the views of the philosopher Michael Polanyi “we can know more than we can tell”. He viewed tacit knowledge as highly personal and deeply rooted in action and in the individual’s commitment to a specific context.

2.3 The two dimensions of knowledge

Tacit knowledge

Tacit knowledge forms a consequential element in the organisational knowledge base and has a central role in organisational learning (Howells, 1996). Tacit knowledge is a practical know-how this is acquired through experience without direct instructions (Wagner, 1987; Wagner and Sternberg, 1987). It is the knowledge that is applied without thinking, generated and used by individuals without being aware of it and is

dynamic and created through repeated experience and experimentation (Raven, 1997). Michael Polanyi (1958, 1966), a philosopher, was one of the first to present and develop the concept of tacit knowledge, where tacit knowledge is used as a tool to handle what is in focus. He asserts that knowledge is a true discovery, is public and, to very great extent, is private and personal, since it is constructed by humans and, thus, contains emotions. He concluded that all knowledge is tacit or rooted in tacit knowledge. Tacit knowledge is an unsurpassed set of beliefs, perspectives, values and assumptions through which we filter and interpret what we see and do (Saint-Onge, 1996). It is hard to formalise and communicate (Nonaka and Takeuchi, 1995,1996). Tacit knowledge is about how to do things with no available verbal awareness (Myers and Davids, 1993). Choo (1998) argued that tacit knowledge is elusive, has a number of defining features. It is hard to verbalise, articulate and codify using words and symbols. Tacit knowledge is distributed in the totality of the individual's action experience and is action centred. Tacit knowledge can not be verbalised; it is contextual relative and is always acquired by people through interaction in the real environment rather than the artificial situation (Sternberg, 1996). Both Sternberg and Choo agreed that tacit knowledge could be shared, taught and learned by example. Reber (1989) concluded, in his research on implicit learning and tacit knowledge, that the latter is optimally acquired independently of conscious efforts to learn and it can be used implicitly to solve problems and make sound decisions about a novel stimulus state of affairs. An example of tacit knowledge can be viewed in the form of personal-interactions, experience and craftsmanship of experts; for example, it cannot be articulated through procedures and recipes.

Explicit knowledge

Explicit knowledge is the type of knowledge that can be expressed in language and numbers, is easy to formalise and to articulate. It refers to the knowledge that it is transferable in a formal and systematic way (Polanyi, 1996). Explicit knowledge is easy to define, capture and transfer in different formats (Bhatt, 2000). Explicit knowledge can be objective and inter-subjective (Johannessen, 1999) where it is objective, if it is public and testable.

Tacit and explicit knowledge are complementary to each other and, in the creative actions of people, they interact and influence each other. This classification of knowledge into two main types (tacit and explicit) is considered the foundation that leads to the emergence of new types of knowledge which provides a better understanding of organisational knowledge creation. The emerging new types of knowledge are discussed in the following section.

2.4 Understanding of the concept of organisational knowledge.

Teece (1998) presented taxonomies for the nature of knowledge in a business context. He classified knowledge into codified tacit knowledge and uncoded tacit knowledge. A codified knowledge can be such as blue print and computer codes. Uncoded knowledge requires face-to-face communication and is slow and costly to transmit. Baumard (1999) classified knowledge into two categories, objective-social and subjective-personal. A general agreement can be derived from the above-mentioned classification of knowledge. It can be divided into two types, an objective

and a subjective knowledge form, where both types of knowledge can be further classified based on the degree of codification and diffusions.

Boisot (1995) contrived a typology of knowledge where he classified knowledge into four types. Personal knowledge is uncodified and undiffused depicting knowledge that grows from the person's own experience and is not accessible to others. Commonsense knowledge is uncodified and diffused representing the knowledge acquired gradually overtime through experiences. Proprietary knowledge, codified and undiffused, explains the knowledge created by individuals to make sense of certain situations; public knowledge is codified and diffused, like books, lectures and journals.

Choo (1996, 1998) proposed a classification of knowledge within the organisation and he advised that it might be useful to differentiate knowledge into three types: tacit, explicit and cultural. Tacit knowledge is the implicit knowledge used by individuals to perform their tasks and to make sense of their environment. According to Choo (1998), tacit knowledge is uncodified, undiffused and learned by doing and expressed by actions. Explicit knowledge is formal and can be expressed and easily communicated. Explicit knowledge can be both an object and ruled-based knowledge. Object knowledge can be found in the form of software codes, database, patterns and so on. Ruled-based knowledge can be found in rules and routine. The third type of Choo's classification of organisational knowledge is cultural knowledge which portrays the shared beliefs, norms, ideas, assumptions, expectations and philosophy used by individuals and groups in the organisations to comprehend, justify, reckon and construct reality.

Johannessen et al., (1999) presented a typology of knowledge where he classified individual knowledge into four types of base (systematic knowledge, explicit knowledge, tacit knowledge and hidden knowledge, relationship knowledge) on the basis of attainability and how easy and difficult to communicate and comprehend. When knowledge is attainable but difficult to comprehend and relatively easy to communicate it is referred to as systematic knowledge and, according to Johannessen et al., (1999), it can be viewed as both a process and a product². Systemic knowledge is thus “*a form of split interpretation competence among the persons sharing the perspective*” (Johannessen et. al.,p.128). Therefore, systemic knowledge directly affects organisational members as to what type of explicit knowledge is pertinent and significant for the organisation. The second type of individual knowledge base is referred to as explicit knowledge where it is attainable and relatively easy to comprehend and communicate. Explicit knowledge is comprised within the individual knowledge base; it is about knowing facts, it can be as objective and public and it can be effortlessly communicated to other individuals as information. The type of individual knowledge base is concerned with the type of knowledge that is attainable but not easily comprehensible and difficult to communicate. Tacit knowledge is seen by Johannessen et al., (1999 p. 129) as the type of knowledge that can be learned through apprenticeship and experience. This view is supported in the knowledge literature (Ducker, 1993, Nonaka 1991, 1994, Nonaka and Takeuchi, 1995, 1996). Johannessen et al. (1999) went further in his definition of tacit knowledge, where he argued that, since the outcome of tacit knowledge is tangible, it can be viewed as an object and can be tested. “*Tacit knowledge is objective in the*

² a product it is knowledge on how we think, and a process it is knowledge on knowing how we know.

sense that it is objective in its consequences, i.e. empirically testable” (Johannessen et al., 1999, p. 127). Hidden knowledge can be viewed as a kind of personal paradigm that inspires the way we think and behave, synchronises the progress of mental models, the nature of the thought we make. Hidden knowledge can be classified under two modules: disposition to think and disposition to act (Johannessen et al., 1999). This type of knowledge can be regarded as the deep root of tacit knowledge since both share the characteristics of tacit knowledge, where it is attainable but not easily comprehended and communicated. The last type of individual knowledge base classified by Johannessen et al., (1999) is the relationship knowledge, which it can be extracted by establishing relationships among and between focus groups in order to draw upon their expertise. This type of knowledge is attainable, easy to comprehend, but hard to communicate.

Spender (1996) categorises organisational knowledge based on the interaction of the two types of knowledge tacit and explicit with the degree of individualism and collectiveness involved in each type of knowledge. Four types of knowledge emerge: conscious knowledge (explicit-individual), objectified knowledge (explicit-social), automatic knowledge (implicit-individual) and collective knowledge (implicit-social).

Nonaka and associates (Nonaka 1991, 1994; Nonaka and Takeuchi, 1995; Nonaka et al, 2000b) presented a typology of organisational knowledge based on the conversion of the main two types of knowledge (tacit and explicit). The conversions of knowledge between the two types were aided by a number of organisational mechanisms, such as socialisation, externalisation, combination and internalisation (for details see chapter three). The product of these conversions lead to identifying

four type of knowledge: sympathised knowledge (tacit-to-tacit), conceptual knowledge (tacit-to-explicit), systemic knowledge (explicit-to-explicit) and, finally, operational knowledge (explicit-to-tacit). Nonaka and associates viewed tacit knowledge as subjective, hard to articulate and formalised and they regard explicit knowledge as objective, rule based, easy to articulate, formalised and relatively easy to communicate.

It can be concluded that these types of knowledge: the codified tacit knowledge of Teece (1998), the objective-social knowledge of Baumard (1999), the public knowledge of Boisot (1995), the explicit knowledge of Choo (1998), the objectified knowledge of Spender (1996), the explicit knowledge Johannessen et al., (1999), the systemic knowledge of Nonaka and associates (Nonaka 1991, 1994; Nonaka and Takeuchi, 1995; Nonaka et al, 2000b), have a common denominator in that they are objective, codified, attainable, easy to comprehend, transfer and diffused. In order to simplify later discussions these types of knowledge will be referred to as systemic knowledge. It can be inferred that these types of knowledge: the tacit knowledge of Choo (1998), the uncoded tacit knowledge of Teece (1998), the personal knowledge of Boisot and subjective knowledge of Baumard (1999), the tacit and hidden knowledge of Johannessen et al., (1999), the automatic knowledge of Spender (1996) and the sympathised knowledge of Nonaka and associates, have a common denominator in that they are subjective and hard to comprehend, codify, transfer and diffuse knowledge. These types of knowledge will be referred to as sympathised knowledge. Boisot's common-sense knowledge and Choo's cultural knowledge

represent the highly diffused and uncodified knowledge. Choo's cultural knowledge can be moved to be a public knowledge when it codified.

Between tacit (personal-subjective) and explicit (public-objective) of Choo, Nonaka, and Teece and based on the degree of individualism or collectiveness concerning the type of knowledge, a diversity of tacit and explicit knowledge embodiments in organisation emerges, such as conscious, positional and declarative knowledge, delineate the explicit-individual knowledge, where objective/scientific knowledge is the explicit-collective knowledge. Automatic and procedural knowledge represents the tacit-individual, where the common sense and collective knowledge is the tacit-collective knowledge (See Baumard, 1999, P30, Spender, 1996, P. 70). Both systemic knowledge and relational knowledge presented by Johannessen (1999) can be viewed as collective knowledge; the degree of comprehensibility will determine on which side these types of knowledge will fall, where higher comprehensibility will lead these type of knowledge to explicit territories. At this point a question may be raised: how germane are these types of knowledge to the organisation? Tacit knowledge is based on the individual experience, which is the basis of all knowledge. All knowledge is tacit knowledge or rooted in tacit knowledge (Polanyi, 1966). Tacit knowledge is indispensable to the organisation because the organisation can only learn and innovate by somehow leveraging on the tacit knowledge of its members (Choo, 1998). Tacit knowledge is vital to the organisation in solving technical problems when the organisation lacks formal knowledge (Senker, 1998). Tacit knowledge shapes the way the leaders of the organisation perceive their firm's place within their industry. It induces how the firm make decisions and shapes the collective behaviour of its members (Saint-Onge, 1996). Explicit knowledge can be either rule-

based or object-base. Ruled-based is when the knowledge is codified into rules, standard operating procedures; most organisation operations are controlled by set of rules and standard operating procedures. Organisations depend on physical objects, such as documents and models, which is a representation of the organisational explicit knowledge. Cultural and common sense knowledge is also vital to the organisation in supplying it with the pattern of shared assumption and ideas.

Agreeing with the popular knowledge creation literature earlier presented, a distinction between the two types knowledge, tacit and explicit, is important in this study, since this study will be concerned with the creation and sharing of organisational knowledge through the interaction between the two types. Having defined knowledge from different perspectives, and the contributions of researchers to further the understanding of knowledge in general and organisational knowledge in specific, the next section will briefly review the main elements of knowledge.

2.5 Key elements of knowledge

According to Davenport and Prusak (1998), knowledge is a “slippery” concept; thus, they identify its key components as experience, truth, judgment, rules of thumb, and values and beliefs. Huseman and Goodman (1999) have also elaborated, from a practical point of view, on these key elements (for details see Huseman and Goodman, 1999, p.108-115). Knowledge can be viewed through experience, since the latter can provide the historical perception from which we perceive and comprehend the new circumstances and events. Huseman and Goodman (1999, p.

108) put it as “ *Experience is the essential bridge between what happened in the past and what is happening in the present,..., experience also holds value for critical understanding it adds to a new situation*”. According to Davenport and Prusak (1998), the application of experience in business could be as easy as identifying a decline in sales as a seasonal phenomenon and, thus, no reason for panic. The second element of knowledge is truth. It can be described as a representation of events as they actually transpire, since knowledge conveys how things are truly are, thus, truth is a sort of crucial understanding that bridges the gap between the objective and the outcome (Huseman and Goodman 1999). The third element of knowledge is judgement. As Weick (1996) put it, judgment is a process of creating a contextual reality. Judgement as an element of knowledge is the ability to make sense of circumstances that are entirely new. A judgement is an integral part of knowledge (Huseman and Goodman 1999) that allows the organisations to tackle new critical situations, or advise a new strategy of how to embark upon a new situation when it becomes too intense. The intuition or the “rules of thumb, instinct, or gut feelings” is the fourth element of knowledge. Intuition or rules of thumb were defined by Davenport and Prusak (1998, p. 10) as “*flexible guides to action that developed through trial and error and over a long experience and observation*”. Huseman and Goodman (1999, p. 112) defined intuition as an “*unconscious decision maker born of experience and refined through trial and error*”. Thus intuition is a critical part of knowledge. It provides speed since it allows the knower to deal quickly with new situations and he does not need to relearn the aspects of a new situation. The last key elements of knowledge, as identified by (Davenport and Prusak 1998) and supported by (Huseman and Goodman, 1999) are values and beliefs; both are considered very essential to knowledge. Nonaka and Takeuchi (1995, p.58) viewed knowledge in a

way that it “is about beliefs and commitment”. According to Davenport and Prusak (1998), values and beliefs, in large, determine how and what the individual views, comprehends and conclude from his observation. In an organisation, members’ values and beliefs will have impact on the overall values and beliefs upheld by the organisation.

Having defined it from different perspectives and considered the key components of knowledge, a workable definition of knowledge in the context of this study is needed. This study adopted the definition of knowledge based on the work of Davenport and Prusak (1998, p.5) where they view knowledge as “*a fluid mix of frames experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information*”. Following this definition of knowledge, it can be synthesised that knowledge is a mixture of various elements, intuitive, partly hard to capture in words to a certain degree, not always transferable and both individual and/or social (collaborative) specific.

2.6 Organisational learning

The work of Argyris, Schon and Senge on the theory of organisational learning is highly recognised and is frequently cited in literature. According to Pemberton and Stonehouse (2000) much of the contributions on the theory of organisational learning are linked to the works of Argyris, Schon and Senge. Argyris and Schon introduced the concepts of “single” and “double” loop learning, whereas Senge introduced the concept of “adaptive” and “generative” learning (Argyris, 1992; Argyris and Schon, 1978; Senge, 1992). Single-loop learning is the process of rectification of ideas and

corrections of errors through a feedback mechanism. It is the most fundamental learning style, as it focuses on immediate problems and opportunities, single loop learning confines learning to the task at hand. This view corresponds with Senge's concept of adaptive learning where its focal point is on the evolutionary transformation as a response to developments in the business environment that are crucial for the endurance of an organisation. Double-loop learning is cognitive and goes beyond the questioning of a phenomenon and the immediate solutions of problems by developing means that may determine future organisational behaviour and bring about new methods of doing business (Argyris and Schon, 1978; Argyris, 1992). Double-loop learning questions the overall effectiveness of practices and advises on basic changes that might be essential for better performance. Generative learning is focused on identifying and creating new business opportunities based on leveraging in existing competencies (Senge, 1992).

The nature of the competitive environment of the knowledge-based economy (Quinn, 1992; Drucker, 1993) assures that a learning organisation must surpass the single and double-loop learning, adaptive and generative learning, by placing more importance on meta-learning (Stonehouse and Pemberton, 1999; Pemberton and Stonehouse, 2000). In this manner, a learning organisation creates an organisational environment that both fosters new knowledge and takes advantage of its accumulated knowledge asset.

2.7 Knowledge creation as a subset of knowledge management

2.7.1 Defining knowledge management

Knowledge management (KM) is the process of making complete use of the value generated by the transfer of intellectual capital, where this value can be viewed as knowledge creation, acquisition, application and sharing (Knapp, 1998). KM is any process which leads to create, acquire, capture, share and use knowledge, where it resides, to increase in value the learning and performance in organisation (Scarborough et. al., 1999). Snowden (1998) defined knowledge management as the process of identification, optimisation and active management of intellectual assets, either in the form of explicit knowledge, or tacit knowledge, where explicit knowledge is held in objects and individuals or communities possess tacit knowledge. He identified the process of optimisation of explicit knowledge through consolidation and making available of artefacts; the optimisation process of tacit knowledge can be attained through the creation of communities that they can share and develop their tacit knowledge. Finally, he asserts that actively managing the intellectual assets of the organisation can be done through the creation of management processes and infrastructure to bring together artefacts and communities in a common environment, which will sustain the creation, utilisation and retention of intellectual capital. Quinn et al. (1996a, 1996b) equated knowledge with professional intellect. Wilmott (1998) associated KM with the capturing and disseminating of knowledge; he viewed KM as integration between information and communication technologies (ICTs)³ and the new work organisation. According to him if ICTs is well resourced and executed it can provide a capacious intellectual capital library that is speedily accessed,

³ According to Wilmott, ICTs is a form of technology that can be used to uphold and improve established networking between organisational members, as a means of making additional connection through e-mail and video conferencing facilities.

interactive and of instantaneous value added to the user. Bajaria (2000) sees KM as the practise that makes knowledge instantaneously available in usable format and uses it. According to Wiig (1997), KM encompass four topics of importance: top-down monitoring and support the progress of knowledge-related activities; creation and maintenance of the knowledge infrastructure; renewing, arranging and transforming knowledge assets; using knowledge assets to attain its value. Therefore, KM is the process that sustains the way of working in which the significance of knowledge is conceived, appropriated and shared. In other words, KM is a set of practices developed in an organisation to create, acquire, maintain and transfer knowledge.

2.7.2 Knowledge management and organisational learning

According to Pemberton and Stonehouse (2002), successful learning organisations construct an organisational environment that coalesces its initiatives on organisational learning with knowledge management. A learning organisation is an organisation with a well-developed capacity for double-loop learning, which can be seen as objective oriented learning and learning through critical questioning, where there is ongoing attention to learning how to learn and where key aspects of organisational functioning support learning (Field and Ford, 1995). The popular literature on organisational learning (Senge, 1992; Field and Ford, 1995; Kessels, 2001; Pemberton and Stonehouse, 2002) is mainly interested in the eternal creation or generation of new knowledge that can be added to the existing knowledge assets of the organisation, where knowledge management is mainly focused on the creation, codification, storage, sharing and dissemination of existing knowledge assets all over the organisation. As a consequence of KM focused activities, develop and leveraging

on the core competences (Prahalad and Hamel, 1990; Stalk et. al., 1992) will yield better performance and sustainable competitive advantage.

2.7.3 Knowledge management at work in organisations

KM is experiencing considerable attention in today's business environment and in the research literature. A sense of its importance can be felt from the increasing number of researchers and practitioners who have recently turned their attention to KM. Bailey and Clarke, (2001, p. 58) viewed the prospect of knowledge management as a "*... real potential as a twenty-first century managerial and organisational discipline has to be apparent to practising managers*". Nevertheless, knowledge management is not totally new, since knowledge, expertise and skills have been managed implicitly as long as work has been performed (Wiig, 1997), where organisations are implicitly measuring their knowledge assets by their ability to leverage that knowledge and quickly react to new changes in market demands in a more effective manner than their competitors. Organisations are acknowledging the significance of improving their capability to manage and utilise their knowledge assets more effectively. According to Teece (2000), KM can be employed to explain the nature of procedures and techniques used to obtain the most from an organisation's knowledge assets. Wiig (1997) suggested that KM could be adapted to be use in a number of strategies, in which organisations can attempt to gain a superseding value from their existing knowledge. This view is supported by Ellen Knapp, a chief knowledge officer and a KM practitioner, in which she indicated that organisations are implementing knowledge management strategies and acquiring the benefits for doing so (Knapp, 1998). Organisations are likely to pursue either one, or a collective of, five

knowledge-related strategies. The five knowledge management strategies as identified by Wiig (1997).

- *Knowledge strategy as business strategy*: focuses on knowledge creation, capture, regeneration, sharing and utility to be used at each point of action.
- *Intellectual asset management strategy*: focuses on knowledge organisational level management of explicit intellectual assets such, as copyright, operational and management practices, technologies and other structural knowledge assets.
- *Personal knowledge asset responsibility strategy*: focuses on individual knowledge responsibility for knowledge related activities that lead to improving competitive position and to make sure that the employee's most competitive knowledge assets within their area of responsibility is accessible and can be applied to the organisation's work.
- *Knowledge creation strategy*: focuses on research and development knowledge, learning and motivation of employees to comprehend lessons learned to acquire new and improved knowledge that will lead to better degree of competitiveness.
- *Knowledge transfer strategy*: focuses on knowledge methodical tactics to transfer acquire, manage, restructure, sharing knowledge and adopting best practices to be exploited and used at point of action aiming to improving competitive status.

KM in organisations focuses not only on managing the knowledge assets of an organization but also on managing the process “strategies” that act on these assets. As Warkentin et al., (2001, p. 150) put it, “*Organisations are focusing on designing and developing a knowledge management environment to transform, and ideally improve, the way they create, preserve, use and share corporate knowledge between knowledge workers*”. Vincenti (1990), Faulkner (1994) and Coombs and Hull (1998) categorised knowledge management activities and their related practices into three main processes: knowledge processing; knowledge domains; knowledge formality.

Most organisations use these processes in order to:

1. create or generate knowledge;
2. organise knowledge through storage or memory;
3. share and transfer knowledge;
4. apply or leveraging knowledge.

These processes are considered to be the major research domains of knowledge management (Finerty, 1997; Wiig, 1997; Johnson, 2000; Warkentin et al., 2001).

2.7.4 Major domains of knowledge management

The area of knowledge management can be divided into four domains as listed earlier. These domains covered by KM initiatives are consistent with the views of Huber (1991) where he identified four knowledge management aspects linked to organisational learning, which are described as knowledge acquisition, information distribution, information interpretation and organisational memory.

Generally, knowledge creation or generation is one of the most studied areas of KM. The concept of knowledge creation is frequently cited in the organisational learning and innovation literatures (Garvin 1993; Baets 1998; Coombs and Hull, 1998; Carayannis et. al., 2000; Carayannis and Forbes, 2001). Knowledge creation was integrated in the broader views on the theory of organisational learning (Huber, 1991). Garvin (1993) associated organisational learning with knowledge management through equating the concept of organisational learning with the process of knowledge creating and transfer. This view is also supported by Baets (1998) as he indicated that the knowledge-based approach is a pre-requisite to learning. Creating and capturing knowledge can be seen as the most crucial for organisations in order to develop their capabilities and to enhance their competitive status. Another point of view on creating and capturing is that it is the means to attain the highest output possible from the organisation's intellectual capital assets (Dawson, 2000). Knowledge creation has not been particularly focused on the overall problem of idea generation and realisation, which are the characteristics of the innovation management literature (Johnson, 2000). From a knowledge management perspective, knowledge creation is viewed as a means of business success (Nonaka and Takeuchi, 1995; Leonard-Barton, 1995). Nonaka and Konno (1998) introduced "Ba"⁴ to sustain knowledge creation, and Nonaka and Takeuchi (1995) utilised the analogy of hypertext organisation and the 'middle-up-down' strategy (Nonaka, 1988) to support and facilitate knowledge creation. Boisot's (1995) I-Space shows a social learning cycle where knowledge creation process passes through stages of codification and diffusion in a circular pattern. This view can be related to Nonaka and Takeuchi's

⁴ According to Nonaka and Konno, "Ba" is a Japanese concept that can be translated to the English word "Place".

(1995) knowledge spiral, which reflects the process of the mobilisation of individual knowledge through the interaction between tacit and explicit knowledge.

The research in the area of knowledge sharing (Zander and Kogut, 1992; Sveiby, 1996; Chen, 1997; Lam, 1997) and transfer can be found in the literature of technological transfer (Chen, 1997; Gilbert and Cordey-Hayes, 1996; Carayannis, 1999) and innovation diffusion (Rogers, 1995; Von Hippel, 1987,1988,1989). Evidently, there is a vast amount of literature in these areas although the list provided is not extensive. However, such literature did not specially deal with knowledge, *per se*. For example, Rogers's (1995) research is unique in tracing the process of the diffusion of innovation and the work of Von Hippel (1987,1988,1989) regarding the importance of the customer and supplier as an essential tool for innovation leading to product development. With regard to technological transfer, the work of Carayannis (1999) focused on knowledge transfer through technological hyper-learning in five industries. Generally, the literature indicated that prior experience concerning transfer mechanisms, be they relating to a person or, a thing, contributes to the knowledge transfer.

Organisational memory is defined as stored information from an organisation's history that can be utilised for decision-making (Laudon and Laudon, 2002; Walsh and Ungson, 1991). Cyert and Goodman (1997) highlighted the need for knowledge dissemination in both university and industry, and to incorporate such knowledge in their organisational memory. With regard to the negative effect of organisational memory, Moorman and Miner (1997) pointed out that environmental instability

coupled with scattered memory might impede creativity. Nonetheless, organisational memory is considered as an essential element of organisational learning (Johnson, 2000).

Cohen and Levinthal (1990) argued that the ability of an organisation to create knowledge to the extent that it acknowledges the significance of new, external information, integrates it, and harnesses it for commercial purposes and determines its innovative capabilities. This leads us to infer that the previously discussed aspects of knowledge management are interconnected; that is to say that knowledge creation may depend on knowledge transfer, which may be affected by organisational memory.

In the light of the previous discussion, similarities between knowledge management and organisational learning are centred around the process of creating, or developing new knowledge, which can be improved through a supportive culture, information and communication technology, and infrastructure. The central aim of organisational learning is to keep up an unremitting development of new knowledge. Considering the dynamic nature of knowledge (Nonaka, 1991, 1994; Nonaka and Takeuchi, 1995) and the related problems of its management and creation requires a meticulous focus on organisational learning and knowledge management (Pemberton and Stonehouse 2000).

2.8 Existing theories of organisational knowledge creation processes

The reason behind the organisation's drive to create and employ knowledge is to innovate and develop new ways of achieving sustainable competitive. Nonaka and Takeuchi (1995, p. 3) defined organisational knowledge creation as "*the capability of a company as a whole to create new knowledge, disseminate it throughout the organisation, and embody it in product, services, and systems*". Concisely, it is the processes that enable the knowledge created by individuals to be augmented, amplified, justified and crystallised within the organisation, as a part of the organisational knowledge system (Nonaka, 1994; Nonaka and Takeuchi 1995, 1996). Based on the findings of Wikstrom and Normann (1994), Nonaka and Takeuchi (1995), Leonard-Barton (1995) three theories on the knowledge creation process are identified.

Organisational knowledge creation processes (Wikstrom and Normann 1994)

Wikstrom and Normann (1994) identify three types of knowledge creation processes in an organisation: generative processes, productive processes and representation processes. Generative processes are those by which new knowledge is created in the course of problem solving, leading to an increase of the overall knowledge pool of the organisation which, in return, can be used in a way to advance the organisation's competitive and innovative standing. Productive processes are the applications of the generated knowledge into operational activities leading to an advancement of existing product/services or the introduction of a new product or service. In other words, productive processes are the operationalisations of the new knowledge. Representation processes are the processes that pass the distinct knowledge to its customer. The knowledge is represented by the product sold or the services provided

to the customer, since the product sold or the services provided will reflect all knowledge incorporated in it.

Organisational knowledge creation activities (Leonard-Barton 1995)

Leonard-Barton (1995) presents another interesting theory of organisational knowledge creation process where she identified four processes by which organisations are able to create and build its knowledge. The four are: shared creative problem solving; implementing and integrating new methodologies and tools; experimenting and prototyping; importing knowledge from outside. Shared problem solving is an activity where organisation members from different knowledge backgrounds are brought together; then their knowledge is directed toward problem solving. Implementing and integrating new methods and tools, activity where individual or group sense making knowledge is introduced and linked to methods and tools to improve internal operation. Experimenting and prototyping are activities aimed to extend the organisation's existing capabilities and to develop new ones for the future. Importing knowledge from outside can be considered as an activity to increase the organisation's absorptive capacity. It is the organisational ability to create new knowledge and to use it, thus, increasing the abilities of the organisation to scan new opportunities.

Phases of organisational knowledge creation (Nonaka and Takeuchi 1995, 1996)

Nonaka and Takeuchi (1995) proposed a five phase model of the organisational knowledge creation. These phases are sharing tacit knowledge, creating concepts, justifying concepts, building an archetype and cross-levelling knowledge. Sharing tacit knowledge corresponds to socialisation, where tacit knowledge is shared

between individuals in the organisation. Creating concepts corresponds to externalisation, where dialogue, metaphors, analogies and models are used to convert the tacit knowledge to the explicit one. Justifying concept corresponds to internalisation, where screening process of the newly created concept are conducted to ensure that the new concepts are not in conflict with the organisation's objectives and intention. Building and archetype is the process of conversion of the accepted concept into something tangible. A prototype of a new product is an example of this phase. Cross levelling of knowledge is an interactive spiral process of knowledge use gained to activate a new cycle of knowledge creation. Building an archetype and cross-levelling are corresponding to combination.

Similarities between organisational knowledge creation theories

Similarities can be derived between the three theories of organisational knowledge creation process described earlier in this section. A brief review of similarities are now described.

The generative processes of Wikstrom and Normann are similar to sharing tacit knowledge and creating the concept of Nonaka and Takeuchi and sharing the creative problem solving and experimenting and prototyping of Leonard-Barton, since all are concerned with the generation of new knowledge. The productive processes of Wikstrom and Normann, the justifying concept and building and archetype of Nonaka and Takeuchi, and implementing and integrating the new methods tools of Leonard - Barton are similar in a sense that all of these processes are concerned with the operationalisation and the embodiment of the newly acquired knowledge into tangible

new product. Finally, the representative processes, cross-levelling knowledge and importing knowledge are similar since, all these concerned with the diffusing and sharing of the new knowledge.

In order for organisational knowledge in be created Choo (1998) suggested three overlapping activities: the first is to generate and share tacit knowledge; the second is to test and experiment with explicit knowledge; finally, linking and tapping external knowledge. Even though tacit knowledge is highly personal and hard to articulate and codify, it be shared and externalised through the use of metaphors, analogies, and models (Nonaka, 1991, Nonaka 1994, Nonaka and Takeuchi 1995, 1996). The newly externalised tacit knowledge takes a new face as explicit knowledge, which is then relatively easy to be transferred to other members of the organisation. Knowledge can be acquired from inside and outside the organisation (Davenport and Prusak, 1998) and the innovativeness of the organisation will be strongly dependent on the speed and the apprehension of the knowledge acquired by its members.

The theory of knowledge creation has been written in organisational and economic terms and some preliminary empirical research has been conducted (see for example, Nonaka, 1994; Nonaka and Takeuchi, 1995; Kidd, 1998; Nonaka and Konno, 1998; and Von Krogh, 1998). However, a focus on the enabling conditions and processes of knowledge creation from an intra-organisational perspective is new and compelling, as is evident in the increased interest in knowledge-creating activities. It is apparent from the previous review that theory on knowledge creation has been developed,

particularly from the organisational perspective, but little empirical work demonstrates the validity of these organisational knowledge creation theories.

2.9 Summary

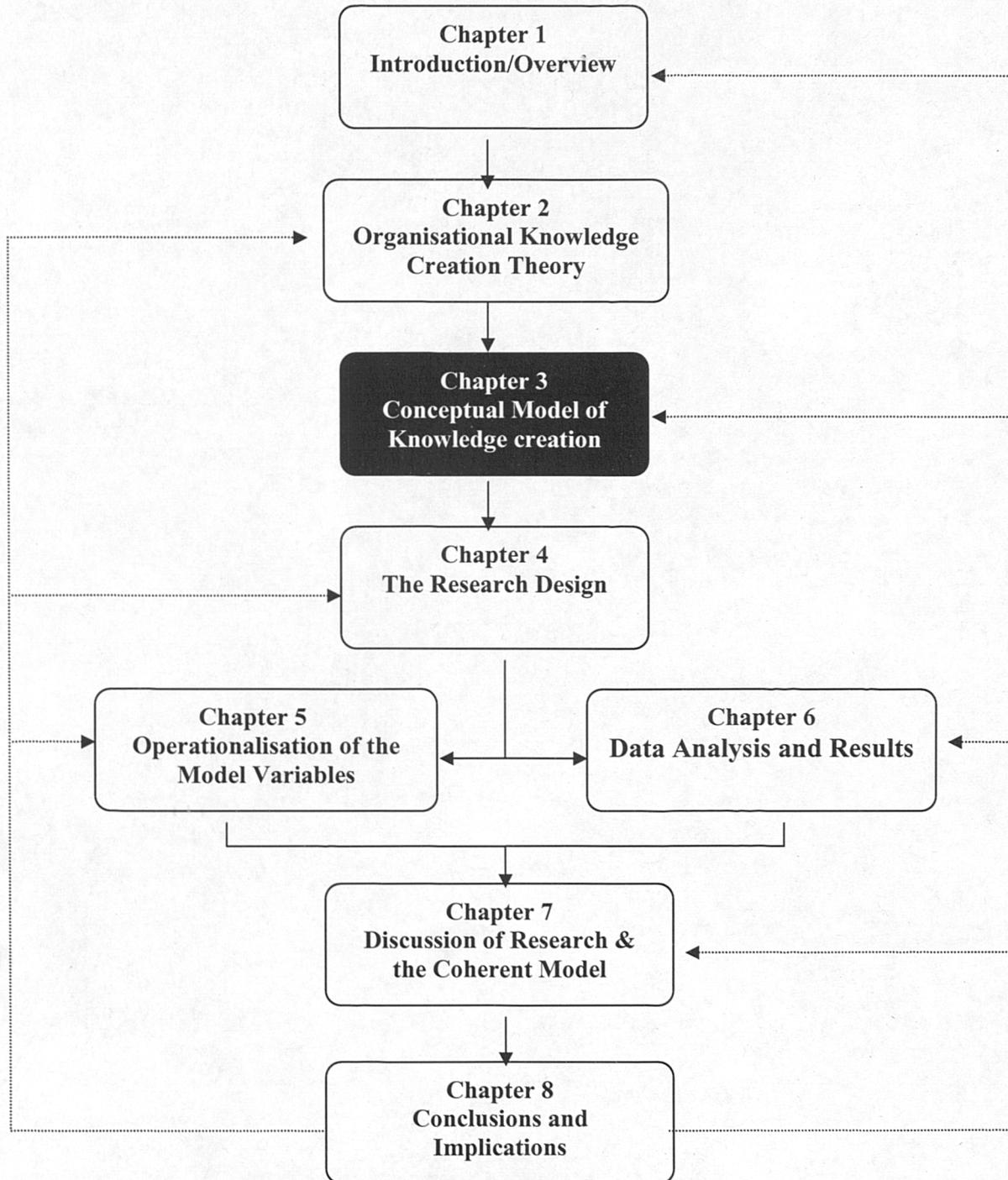
The literature related to the organisational learning and knowledge creation emphasised that knowledge has undeniably become a key economic resource, a corporate asset, a major source of competitive advantage and an agent of change. The concept of knowledge is as old as its creation, although there is still considerable debate with regard to its definition. This chapter started with a general discussion on how knowledge has been perceived from the points of view of different economic theories, and transitions to the knowledge-based economy was presented. Knowledge was defined from different management perspectives and the concepts of organisation learning and knowledge management were thoroughly considered. The organisational needs for knowledge as a key asset for competitive advantage were made explicit. The contributions of previous researchers to further the understanding on the concepts of organisational knowledge were thoroughly discussed. The key elements of knowledge were identified and the distinctions between the two main types of knowledge (tacit and explicit) were clarified, as viewed by several management philosophers and researchers. A discussion of the major domains of areas of research in knowledge management, such as knowledge creation, organising, sharing and dissemination were presented and argued, and the deficiency of research in each of these areas was identified. This chapter concluded with a discussion of the existing theories on organisational knowledge creation. Following discussion of

organisational knowledge creation theory, the factors of knowledge creation enabling environment and the conceptual model will be discussed in the next chapter.

Chapter Three

Conceptual Model of Knowledge Creation

Figure 3.1 Chapter three in the context of the thesis



Chapter Three

Conceptual Model of Knowledge Creation

3.0 Introduction

Expanding the literature development in the previous chapter, Nonaka and Takeuchi's model of organisational knowledge creation will be reviewed, since it will be the base model for this study. The literature on the knowledge creation enabling factors will also be reviewed to comprehend the role of information technology infrastructure that support the knowledge creation factors (ITISKCFs), the culture (CKT) and the infrastructure of knowledge transfer (IKT) to form a conducive knowledge creation environment (KCEE) that supports the organisational knowledge creation activities and an argument on the role of knowledge enabler (ITISKCFs, CKT, and IKT) will be presented. The characteristics of information technology that enable the knowledge creation conditions will be argued based on the literature of the theory of knowledge creation (Nonaka et al, 2000b, Nonaka and Konno, 1998; Nonaka and Takeuchi, 1995; Leonard-Barton, 1995; Khalil, 1996; Scott, 1998; and Wikstrom and Norman, 1994). Finally, a research model will be developed and the hypotheses on the relationships between the knowledge enablers and organisational knowledge creation activities will be generated.

3.1 Nonaka and Takeuchi's model of organisational knowledge creation

A number of researchers have looked at two dimensions of knowledge: explicit and tacit (Kogut and Zander, 1992; Nelson and Winter, 1982; Polanyi, 1966). Explicit knowledge is easy to define, capture and transfer in different formats, whereas tacit knowledge is difficult to codify and transfer, because it is deeply rooted in individual minds and individuals often cannot easily articulate their knowledge bases. Drawing on Michael Polanyi's (1966) distinction between tacit knowledge and explicit knowledge, an enticing knowledge creation model from Nonaka and Takeuchi (1995) viewed tacit knowledge and explicit knowledge as separate but mutually complementary entities. Their model shows that the basis of organisational knowledge creation is in the conversion of tacit knowledge into explicit knowledge and visa versa and organisational knowledge is created based on the interaction and conversion between the two types of knowledge (tacit and explicit) in a spiral manner. A process model of knowledge creation develops on the critical presupposition that individual knowledge is created and enlarged by means of a social interaction between tacit and explicit knowledge. This interaction is called knowledge conversion. The interaction between the two main types of knowledge allows positing four different modes of knowledge conversion. According to Nonaka (1994) and Nonaka and Takeuchi (1995), the knowledge creation process takes place through four modes of knowledge conversion.

The conversion process can be from tacit to tacit (socialisation) leading to the creation of sympathised knowledge, tacit to explicit (externalisation) that leads to the creation of conceptual knowledge, explicit to explicit (combination) directing to the creation of systemic knowledge and explicit to tacit (internalisation) that leads to the creation of

operational knowledge. It is rather important to indicate that the conversion does not occur within individuals but between individuals within an organisation (Nonaka and Takeuchi, 1995).

3.1.1 Conversion of organisational knowledge

Nonaka and Takeuchi have classified organisational knowledge into four types. First, socialised knowledge, which represents the type of knowledge that transpires from the socialisation processes when the objectives of those processes are shared problem solving. The second type of OK is a concept knowledge, which represents the type of knowledge that emerges from the externalisation processes, where the objectives of those processes are to create a concept. The third type of OK is an operational knowledge that exemplifies the type of knowledge that transpires from the internalisation processes, where the objectives of those processes are to justify the newly created concept. The fourth type of OK is a systemic knowledge that epitomises the type of knowledge that emerges from the combination processes, where the objectives of those processes are to build an archetype (in case of the service industry, a prototype can be thought of as an exemplar of operating mechanism).

Socialisation is the process of sharing knowledge and experience with the use of a language. Socialisation can be seen as sharing ideas, mental model and technical skills through interaction between organisational members or a focus group. Information is used for brainstorming, debating and socialisation purposes. Examples of situations

where this happens are master-fellow-relationships, on-the-job-training, imitating others, constructive brainstorm sessions, practising and training. Ideal communications for this type of process is the face-to-face communication. Observing, imitating and practice will lead to the conversion of tacit knowledge from one individual to other creating sympathised knowledge which is, by and large, associated with personal expertise or experience; it becomes imperative that this type of knowledge is used throughout the organisation. Bhatt (2000) stated that tacit knowledge could be reorganised so that it can be used and this can occur through using different dialectical means of information processing, such as critiques, challenges and debates. Nonaka and Takeuchi (1995, 1996) assert that, without a mutual and shared experience, it is exceedingly difficult for an individual to protrude himself into another individual's thinking process. This type of conversion is generally common for those companies that continually produce and process information about their products, services, customers and work-procedures to create new knowledge (Bhatt, 2000).

Externalisation occurs when tacit knowledge is made explicit in the form of metaphors, analogies, hypotheses and models. It is the process of converting tacit knowledge into an explicit concept. It is the attempt to conceptualise our image, then express it in language. At this mode of knowledge conversion, information is mainly used to compile different analogies and metaphors for the creation of new knowledge (Nonaka and Takeuchi, 1995, 1996). They presume that the conversion process is a repeated, time-consuming dialogue and it takes on a form of succession steps, starting with metaphors, analogies, then concepts or model. Externalisation, presumably, is

the most difficult and challenging mode of knowledge creation because tacit knowledge is difficult to articulate, formalise and codify. Externalisation is usually found in the design process. Nonaka and Takeuchi (1995) find externalisation the most important process in knowledge conversion because it is from tacit knowledge that new and explicit designs are born.

Internalisation is the process of embodying explicit knowledge into tacit knowledge. Information sharing provides the ground for internalising explicit knowledge into tacit actions. It is closely related to learning by doing. The process of learning and fraternising by individuals through repetitively doing a certain task so that the explicit knowledge of the applied principle and procedures becomes assimilated as the tacit (Choo, 1998). Conversion of explicit knowledge needs to be lived and experienced by individuals and, hence, information sharing allows members to internalise the experiences through learning by doing. Internalisation can also be seen when experienced managers or technicians give lectures. The interactive process of trial and error and experimentation with explicit knowledge demonstrates internalisation (Scott, 1998).

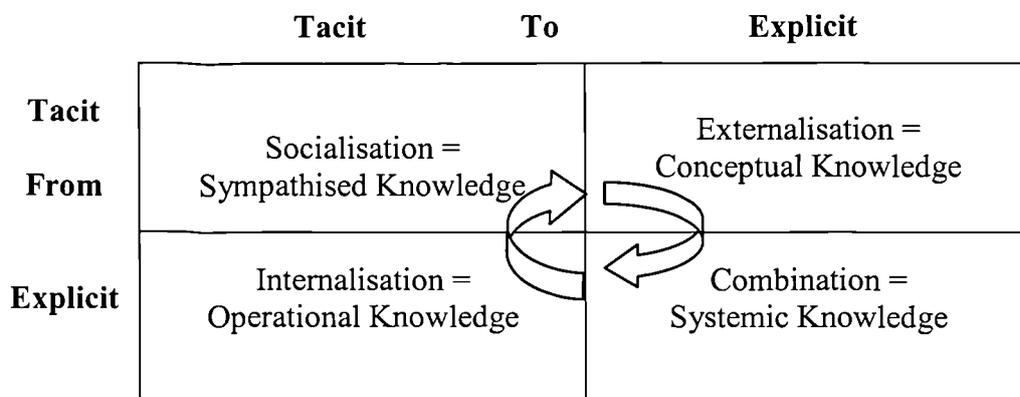
Combination is the process of conglomerating various bodies of existing explicit knowledge that leads to the creation of new explicit knowledge. It is a common form of knowledge creation and transfer such as learning in schools (Choo, 1998). Combination is also the process of converting the individual explicit knowledge into group explicit knowledge, which is eased by the conventional information processing.

Examples of combination are knowledge and information systems. Information can be used to transfer and convert explicit knowledge into easier formats. Combined knowledge can be exchanged via different kinds of communication media, such as face-to-face meetings, telephone conversation, documents, electronic document transferring and communication technology networks which can be used to transfer explicit knowledge into different combinations (Nonaka and Takeuchi, 1996). New knowledge can also be created through the reformation, or reorganisation, of existing information by adding, integrating classifying and sorting explicit knowledge. Combination is the type of knowledge creation which is usually associated with education and training.

Nonaka and Takeuchi's model for knowledge conversion and creation within an organisation takes a form of spiral process in which each type of knowledge tacit or explicit, can be converted and the process can be viewed as a continuous learning process (see figure 3.2). Likewise, organisational knowledge creation demands an interaction and conversion between both tacit and explicit knowledge and between individuals and groups in the organisation. To conclude, four different kinds of knowledge being created from the four kinds of interaction between tacit and explicit knowledge, i.e. the four manner of creating knowledge, together form a kind of spiral of knowledge (Nonaka and Takeuchi, 1995) which starts from socialisation and moves to externalisation to combination to internalisation to socialisation, and so on. In the four different situations, four different kinds of knowledge are being created, over and over again. From the previous discussion we can see that there are many more distinctions that can be made, but the main focus of all these distinctions,

however, is that between tacit and explicit knowledge. The process model of knowledge creation which Nonaka and Takeuchi (1995) developed has the advantage that it is a dynamic model of knowledge.

Figure 3.2 Knowledge conversion and the spiral of knowledge
(Adapted from Nonaka and Takeuchi, 1995)



3.1.2 Enabling factors of knowledge creation

In order for knowledge creation in the organisation to be sustained a conducive environment is required. Nonaka and Takeuchi (1995) identified five enabling conditions. Organisational intention can be exemplified by the organisational vision and mission statement, which guides workable activities. Autonomy is the degree of freedom granted to individuals in the organisation, which promotes self-motivation and leads to the generation of new ideas. Fluctuation and creative chaos is the ease of making changes that simulate the interaction between the organisation and the external environment. It is the tension between the actual performance of the

organisation and the desired future expressed through a clear and unambiguous vision, which is often referred to as the vision led company (Kanter et al., 1992). The existence of redundancy offers an overlapping knowledge within the organisation and between its members, and promoting collaboration (Nonaka and Takeuchi, 1995). Requisite verity prevents information overloading and identifies the subject matter experts.

Leonard-Barton (1995) and Khalil (1996) also identified a number of knowledge creation enablers. Leonard-Barton (1995) identified five enabling conditions to support the organisational knowledge building. Strategic intent is the understanding of core capabilities. Signature skills represent the individuals' cognitive style and the way they approach problems. Creative abrasion is continuous experimentation. An information-porous boundary is a boundary kept perforated so that knowledge and information can be largely diffused. It is this tension between actuality and potentiality which Senge (1990, p. 150) refers to as "*creative tension*". Cognitive diversity is allowing a dual interest for the organisational members. Khalil (1996) identified four factors necessary to create an environment that promotes creativity and innovation. They are access to relevant information, intrinsic or task-oriented motivation, memory mechanism to remind organisational members of available knowledge and transferability of problem-solving experience.

Comparing Nonaka and Takeuchi (1995), Leonard-Barton (1995) and Khalil (1996) enabling conditions for a conducive knowledge creation environment, broadly similar. A comparison is presented in table 3.1.

Table 3.1 Comparison of the knowledge enabling conditions

| Nonaka and Takeuchi (1995) | Leonard-Barton (1995) | Khalil (1996) |
|--------------------------------|---------------------------------|---|
| Intention | Strategic intent | ----- |
| Autonomy | Signature skills | Task-oriented motivation |
| Fluctuation and creative chaos | Creative abrasion | ----- |
| Information redundancy | Information - porous boundaries | Transferability of problem solving knowledge and memory mechanism |
| Requisite variety | Cognitive Diversity | Accessibility to relevant information |

3.2 Information technology and knowledge management

The recent advancement in information technology, such as the web technology exemplified as the networking technology (intranet, extranet and the internet), coupled with the increasing interest of knowledge creation, has dilated the organisational interest in the subject of knowledge management (Malhotra, 1997). Information technology has led many organisations to expect a new world of leverage knowledge (McDermott, 1999). However, organisations in their knowledge management initiatives focused their attention on the trivia of information technology tools by classifying knowledge as static and syntactic, ignoring the human aspects of how individuals or communities in the organisation go about creating and sharing knowledge. It is wrong to view knowledge as unproblematic, predefined and pre-packaged, while disregarding the human dimension of knowledge creation in the organisations (Davenport, 1994). This viewing of knowledge by the organisation has worked against the generation of multiple and contradictory viewpoints necessary to meet the challenge created by the ever changing business environment which, in

return, has hampered the organisational learning abilities (Malhotra, 1997). He considers that knowledge management solutions that are demarcated by memorisation of “best practise” which are embedded in the information technology can only be efficient if the situation its dealing with is linear, static and predictable, given that the business environment is stable or incrementally changing. Malhotra’s views with regard to the knowledge management solutions are based on “best practice” and in line with McDermott, (1999) where the later considers the result of “best practice” intuitive as a “expensive useless information junk yard”. This view is also consistent with those of Davenport and Prusak, (1998, p. 7) when they describe this process as “*de-knowledging*”, where knowledge is sent back from its final form as a knowledge to information and then data, where data is an abstract with no meaning. Davenport and Prusak mention an example of how one of the Anderson consulting knowledge managers, view their own knowledge repository, “ *we’ve got so much knowledge (not to mention data and information) in our knowledge Xchange repository that our consultant can no longer make sense of it. For many of them it has become data*” (Davenport and Prusak, 1998, p.7). In other words, creating knowledge management systems with no regard to the human context in which knowledge is created, the characteristics of knowledge and without understanding the knowledge needed, the levels of details required by organisational members. It can be seen as “robbing” knowledge of its life and, in return, these systems would do little to lever knowledge.

In order for knowledge management initiatives, systems and programs to succeed, Malhotra (1997) suggested Hegelian¹ inquiry systems for an IT enabled knowledge

¹As cited in Malhotra, 1997, Hegelian systems are referred to the philosopher Hegel, where his view of an inquiry systems are based on a synthesis of multiple completely antithetical representations that are characterised by intense conflict because of the contrary underlying assumptions.

management since it is better situated for an ever-changing environment coupled with devoted and serious recognition of the nature of knowledge creation processes. He suggested that for IT enabled knowledge management to succeed more attention should be paid to the nature of knowledge creation processes, where it is characterised as dynamic and evolving, multiple dimensions: tacit and explicit, subjective, interpretative, meaning making bases and constructive. As such, McDermott (1999) suggested that a clear difference should be made between information and knowledge since sharing knowledge requires different set of concepts and tools, and knowledge management systems should embark on the characteristics of knowledge. He suggested that a unique combination of human and information systems is required to leverage knowledge where, in his views, it is the very human ability to use information stored in the computer and to turn it into solutions.

Both the views of McDermott (1999) and Malhotra (1997) are consistent with Wilmott (1998) who sees knowledge management more as a way of signalling the key importance of how knowledge is created, valued and shared within the organisations rather than a technique for encountering the demands or opportunities of the information age. In summary, knowledge management is a set of organisational processes that govern the process of creating, disseminating and leveraging knowledge in the organisation to attain its end objectives.

For knowledge management to succeed it has to take into consideration two things. First, more attention should be given to the context in which knowledge is created and shared; “The Human Act” rather than the outcome of the process. Secondly, more attention should be paid to the knowledge characteristics, where tacit knowledge, the

crucial part of knowledge, is in the human's head and should be nurtured rather than managed. Information technology that aids and enables knowledge management should be looked at as the medium for portraying, incorporating and deploying knowledge to promote collaboration across different functions and attitudes in the organisation.

3.3 Knowledge enabling environment (KCEE)

3.3.1 ITI that supports knowledge creation factors (ITISKCFs)

A number of studies in organisational science have recognised the role and the importance of information technology in contributing to organisational knowledge creation and sharing. Huber (1991) proposed that information systems can contribute to organisational learning. He emphasised the role of information systems in supporting organisational memory. Information systems can promote knowledge management by capturing, codifying, and disseminating knowledge. Quinn (1992) indicated that information systems and technology through databases it can capture managerial knowledge and wisdom, and foster the organisational learning by facilitating explicit knowledge retrieval and providing individuals with specialised knowledge. Scott (2000) illustrated on the role of information systems and technology in facilitating the interorganisational learning. She emphasised on the role of information technology in lower and higher levels of interorganisational learning, cognitive and affective trust, and virtual and humanistic interorganisational collaboration. It is undeniably true that information technology played a tremendous role in supporting the creation and conversion of explicit to explicit knowledge. According to Swan et. al., (1999) research on knowledge management has been

dominated by an information systems/technology perspective, resulting in an overemphasis on codification of explicit knowledge, which is appropriate for databases and other traditional information systems solutions. Yet previous research on knowledge management did not reach the point to explore the role of information technology in the creation and conversion of tacit to tacit, tacit to explicit, and explicit to tacit knowledge. Stenmark (2000) noted that if all knowledge could easily be codified and stored, there would be no need for a new paradigm where old fashioned information management systems would have done the job. This study proposes a different methodology where information technology could play a significant role in supporting the creation and conversion of knowledge both tacit and explicit in an indirect way. This indirect way can be realised through introducing information technology to support knowledge creation factors. Based on the discussion in the pervious section about the enabling factors of knowledge creation, it can be argued that a number of factors are grouped together to form knowledge creation enabling factors (Nonaka and Takeuchi, 1995; Scott, 1998; and Khalil, 1996). These factors can be classified under two categories: first, key factor enablers and secondly, attributes of the key factor enablers. The key factor enablers are intention (intent), autonomy, redundancy (information porous bounders), fluctuation (creative abrasion) and requisite variety (cognitive diversity). The attributes of the key factors enablers are transferability and memory an attribute of redundancy. Accessibility is an attribute of requisite variety.

Autonomy refers to a higher degree of freedom provided to individuals on their own or in teams within the organisation. Autonomy should increase the possibilities of the individual to motive him or herself and should work as a driver for the organisation's

members to generate new and original ideas. According to Nonaka and Takeuchi (1995), autonomy is an important condition for promoting the knowledge spiral. They considered that, as far as circumstances permit, all the organisation's members should be allowed to act autonomously. Information technology can play a significant role in promoting and supporting autonomy either in a direct or indirect way. Direct support comes from the fact that individuals can perform tasks and work on their own whenever the requirements needed to do so are available to them. In other words, the computer and networks technologies literally extended the individual's hand to reach beyond what they are normally capable of and to find the information and knowledge needed. Thus, individuals feel more independent with the presence of technology. An indirect support of information technology to increase the level of independence of individuals is by creating an extra horizon to experiment and try to solve a problem, with virtually no cost to the organisation.

As an extra autonomy might increase the possibility for individuals to motivate themselves to find a solution to a problem, knowing that they will not be criticised for not being able to do so, since they are trying a solution on the virtual reality and space provided by the information technology. There is a general agreement in the literature that fear of taking risks could inhibit creativity. For example, an individual comes up with an original idea or a novel solution to a problem but fears that being incorrect might deter him from making his idea or solution known to the public (Khalil, 1996). It is important to ensure the creativity flow by encouraging individual willingness to take risks. Information technology tools can provide the platform for an extra horizon encouraging individuals to take risks. Such tools as modelling, prototyping and decision supports can serve as extra horizons to encourage organisation members to

take on new ideas and to encourage experimentation. According to Scott (1998), autonomy has been widespread on the intranet, and the web technology has been the grassroots movement for promoting such autonomy where anyone can post a web page.

Redundancy in context of this study means the existence of information that goes beyond the immediate operational requirements of the organisation's members (Nonaka and Takeuchi, 1995). Redundancy can be considered as an intentional overloading and overlapping of information between groups that promotes cross-functional collaboration (Scott, 1998). Sharing redundant information within the organisation will encourage individuals to share their own tacit knowledge. Redundancy allows the organisation's members to sense what others are trying to articulate and promote cross-functional collaboration which, in return, accelerate the knowledge creation process. Information technology, such as intranet, GroupWare and web technology, offers the organisation's members wide access to organisational information.

Information technology is deemed to play a significant role in providing the required redundancy. Memory as an attribute of redundancy is considered in this study, individuals are relying heavily on their memory when trying to solve a problem, or to bring up information of a similar case or piecing up relevant knowledge to form a potential solution. According to Weisberg (1993), creativity is information intensive and it is heavily dependent on the availability of memory. Information technology

can provide an organisation's members with various memory reminding mechanisms to assist them to fit the information into the new situation.

Fluctuation/creative chaos, in a constantly changing business environment. An organisation that does not react quickly to changes, where information is constantly moving and changing rapidly, will be left behind and eventually dies. An organisation should adopt an open posture towards any environmental change in order to improve its ability to create and capture new knowledge. The speed, flexibility and ease of making changes given to organisations by information technology such as the web technology will help an organisation to react quickly and update its information with virtually no cost. This will contribute to the breakdown of routines, which triggers creative chaos and stimulates the interaction between the organisation and its fluctuating environment (Scott, 1998).

In the context of knowledge creation, requisite variety means preventing information overload and finding the subject matter expert. Information technology is viewed today as an information pull technology rather than an information push, which is in favour of the organisation's members who are looking for who owns what information. Accessibility is an attribute of requisite variety; it refers to the ability to access relevant information. It is considered an essential trait in enabling people to make and create augmentation of knowledge; unless people have access to the information when they need it, it seems impossible for them to create new knowledge. People use past information as a ladder or a stepping-stone in their drive to create new

knowledge at a higher level (Khalil, 1996). Information technology tools can be used to increase accessibility. For example, using databases and friendly graphical user interface (GUI) should make it possible for people to easily access various type of information. Accessibility is considered an important criterion that information technology tools should provide to facilitate the augmentation of new knowledge and should help to spread that knowledge across the organisation.

Intention is symbolised by the organisation's mission statement that endures workable activities. The organisation's vision and operational standards can also exemplify intention. Intention is deemed to be a momentous factor which is transmitted via formal channels from the top management to the organisational members. An example of intention is when the leadership convey their vision regarding what type of knowledge should be developed. Scott (1998) argues that organisations use IT infrastructure capability to communicate their intention. For example they use IT systems capability to post their organisation's mission and letter from the CEO and other top management. Comparing the type of support that IT infrastructure can provide for intention with the previously mentioned knowledge enabling factors, the support here can be seen as static while the support of other factors is dynamic and, hence, this factor was seen to be more appropriate to be included in the culture of knowledge transfer, which is discussed in the following section.

To conclude, it was argued that IT could deliver the necessary support to enhance and improve the enabling role of the knowledge creation conditions. For IT infrastructure capabilities to support the knowledge enabling factors IT should possess a number of

capabilities such as availability (the ability to provide redundant information), transferability of information, accessibility, a memory reminding mechanism, ability to act as a transformer, ability to provide a virtual space for experimenting and testing new ideas, tracer of information, enabling flexibility and integration, enabling speed and easiness of making changes to react to any new development and enabling communication and sharing of information.

3.3.2 Culture of knowledge transfer

Even though tacit knowledge possessed by individuals in organisations cannot be codified easily and imitated by competitors (Teece, 1987), the mobility and idiosyncrasies of experts can be too demanding to assimilate into organisational culture effectively. According to Ahmed et al., (2002) culture is a primary determinant of knowledge management where that later is seen as a pervasive attitude that empower businesses to see further than the present and to create the future. They have indicated that it is not enough to simply deciding that the organisation has to be able to manage knowledge, this decision has be supported by actions that create an environment where individuals are easeful with knowledge sharing and transfer. Therefore, organisations should strive to create an environment that would make it simpler to convert tacit rules and knowledge into explicit knowledge Bhatt (2000) and to be disseminated a cross the organisation. If the notion of knowledge culture, as indicated by Ahmed et. al. (2002), is to be useful then its significance will be attained as long as we understand what we mean by this term. Before attempting to delve deeper into the concept of knowledge culture (termed in this study as the culture

of knowledge transfer) it is important to understand that knowledge culture has developed from wider concepts such as organisational or corporate culture. At a basic level, culture may be defined as “the way we do and think about things around here” (Williams *et al.*, 1994). According to Davis (1984) corporate culture offers a contrast to the past rigidity of management models. He defines culture as the pattern of shared beliefs and values that give organisation members meaning, and provide them with the rules for behaviour in their organisation. Corporate culture can be also seen as the values, beliefs, norms, and traditions within an organisation that influence the behaviour of its members. There is a magnitude of definition of culture as Ahmed *et. al.*, (2002) indicated where most suggested culture is the pattern of arrangement or behaviour adapted by the group such as corporate and teams as an approved method of solving problems. From a learning perspective, generally, learning definitions of culture deal essentially with the way we act or the way we think (Maull *et. al.*, 2001). A more widely recognised definition of culture was provided by Schein (1984) where he describe culture as a pattern of basic assumptions that a given group has created, discovered, or developed in learning to cope with its problems of external adaption and internal integration, and that have worked well enough to be considered valid and, hence, to be taught to new members as the appropriate way to perceive, think, and feel in relation to those problems. According to this definition, the core feature is that culture is taught to new members as the correct way to behave and to react to problems when arise and, hence, support the organisational aim for survival and growth. Viewing culture as mental programming, Hofstede (1980) defines culture as the collective programming of the mind, which distinguishes the members of one category of people from another. According to (Maull *et. al.*, 2001) this definition stresses that culture:

- is collective and not a characteristic of individuals (shared values);
- is mental "software", therefore invisible and intangible as such;
- is interesting only to the extent that it differentiates between categories of people

Ahmed et. al., (2002) indicated that culture can also be viewed either explicit or implicit. Explicit culture represent the idiosyncratic patterns of behaviour by individuals and the specific artefacts the they produce and live within, where implicit culture involves to the value, beliefs, and norms which reflect the observed patterns of behaviour resulted from the explicit culture. They have indicated that the strength of the culture relies in the proportion of members holding strongly to specific beliefs and standard of behaviour and the match between the implicit and explicit aspect of culture.

Knowledge culture can be considered as a key factor, the presence of such culture "*knowledge-friendly culture*" the process of knowledge creation will be most efficient and stronger. In a survey conducted by Davenport and Prusak (1998) on the factors leading to knowledge project success, a *knowledge-friendly culture* was named the most consequential conditions. They propose that the knowledge friendly culture has different segments that have a positive orientation to knowledge. These segments can be viewed as:

- employees are bright, free and willing to explore;
- absences of inhibitors, (e.g. employees, are not resentful to the organisation and they do not fear sharing their knowledge);

- the fitness of knowledge management projects to the organisational knowledge culture.

They describe remedies for culture factors that inhibit knowledge transfer. Where there is lack of trust, they propose that the organisation should build relationships and trust through face-to-face meeting. This is also supported by (Nonaka, 1991, Nonaka and Takeuchi, 1995, 1996). According to Ahmed et. al., (2002) trust should be viewed from two dimensions, managers trusting employees to act in the organisation's best interest, and managers should act in a way that earn trust of their workforce. In the case of the existence of different cultures and frame of reference, a common motive should be created to overcome the diversity through education, teaming and job rotation. A place and time for knowledge transfer should be established (El Sawy et. al., 2001, Nonaka et. al., 2000A, Nonaka and Konno, 1998, Davenport and Prusak, 1998) through fairs and talk rooms whenever the organisation senses there is a lack of time and meeting places.

Organisations should provide incentives on the basis of sharing, not owning, knowledge (McGourty et. al., 1996). Ahmed et al., recognised the value of incentives in promoting knowledge sharing by emphasises on awards and rewards, it is the manner in which successes and failure are celebrated and rewarded, where ideas are valued, attention, support, and encouragement from the top management, and a respect for the beginning ideas.

When the organisation's ability to create knowledge and use it is weak, it should provide time for learning (O'Dell and Garyson, 1998) and hire employees for their

openness of ideas. According to Ahmed et. al., (2002) the amount of time and training given to the employees to develop and share new ideas and new possibilities should be supported by key actions and features such as encouragement of lateral thinking and skill development, opportunity, time, promotions, and infrastructure (e.g. rooms, equipment, etc.).

Whenever a belief arises among members that certain groups claim that they are the source of knowledge, the organisation should encourage the notion that the quality of ideas is more important than the status of source. Finally, an organisation should expand the horizon of intolerance by accepting and rewarding the creative errors and collaboration (McGourty et. al., 1996). Adopting this action by the top management will extend the degree of which individuals are given the latitude in defining and executing their own ideas and work, leading to more freedom to experiment, challenging the status quo, freedom to try thing and fail (Ahmed et al., 2002). By developing a knowledge culture, the organisations will set an important track in a knowledge-based company by move from imagination to motivation, to action and, further, to evaluation, satisfaction and realisation (Thurow, 1996). Effective knowledge management requires a supportive, collaborative culture and exclusion of traditional rivalries which means that organisation must assumes the basic level of contemporary organisational skills, such as collaborative work, effective listening, and using problem-solving paradigms (O'Dell and Grayson, 1998).

3.3.3 Infrastructure for knowledge transfer (IKT)

Infrastructure for knowledge transfer is a representation of the innovative work environment that is conducive to knowledge creation. In this study, there are four elements adopted to represent this construct: creative behaviour of individuals; skills and knowledge; integration of individuals, team and functions; and information and communication system.

According to Tang (1999, 1998) the availability of information, skills and knowledge, together with creative behaviour and the integration of people in the organisation, will determine the ability and inclinations of the organisation's members to raise projects and find an innovative solution. Knowledge creation is about doing and raising a project and finding a solution for a problem facing the organisation. Nonaka and Takeuchi, 1995; Leonard- Barton, 1995; and Khalil, 1996) all equate knowledge creation with innovation. Since the innovative work environment is designed to explore and find new answers for a critical problem, it was seen then an appropriate enabler of knowledge creation. Ahmed et. al., (2002) indicated that organisations need to consider the type of employees that can most effectively drive knowledge management since creative individuals play a significant and a fundamental role in creating and sharing knowledge. A number of personality traits and characteristics have been linked to the creative individuals. A select few of these summarised by Ahmed et. al., (2002) and Tang (1998) are as follows:

- high energy
- taking initiative to raise a new projects
- broad interests (e.g. show great interest in others work)

- attraction to complexity
- self-confidence and firm sense of self as creative
- intuitions and intellectual honesty
- high valuation of aesthetic qualities in experience

Organisations should try to nurture such characteristics and empower them in an organisational setting to encourage individuals to create and share knowledge rather than trying to use this type of inventory of the personality traits as predictor of learning and sharing accomplishment (Ahmed et. al., 2002). Knowledge management is a dynamic process which requires a continuous input of creative behaviour where that latter can be viewed as the process of coming up with, or generating, new ideas and the supportive knowledge creation environment represents the process of putting these new ideas into action. Plsek (1997, p.28) defined creativity as *“the connecting and rearranging of knowledge in the minds of people who will allow themselves to think flexibly to generate new, often surprising ideas that others judge to be useful”*. Since the future is basically unpredictable, creativity will serve as our main guidance when venturing into the unknown; the more unpredictable and uncertain the world is, the more companies must rely on creative initiatives from the employees to be able to create the desired future (Thurow, 1996). The degree of creativity decides whether information is changed into knowledge upon which action is based (Johannessen et. al., 1999). Creativity depends upon the process of creating and applying new knowledge. Gurteen (1998) considered creativity at the very heart of knowledge management. Drucker (1993) put it this way: “Making it productive”, referring to the process of knowledge creating and utilising. In order for knowledge management to

have a real impact on the way the organisation is doing business that is knowledge management has to be about how to utilise knowledge.

To enable teaming, help from the entire organisation is key. Collaboration among everyone in the organisation and the willingness of people to share their knowledge to help others is the main elements. Integration of people, teams and functions is a key enabler of knowledge (Wheelwright and Clark, 1995; Prahalad and Hamel, 1990; O'Dell and Garyson, 1998; Davenport and Prusak, 1998, Nonaka and Takeuchi, 1995, Von Krogh, 1998). According to Nonaka and Takeuchi, knowledge creation starts with the individual, then continues with teams and, subsequently, involves the whole organisation (c.f. Nonaka and Takeuchi's work on the phases of knowledge creation). According to O'Dell and Garyson (1998), collaborative relationships enable tacit knowledge and high-value practices to transfer; thus, creating a collective sense of purpose will inspire the organisation's members and lead to achieving a common objective for the organisation.

Previous knowledge and accumulated skills of individuals are recognised by many researchers and management philosophers (Polanyi, 1966; Cohen and Levinthal, 1990; Huber, 1991; Nonaka, 1991; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Davenport and Prusak, 1998; O'Dell and Garyson, 1998; Choo, 1998) as key enablers for the creation of new knowledge. Cohen and Levinthal (1990) indicated that accumulated prior knowledge facilitates an organisation's capability to create new knowledge. Knowledge creation is affected by relevant skills such as expertise (previous knowledge), technical skills, talent, in which skills and in depth-knowledge improves the possibility of creating a new understanding (Ahmed et. al., 2002).

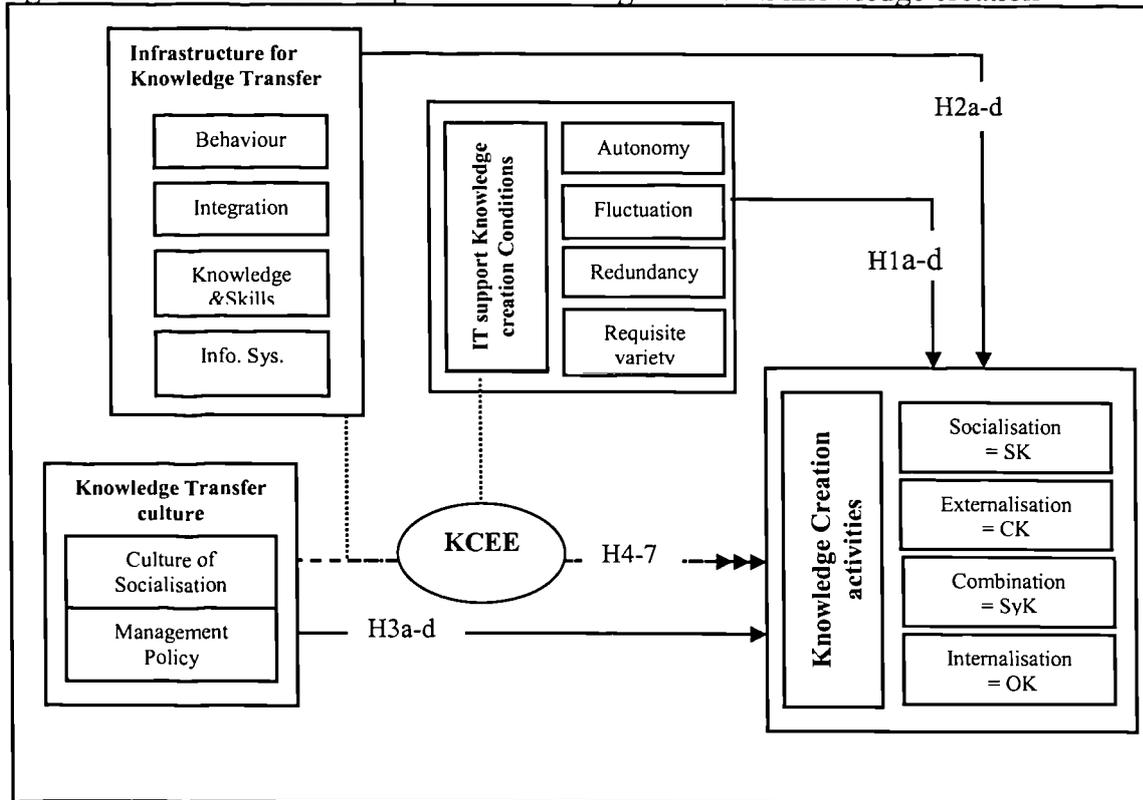
Previous knowledge should be linked to new information to create new knowledge (Huber, 1991). In other words, individual creativity, insights and resourcefulness, will facilitate the process of knowledge creation and sharing and, hence, disseminate new knowledge across the organisation. Another way of looking to the role of knowledge and skill is from the perspective of the competency-based theory (Hamel and Prahalad, 1994) and its strategies which it is dependent on people in which knowledge and expertise drive new-product development. Throughout the development of the theory of organisational knowledge creation in this study it was noted that previous knowledge is the core for new knowledge.

3.4 Research model development and hypotheses generation

Based on the theoretical development in the previous sections, a research model that relates information technology support for knowledge creation enabling factors, culture and the infrastructure for knowledge transfer to the organisational knowledge creation activities is developed (See figure 3.3).

The model proposes that information technology that provides support for a conducive knowledge environment will lead to positive participation in tacit knowledge creation activities. Nonaka and Takeuchi (1995), Leonard-Barton (1995) and Khalil (1996) argued that the knowledge creation process requires the presence and support of a number of factors which, in the context of this study, are grouped under three major factors: ITISKCFs, CKT and IKT.

Figure 3.3 The research conceptual model of organisational knowledge creation



The discussion in sections 3.2 and 3.3.1 demonstrated that the process of knowledge creation requires a higher degree of support from the knowledge enabling environment and ITI was presented in the discussion as the factor that will enhance and strengthen the environment. The argument here is that if knowledge creation factor is supported by the organisation the more likely individuals will engage in knowledge creating activities. As illustrated in section 3.3.1 the potential of information technology to provide the needed support, thus, we can hypothesised the following:

H1: There is a direct positive relationship between ITISKCFs and the time spent on organisational knowledge creation activities (SK, CK, SyK and OK).

H1a: There is a direct positive relationship between ITISKCFs and the time spent on sympathised knowledge creating activities.

H1b: There is a direct positive relationship between ITISKCFs and the time spent on conceptual knowledge creating activities.

H1c: There is a direct positive relationship between ITISKCFs and the time spent on systemic knowledge creating activities.

H1d: There is a direct positive relationship between ITISKCFs and the time spent on operational knowledge creating activities.

The presence of a culture of knowledge transfer “*knowledge-friendly culture*” and infrastructure of knowledge transfer as argued in section 3.3.2 and 3.3.3, is more likely to provide the cushioning needed for the activities of knowledge creation to proceed. It is expected that both culture and the infrastructure of knowledge transfer will strength the relationship between individuals and thus encourage knowledge creating activities. Combining the previous development on these sections, it can be hypothesised that

H2: There is a direct positive relationship between IKT and the time spent on organisational knowledge creation activities (SK, CK, SyK and OK).

H2a: There is a positive relationship between IKT and the time spent on sympathised knowledge creating activities.

H2b: There is a positive relationship between IKT and the time spent on conceptual knowledge creating activities.

H2c: There is a positive relationship between IKT and the time spent on systemic knowledge creating activities.

H2d: There is a positive relationship between IKT and the time spent on operational knowledge creating activities.

H3: There is a direct positive relationship between CKT and the time spent on organisational knowledge creation activities (SK, CK, SyK and OK).

H3a: There is a positive relationship between CKT and the time spent on sympathised knowledge creating activities.

H3b: There is a positive relationship between CKT and the time spent on conceptual knowledge creating activities.

H3c: There is a positive relationship between CKT and the time spent on systemic knowledge creating activities.

H3d: There is a positive relationship between CKT and the time spent on operational knowledge creating activities.

The integration of the enablers of knowledge creation (information technology that support the knowledge creation factors, culture and infrastructure of knowledge transfer) is hypothesised to form a wider and more effective knowledge enabler environment. Considering the arrangement presented in this chapter about the autonomous (independent) ability and the possible role of each of the enablers that might have of the activities of organisational knowledge, it was decided to see whether an integration of the enablers in a form of one enabler, that is termed in this

study as the knowledge creation enabling environment (KCEE), will have any impact on the activities of organisational knowledge. In other words, will merging the effect the autonomous impact of each enabler, which can be seen as a shared effect enhance the activities of the organisation's knowledge creation? For this purpose the following hypotheses are formalised and will be tested.

H4: There is a direct positive relationship between KCEE and the time spent on sympathised knowledge creation activities.

H5: There is a direct positive relationship between KCEE and the time spent on conceptual knowledge creation activities.

H6: There is a direct positive relationship between KCEE and the time spent on systemic knowledge creation activities.

H7: There is a direct positive relationship between KCEE and the time spent on operational knowledge creation activities.

Knowledge in general, and tacit knowledge in particular, is linked to individuals as previously stated in the literature of knowledge creation. Explicit and tacit knowledge contains both individual and organisational characteristics since both types of knowledge are partly created in the organisational context. As such, knowledge creation can be manifested through individual knowledge creation activities. It is interesting to investigate to see whether these enablers, in a form of individual effect or a shared effect, will enhance and or advance the process of organisational knowledge creation.

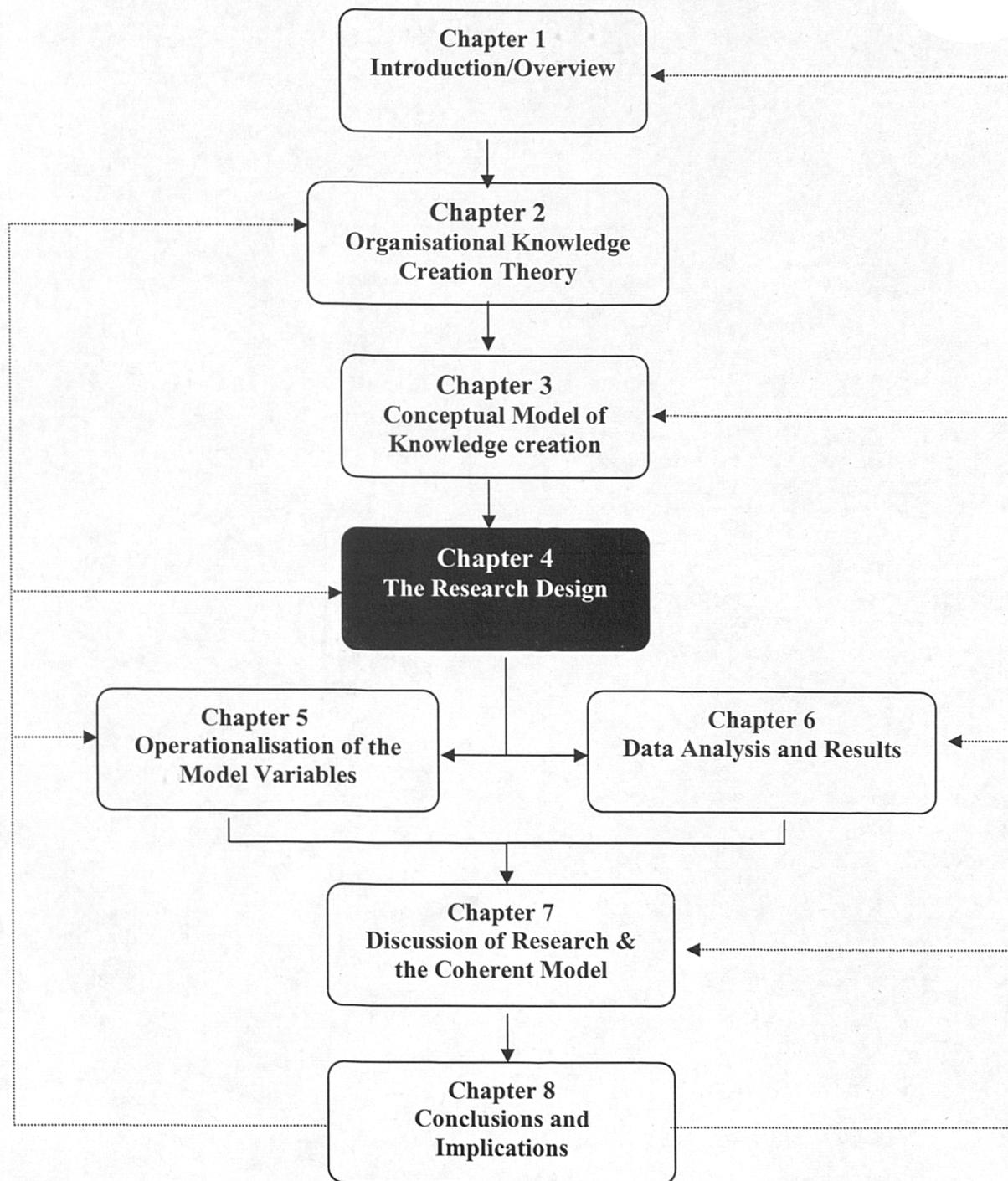
3.5 Summary

Nonaka and Takeuchi's (1995) model was presented to form the basis of the development of this research model. An arrangement was put forward in the role of information technology in knowledge management since it is the larger domain for knowledge creation. The research proposes a different methodology to solve for the dilemma of information technology enabled knowledge creation. An argument supporting the literature was presented to support the enablers of knowledge creation (ITISKCFs, CKT and IKT). The research model is developed and the hypotheses were generated. The next chapter will present the methodology adopted in this study to satisfy the research objective and to enable for the testing of the research model and the generated hypotheses.

Chapter Four

The Research Design

Figure 4.1 Chapter four in the context of the thesis



Chapter Four

The Research Design

4.0 Introduction

Figure 4.1 shows the location of this chapter in the context of the overall thesis. The preceding chapters assert that the research into enablers of organisational knowledge creation and organization innovativeness was worthwhile. This chapter describes the research methods used to investigate and examine the role of information technology infrastructure and the culture of knowledge transfer to enhance the organisational knowledge creation and organization innovativeness. A survey design and analysis was adapted as the method that guides the data collection and analysis to establish the existence and importance of the relationships among the enablers of knowledge creation and the process of knowledge creation and conversion. The process of operationalisation and measurement of the model variables and testing the research hypotheses developed from the research model will be discussed. The survey design exploits the methods and recommendations proposed by (Czaja and Blair, 1996, Oppenheim, 1992, 2000, Robson, 2000, Cohen et al, 2000) and the response enhancing procedures recommended by (Oppenheim, 2000, Robson, 2002). The survey analysis exploits the recommendation concerning the multivariate data analysis technique and structural equation modeling (Byrne, 1994, Benter, 1995, Mueller, 1996; Hair et. al, 1998). The instrument used in the survey is displayed in Appendix (B).

4.1 Research design

Oppenheim (2000) has distinguished between the two terms that some researchers use interchangeably: ‘research design “methodology”’ and ‘research technique “methods”’. The term research design or methodology refers to the overall strategy of the research. Thus, the research design should advise us on how the sample will be drawn, what groups and/or subgroups it must include, what contrast should be made, what variables we need to consider and measure and how these measures are linked to external events. The research design is concerned with making our problems accessible by directing our research in a way that generates precise answers to precise questions. Hussey and Hussey (1997) defined the term ‘research methodology’ as the overall tactics of the research process that comprises theoretical underpinning, data collection and analysis. The term ‘research techniques’ or ‘methods’ are the methods used for data generation, collection, measurement, quantification and to make sure that the instrument is appropriate, valid and reliable. According to Creswell (1994), there are two approaches that the research methodology can be derived from. These two approaches can be classified into two main categories: a positivistic and a phenomenological approach. These two categories are sometimes described by different terms. The positivistic approach can sometimes be labelled as traditional, quantitative, or empiricist. Whilst the phenomenological approach can be labelled as post-positivistic, subjective, or qualitative. Ibrahim (2000) noted that the terms that are associated with each approach are not necessarily interchangeable and, in many cases, have emerged as a corollary of the author wanting to bestow a different approach.

The positivistic approach seeks causes of social phenomena or objective knowledge (facts) that can be gained from experience or observation, while paying little attention to the subjective state of individuals, thus, employing a logical reasoning to attain objectivity when investigating a phenomenon and explaining causality. The positivistic approach is largely based on quantitative data. Explaining causality requires the establishment of relationships between variables and linking them to a certain theory. The benefits of positivistic approach are cost effective and speed in data collection, the ease of analysis, apposite for testing hypotheses and determining relations between variables and establishing the reliability and generalisability of data. The phenomenological approach or post positivistic, on the other hand, has emerged as a result of denunciation of the application of positivistic approach in social science. The view adapted by this approach stems from the belief that reality is not objective and exterior, but socially formed and given meaning by the individuals. Distinctively, this approach focused on the subjective state of individuals paying a considerable attention to the subjective aspects of individual activity by embracing the meaning rather than the measurement of social phenomena (Easterby-Smith, et al, 1991). This approach advocates the use of qualitative methods that focus on generating hypotheses in order to illustrate and explain the phenomenon in its context. The benefits of the phenomenological approach become visible by enabling researchers to examine change processes over time and more in depth and offer rich and distinctive insights (Easterby-Smith, et al, 1991). The criticisms of the approach and associated qualitative methods arose from the fact that it is rather resource-intensive; the analysis and the interpretation of data is often complex and requires distinctive skills, lack of well-formulated hypotheses and, more important, in comparison with the positivistic approach, the validity and reliability of the derived finding are often seriously

questioned because of the probable subjective influence of the researcher. Considering the benefits and drawbacks of the two approaches in addition to the study's limitations, which are discussed below, the researcher has adopted the positivistic approach due to the following reasons.

- Resource limitation (economy: time and cost of the study) considering the fact that the researcher is partly self-funded and considering the issue of residency.
- The difficulties to gain an access to the UK financial institutions considering the cultural and language barriers and the issue of sponsorship. This has made it extremely difficult to access the targeted group in person and to be able to conduct any sort of phenomenologically relevant approaches.
- The issues of validity and reliability are often seriously questioned because of the 'soft' nature of the data and the issue of subjectivity in phenomenologically related approaches.
- The need to satisfy the research objectives in terms of factor analysis and testing hypotheses and to verify relationships between the variable and constructs of the study that are not possible in phenomenological related approaches.
- Previous researches in similar areas have utilised the quantitative methods as an appropriate strategy to achieve the required objectives (e.g. Nonaka et al, 1994; Zoonky, 1999). In addition, most books on research methodology have

emphasized the popularity and the adequacy of quantitative methods in carrying out research (Robson, 2002; Cohen et al, 2000).

4.2 Data collection methods

The decision was made earlier, in section 4.1 to adopt the positivistic methodology, the need for quantitative data to satisfy the objectives of the study and the need for a large sample to carry out the data analysis. In addition, the researcher needed to examine the factorial design of the variables of the study, the relationships between the variables and the constructs of the proposed model discussed in chapter four. Considering the advantages and disadvantages of the mail questionnaire in comparison with other data collection methods, such as face-to-face interviews and telephone interviews identified by (Oppenheim, 1992, 2000, Robson, 2000, 2002; Czaja and Blair, 1998; de Vaus, 1996; Newell, 1999, Bourque and Fielder, 1995; Frey and Oishi, 1995), the study adapted the mail questionnaire methods to satisfy the previously mentioned constraint. A summary of the advantages and disadvantages of the mail questionnaire in comparison with other data collection methods can be seen in table 4.1

Table 4.1: Summary of the advantages and disadvantages of different data collection methods (sources: multiple references on research methodology)

| Criteria | Mail questionnaires | Face-to-face interviews | Telephone interviews |
|-------------------------------|---------------------|-------------------------|----------------------|
| Economy (cost & time) | High | Low | Moderate |
| Efficiency of data collection | High | Moderate/High | Moderate |
| Response rate | Low | High | Moderate |
| Distribution of sample | Wide | Must be clustered | May be wide |
| Sensitive topics | Good | Fair | Fair/good |
| Assuring Anonymity | High | Fair | Fair |
| Sample Size | Large | Small | May be large |

4.3 Questionnaire design, pre-test stages and the pilot study

The survey instrument (questionnaire) development process was guided by the following practice recommended by social research:

- a) initial design and development of the survey instrument
- b) pre-testing and enhancement through panel of experts opinion
- c) pilot test.

a) Initial design and development of survey instrument

Many criteria should be considered when designing a questionnaire survey. Recommendations by Fink (1995), Cohen and Manion, (1994), Bell (1999), Oppenheim (2000), Robson, (2000), and Cohen et. al., (2000) on the choice of wording, questionnaire design and layout were adopted. Attention was paid to the choice of wording since the language of questionnaires is an exceedingly important attribute of their effectiveness and should reflect the respondent's own language usage. The wording of the questionnaire can also help to avoid pitfalls, such as leading and double-barreled questions. Items in the questionnaire were designed to bring them as close as possible to being simple, clear, short, technically accurate, bias free and at an appropriate reading level. Recommendations on how to structure the questionnaire layout (by Oppenheim, 2000; Robson, 2000; de Vaus, 1996; Fink, 1995b) were taken into account when designing the questionnaire, such as started with a brief description of the meaning of main concepts, being consistent in style and providing instructions on how to answer each section of the questionnaire. An initial draft of the questionnaire was developed based on an extensive literature review and

existing measures. Initial concepts were conceived. Key concepts such as IT capability that enhance the information attributes to support the construction of a conducive environment for knowledge creation activities, organisational knowledge creation activities, culture of knowledge transfer and infrastructure for knowledge transfers were identified. Initial measurements of these concepts were developed. Items measuring the manager's perceptions on IT capability and culture of knowledge transfer were self-constructed in the light of the existing literature and theories (Nonaka, 1991; Nonaka et al, 1994, 2000b; Nonaka and Takeuchi, 1995,1996; and Leonard-Barton, 1995; Choo, 1998; Huseman and Goodman 1999; O'Dell and Garyson, 1998; Davenport and Prusak, 1998) and other literature sources for appropriate phrasing of specific items. Items measuring activities of organisational knowledge creation and innovative work environment were adapted from Nonaka et. al., (1994) and Tang (1998,1999) with minor adjustment added to some items.

b) Enhancement through panel of experts

After the initial development of the constructs, which reflect the main key concepts of the research model, a draft questionnaire was pre-tested informally to a group of friends and colleagues all of whom are research students at the University of Huddersfield. They provided many constructive suggestions regarding the structure, wording and presentation of the draft questionnaire. Taking their comments into consideration a second draft of the questionnaire was produced. This method of retesting the draft questionnaire was encouraged by a number of authors in social science research. Robson (2002, p. 254) stated that:

“ The draft questionnaire is best pre-tested informally... Colleagues, friends and family can usually be cajoled into reading them through and providing (hopefully) constructive comments wording”

Remenyi et al. (1998, p. 151) stated that:

“Approaches to pre-testing can be fairly informal where one consults friends, colleagues, expert and people of adverse opinions, or it could be more informal, involving a pilot study which is a replication, on a small scale, of the main study”

Measurements were also improved with the aid of five university research professors, each holding a Ph.D. either in management, business, or information technology. Feedback obtained has helped in the refinement of the items in terms of more objective methods for measuring indicators and better wording. The pre-testing stages provided many useful suggestions which are incorporated in the pilot version of the question. The initial pilot version was discussed with the researcher's supervisors and the pilot version was reviewed and approved by them prior to pilot study. Other objectives were also met from the pre-testing, such as establishing both face and content validity for the questionnaire.

c) The pilot test

Initiating the pilot test, a mail questionnaire was administered at beginning of April 2001. Twenty-two respondents were selected randomly from both retail banks and building societies. The questionnaire targeted the middle managers in both the

marketing and product development departments. The respondents were asked to complete the questionnaire and provide any comments, if applicable. Six questionnaires were completed and returned from the initial mailing. In order to increase the response many telephone calls were made and a reminder was sent. Two further completed questionnaires were received. A total of eight completed questionnaires were returned. This constitutes a response rate of 36.4 per cent of the total sample in the pilot study. None of the respondents recommended any comments, which suggests that the questionnaire was clear and easy to complete. An analysis of the responses provided in pilot test led to the removal of one question for unclarity reason. This question was about the role of constantly changing information facilitated by the computer in questioning the validity of basic attitudes. Another question, concerning the number of innovating projects that the respondent was involved with, was modified by an increase in the scale of a maximum of 'more than five' to a maximum of 'more than fifteen'.

4.4 Structure and the content of the final version of the questionnaire

The recommendation of the pre-testing stages, including the pilot work and other validation mentioned earlier, were integrated in the final version of the questionnaire. The data obtained was inclusive and there was no evidence to suggest that the respondents had difficulty with any of the questions. Enormous efforts were invested in designing the layout and the appearance of the questionnaire to encourage the completion of it. The first page contained the university name and logo and an assurance statement regarding the confidentiality of information and a statement indicating the imperativeness of participation by the respondent to the success of the

study. The second page contains explanatory notes on the terminology used in the questionnaire. The questionnaire was split up into four sections in order to facilitate understanding.

- Section 1 contains questions regarding the use of computers; this section was designed to examine the IT infrastructure capability in supporting the knowledge-based environment.
- Section 2 contains items about the dynamics of the respondents' work in relation to knowledge creating activities.
- Section 3 contains items about the respondents organisation; this section was divided into two subsections, 3A and 3B
- Subsection 3A contains items aimed at examining the aspects of the innovative work environment (referred to in this study as the infrastructure of knowledge transfer of the organisation).
- Subsection 3B contains items aimed at examining the aspects of the culture of knowledge transfer supported by the organisation.
- Section 4 contains questions aimed at obtaining information for classification purposes and to test for non-response bias.

In section 1 items were developed and constructed in the light of the existing literature of organisational knowledge creation (Nonaka and Takeuchi, 1995, 1996; Khalil, 1996, Leonard-Barton, 1995; Choo, 1998; Huseman and Goodman 1999). Items 1-5 were designed to understand the characteristics of the information technology infrastructure that supports redundancy of information, which is the first enabling factor of knowledge creation hypothesised by Nonaka and Takeuchi (1996). The items aimed at examining if information technology can offer the necessary redundancy by supporting the availability, transferability and enabling the sharing of information and assisting the individual to understand his/her role in the organization. Items 6-9 were designed to understand the characteristics of information technology infrastructure that supports the fluctuation of information as a second enabling factor of knowledge creation. The items aimed to examine whether information technology can offer the necessary fluctuation that triggers the memory, facilitates development through informational updating, assists in removing consistency and ease of change that leads to a break of the work routine. Items 10-14 were designed to understand the characteristics of the information technology infrastructure that supports the requisite variety of information, the third enabling factor of knowledge creation. These items aimed to examine how information technology can support requisite variety through facilitating accessibility to information, integrating the organisation with the outside environment and identifying the location and the source of information. Items 15-19 were designed to understand whether information technology could offer an extended degree of individual work related autonomy by storing and delivering the necessary information, triggering risk taking initiatives and expanding individual freedom boundaries. Items 15-19 represent the second dimension of IT infrastructure capability.

Section 2 was designed to explore the dynamics of knowledge creation activities; items in this section were adapted from Nonaka et al. (1994, 2000b). Items 1-10 are about the activity of shared problem solving through socialisation which leads to production of sympathised knowledge. Items 1-8 are about the accumulation of knowledge and items 9-10 are about the transfer of knowledge. These two sets of items were reworded to fit the new context. Items 11-15 are about the activity of creating concepts through externalisation which leads to the production of conceptual knowledge. Items 16-23 are about the activity justifying concepts through internalisation which leads to the production of operational knowledge. Items 24-31 are about the activity of building a prototype through combination which leads to the production of systemic knowledge.

Section 3A was designed to obtain the respondents' opinion on the different aspects of the infrastructure for knowledge transfer (IKT). Items in this section were adapted from Tang (1998, 1999). Items 1-4 and 9-12 were designed to measure the respondents' perceptions of creative behaviour and integration aspects of IKT. Items 5-8 and 13-16 were designed to measure the respondents' perceptions knowledge and skills, and information systems.

Section 3B was designed to obtain the respondents' opinion on the different aspects of culture of knowledge transfer practiced and supported by the organisation. The different aspects of culture of knowledge transfer comprise two dimensions which have been identified as a result of the data analysis. The first dimension was named as the socialisation oriented culture of knowledge transfer which is represented by items

1-4. These items include statements about whether the organization encourages the face-to-face meeting, establishes common ground for education, discussions, teaming, whether the organisation establishes time and space for knowledge transfer such as fairs, talk rooms, and/or conference reports and finally, whether the organisation provides incentives based on sharing knowledge. Items 5-10 represent the second dimension which represents the organisation's policies regarding the culture of knowledge transfers. These items include statements about the number of policies that encourage the promotion of the culture of knowledge transfer. Such statements include leadership visions regarding the type of knowledge that should be developed, flexibility, appreciation of knowledge no matter the hierarchical-level of the source, statement regarding the hiring policy and, finally, statements regarding clemency toward creative errors.

The final section, section 4, was designed to obtain the following information.

- Respondent's level of education.
- Respondent's management position.
- Respondent's involvement in the innovative projects.
- Respondent's length of experience at his/her current position.
- The number of approval levels from the respondent's current position to the department's executive officer.
- Respondent's age.

Such questions were designed for classification purposes and were tested for possible bias from the respondent's backgrounds.

4.5 The population, the actual sample selection and, other related decisions

Shaping decisions concerning the selection processes can be influenced by the type of methods adopted to form these decisions. Some may take a scientific form and others many take a nonscientific one (Colgate, 1998); for example, choosing organisations to partake in a questionnaire survey may involve meticulous sampling procedures. Equally true, personal contact and academic discourse may also have a momentous influence on the decision whether organisations are included or not.

4.5.1 Decisions related to population and sample selections

Financial services institutions are, clearly, representing a knowledge and information based industry (Abell and Oxbrow, 2001); their key business imperatives such as risk management, client relationship and continuous innovation, depend upon strong knowledge performance capabilities (Moss and Thompson, 1998). Recent development of information technology and the emergence of globalisation have changed the market and put more strains on the financial institutions or, more specifically, banks need to rely more on knowledge to advance their degree of competitiveness in a turbulent and volatile market. For these reasons, the financial services industry was seen as an appropriate business environment that is particularly suitable to test for the research model and the knowledge creation process (for more details, see chapter one). Identifying the population of the financial services industry

started first by utilising an electric database (fame) aiming to identify the UK based retail financial service institutions. The findings disclose many different types of financial services sectors that assume retail activities, such as banks, building societies, insurance companies, investment trusts, etc. The findings also reveal that other types of organisation fall outside the traditional boundaries of the financial service sector which undertake retail financial services, for example, Tesco Financing and many others. A decision has to be made on the type of financial institutions to be included in the study since many organisations undertake retail financial activities and choosing all will be beyond the ability of the research to embrace. The decision was made that only retail banks and building societies would be considered in the study since the boundaries that have existed between the two sectors were gradually scoured (Colgate, 1998). The rationale behind this decision was also based on the similarities between the two sectors, mainly regulation, competition and technology. Another objective in choosing banks and building societies was to maintain the extent of manageable study. Hussey and Hussey (1997) defined a research population as any exactly defined set of people, or collection of items, that is under investigation. In the light of this definition, and considering the decisions made earlier in this section regarding the boundaries of the research population, the research population and the actual sample are identified as “All the UK retail banks and building societies, which provide roughly homogenous financial products and services”. According to this definition foreign retail banks were not included due to the fact that these banks operate in the UK on a small-scale basis (e.g. Arab Bank has two branches only which are located in the London area) and were formerly placed in the UK to serve its nationals. The research identifies twenty retail banks (subsidiaries are not included) and sixty-nine building societies. The lists were obtained from many different

sources; The Banks Directory, 1995; Fame Electronic Database; Internet search; previous research on the retail banking industry (Colgate, 1998); the Directory of Building Societies, 2000-2001/2002.

4.5.2 Strategies for selecting banks and building societies and the actual sample

To ensure access to prospective respondents, and as is common practice in social research, there was an urgent need to establish a contact person (informant) within each bank and building society. The initial decision at this stage was to use a telephone contact for both. Contacting institutions at an early stage of empirical research to obtain their participations is recognised by a number of researchers (Ibrahim, 2000; Colgate, 1996, 1998; Wright et. al, 1995). This strategy proves to be appropriate for banks only. The process of reaching the appropriate subject to establish a contact at the banks in the population defined in the preceding section was difficult, to a certain degree, given that banks do not advertise or publish the names of their employees (e.g. head of department, section, product etc.) for public use. The researcher had to go through lengthy channels of transfers. Upon reaching the target department the researcher identified his name and his institution and the purpose of the call in short, then he asked if he could speak with the person who can make decision concerning whether the target department would be interested in joining the study. When reaching the probable contact person a brief overview of the research was described to him with the aim and the objectives of the study and then asked if his department might be interested and if he would be willing to act as contact. To obtain a positive response, a cost/benefit argument was adopted explaining the benefit that his/her department might obtain in return for a few minutes that his/her staff

might spend when answering the questionnaire survey (a brief description of the questionnaire survey, the number of pages and the time required to fill out the questionnaire survey was stated to the contact person). Finally, when the approval was obtained a question regarding the number of questionnaire surveys that his department could accommodate was asked. Most established contacts from the retail banks agreed to accommodate an average of ten copies of the questionnaire at most; this number was adequate to ensure a minimum sample size for data analysis, considering the number of financial institutions (banks and building societies) in the actual sample. The end result of telephone calls was that a total of fourteen retail banks (70% of the population) agreed to receive the questionnaire (see appendix C). The remaining retail banks asked to be excused from this study. Reasons for non-participation between the non-participant banks generally were that it is the bank's policy not to answer questionnaires, or they are overwhelmed with the number of questionnaire that they received each week, making it difficult for them to respond to every one.

Concerning the building societies, in the context of this research, telephone contacts proved to be an ineffective strategy in establishing informants. After contacting a number of the building societies identified in the population, accommodation of the study was denied, the justification for non-participation given to the researcher was either that they are small entities and they are overwhelmed by other researchers so they can only accommodate a few, or they adopted an internal policy not to be involved with any outside research. To reserve the maximum number of the remaining probable contacts in the building societies a different strategy was adopted.

A mailed letter stating an overview of the research with the aim and the objectives of the study, highlighting the benefits of the study if they choose to accommodate the questionnaire survey was sent to the remaining building societies (see appendix C) in the population (unlike banks, names such as general manager, heads of major departments, were published in the directory of building societies 2000-2001). The researcher assured the confidentiality of information conveyed regarding the respondent's name and his/her organisation. Considering the large number of building societies operating in the UK in comparison with retail banks, the relatively small number of employees in each targeted department and to insure the maximum accommodation of the questionnaire survey, an average of four copies of the questionnaire was sent to each building society, and a posted return envelopes was included in the mailed survey. This strategy yielded an improved result in comparison to telephone contacts.

A total of fifty-four building societies were included in the actual sample. The remaining fifteen building societies were removed from the sample because they either declined to participate, as stated in this section, or the building society was relatively small in term of the number of employees, which do not satisfy the objective of the study. Details of the number of banks and building societies included in the survey, the numbers of questionnaire survey mailed and returned, and the response rate are discussed in detail in sections 4.6 and 4.7.

4.5.3 The respondent (the middle manager)

The productivity of the knowledge worker has received growing attention during the last decade, where a number of researchers have paid a great deal of attention to this

subject (see for example; Toffler, 1990; Reich, 1991; Lundvall, 1992; Drucker, 1993; Lundvall and Johnson, 1994; D'Aveni (1994); and Archibugi and Michie, 1995), in addition to Nonaka and Takeuchi (1995), and Leonard-Barton (1995). Based on the literature review on knowledge creation and the middle management role in knowledge creation, it was decided that the best and the most suitable people to respond to the questionnaire survey and, hence, to achieve the objectives of the questionnaire by getting the information from the right subject, are the people located at middle management level. According to Nonaka and Takeuchi (1995, p. 233) they stated that “ *in our view, ...middle managers play a key role in the organizational knowledge-creation process*”. They asserted that, in a knowledge-creating company middle managers are positioned as the “*knot*”, “*bridge*” and “*knowledge engineers*”, where middle managers are viewed as key holders of relationship knowledge. Takeuchi (2001, p. 323) states, “ *If top management’s role is to create a grounded theory, middle managers create more concrete concepts that the front-line employees can understand*”, because middle managers serve as the bridge between the top management and the employees on the front line of business. Support for the middle manager’s role as a mediator and knowledge creator can also be found in Bartlett and Ghoshal (1994), Mintzberg (1994), Huber, (1998), Sethi, (1999), Blumentritt, R. (2000), and van den Bosch and van Wijk (2001).

4.6 Administering the questionnaire

The questionnaire was complemented with a covering letter. The objectives of this letter were:

- A. to explain the aim of the research and to convey its importance
- B. to ensure the absolute confidentiality of the information provided by the respondent
- C. to advise the respondent that a summary of the research findings will be provided to him/her when requested.

A copy of the questionnaire is shown in Appendix (B). A total of four hundred and two questionnaires were sent to a population of seventy retail banks and building societies. Two reminders were sent to encourage respondents to answer the survey and to increase the response rate. A total of one hundred and forty two questionnaires were returned, of which one hundred and three completed questionnaires were returned and a six uncompleted questionnaires were returned with their original envelopes and a letter stating that the person addressed to no longer worked for the organisation. A further thirty-three were returned with a letter explaining why they had not been completed. Table 4.3 provides an analysis of reasons of non-completion. The population and the responses and breakdown of the sample can be seen in table 4.2

Table 4.2 Population and response rate breakdown

| Total population | Number of institutions | Number of questionnaires sent | Number of completed questionnaires returned | Number of unreachable respondents | Response rate |
|------------------|------------------------|-------------------------------|---|-----------------------------------|---------------|
| | 14 Retail Banks | 162 | 57 | 0 | 35.2% |
| | 54 Building Societies | 240 | 45 | 6 | 19.1% |
| Total | 68 | 402 | 102 | 6 | 26% |

An analysis of the response rate bias based on the type of organization (retail banks and building societies) was conducted using the Mann-Whitney statistical test based on three factors: respondents' level of education, the number of innovating projects the respondent is involved in, and respondent's management position. This analysis reveals no significant difference between the response rate of retail banks and response rate of building societies. Result can be seen in table 4.3.

Table 4.3 Mann-Whitney test for the responses based on the type of organisation ^a

| Test criteria | Mann-Whitney | Wilcoxon W | Z | Asymp. Sig. (2-tailed) |
|---|--------------|------------|--------|------------------------|
| Respondent's level of education | 1282.500 | 2935.500 | .000 | 1.000 |
| The number of innovating projects the respondent is involved in | 1045.000 | 2698.000 | -1.676 | .094 |
| Respondent's management position | 1079.000 | 2114.000 | -1.583 | .113 |

a. Grouping variable: Type of organisation (retail banks and building societies)

Out of one hundred and three completed questionnaires from retail banks and building societies there was only one questionnaire that was unusable. The source of this uncompleted questionnaire was one of the retail banks in the sample and there was no name attached to this questionnaire; consequently, it was impossible to identify the respondent to inquire about reasons for not completing the questionnaire. Therefore, the questionnaire was neglected. As indicated by de Vaus (1990, p. 99), calculating the response rate can be executed by using the following formula:

Response rate = Number of completed and returned / (Number of respondents in sample – (Unreachable respondents - Ineligible respondents)). Applying this formula, the response rate = $103 / ((402 - (6 - 0)) = 26\%$.

The analysis of the questionnaire's response rate can be seen in table 4.4. After the removal of the uncompleted questionnaire there was a total of 102 returned and usable questionnaires, which constitute an approximate 26% of the total sample; this number was deemed to be adequate enough to carry out the data analysis. A discussion to support the adequacy of the number required to carry out the data analysis is provided in chapter six.

Table 4.4 Analysis of the questionnaire response rate

| | | |
|--|------------|------------|
| 1. Respondent no longer works for the institution | | 6 |
| 2. Returned without completing the questionnaire for different reasons. (See table 5.4) | | 33 |
| 2. Questionnaires return and completed | | |
| 2.1 Useable questionnaires | 102 | 102 |
| 2.2 Unuseable questionnaires | 1 | 1 |
| Total | 103 | 142 |

Table 4.5 Reasons given for non-completion of the questionnaire

| Reasons | Frequency | Per cent |
|--|-----------|-------------|
| The company policy deters participation in surveys | 12 | 36.5% |
| Time and resources prevent participation | 6 | 18% |
| Pressing business matters | 4 | 12% |
| Apology, with no reasons | 11 | 33.5% |
| Total | 33 | 100% |

4.7 The adequacy of the response rate and the test for non-response bias

Dealing with the issue of the non-response rate, many prominent authors in the area of social research, such as Oppenheim (2000), Robson (2002) and de Vaus (1996), have commented on the seriousness of the non-response concern. All have depicted many techniques to be used in order to increase the response rate. Oppenheim (2000, p. 103-106), Robson (2002, p. 249-252) and de Vaus (1996, p. 117-120) proposed the following factors which have been found in many cases able to increase the response rate in mail questionnaires. These factors are summarized in table 4.6.

Table 4.6 Summary of factors aimed in securing a good response rate

| Factors | Objectives |
|-------------------------|---|
| Advance warning | Informing the respondent of the study and inviting participation. |
| Confidentiality | Assuring respondent that no information will be published which might link them or their organisations. |
| Covering letter | Indicate aims, convey importance and encourage reply. |
| Design and layout | Clarify and remove confusions. |
| Follow-up letter | Emphasise the importance of the study. |
| Initial mailing quality | Improved chance of being opened. |
| Sponsorship | Motivate the respondent. |
| Use of incentives | Respondent more helpful when offered incentives. |

Taking into consideration the factors listed in table 4.6 and the recommendations made by Oppenheim (2000), Robson (2002) and de Vaus (1996), it should be noted that numerous efforts have been made in order to encourage the response rate.

Telephone calls, whenever possible, were conducted to invite participation and remind the respondents to answer the questionnaire. A cover letter accompanied the questionnaire and incorporated in it all possible statement defining aims, objectives, conveying the importance of their responses to the success of study and assuring confidentiality of the respondents and his/her organization (see appendix A). Pre-printed envelopes that have the university logo were used and sent via first class mail; pre-paid addressed return envelopes were included in the initial mailing. An electronic copy of the questionnaire was developed and posted on the university web site and it was suggested to the respondents that they might wish to answer it directly using their PC. Many considerations were taken into account when designing the layout of the questionnaire; sections were labelled in bold to remove any confusion and instructions on how to answer each section of the questionnaire were included. Follow-up letters were sent emphasising once again the importance of the study, the value of the their response, and requesting their participation. Consideration was made to the choice of wording and the order of the questions in the survey.

A low response rate is a possible outcome when a mail survey is used to collect data. Kervin (1992, p446) and Moser and Kalton (1989, p. 167) advocate a method for assessing the non-response bias. This method is based on comparing the early and late responses. It is assumed that the respondents who return the questionnaire late are more like a non-respondent compared to those respondents who return their questionnaires early. Considering that many telephone calls were made and two reminders were sent out to encourage respondents, this method was adopted to assess the non-response bias. Analysis of the early and late responses can be seen in table 4.7.

Table 4.7 Analysis of usable early and late responses

| | Frequency | Percent | Cumulative Percent |
|------------------------------|-----------|---------|--------------------|
| Early response | 76 | 73.8 | 73.5 |
| Late response - 1st reminder | 15 | 14.6 | 88.4 |
| Late response - 2nd reminder | 12 | 11.6 | 100.0 |
| Total | 103 | 100.0 | ----- |

Adopting the method of assessing the non-responses bias mentioned earlier were chosen as variables that could be associated with non-response bias: respondent's age, number of months respondent in current job, respondent's level of education, The number of innovating projects the respondent is involved in, respondent's number of approval levels to department executive officer, and type of department in which the respondent works.

A Mann-Whitney test was performed comparing the two sets of responses (early and late responses). The first set represents the early responses obtained from the initial mailing and the second set represent the late responses obtained after the first and second reminders. A second test for non-response bias utilising the Kruskal-Wallis test was adopted; in this test three categories of responses were included: early response for initial mailing, late responses for the first reminder letter and late responses for the second reminder letter. The results indicated no significant difference between early responses and late responses for both test Mann-Whitney and Kruskal-Wallis tests, across all the selected variables. In other words, the results of both tests indicated that the characteristics of the respondents who do not

participate in the study are most probably the same as the characteristics of the respondents who joined the study. The results of both tests can be seen in table 4.8 and 4.9.

Table 4.8: Mann-Whitney test for the responses after the initial mail and the responses after the second reminder ^a

| Testing criteria | Mann-Whitney | Wilcoxon W | Z | Asymp. Sig. (2-tailed) |
|--|--------------|------------|--------|------------------------|
| Respondent's age | 284.500 | 350.500 | -1.657 | .098 |
| Respondent's number of months on current job | 387.500 | 3162.500 | -.256 | .798 |
| Respondent's level of education | 356.000 | 422.000 | -.774 | .439 |
| Respondent's number of involvement in product and process innovation | 371.500 | 437.500 | -.556 | .578 |
| Respondent's number of approval levels to department executive officer | 352.500 | 3202.500 | -.946 | .344 |
| Type of department | 412.000 | 3262.000 | -.007 | .995 |

a. Grouping Variable: time of responses

Table 4.9: Kruskal Wallis test for the three set of responses (initial, first & second) ^{a b}

| Testing criteria | chi-square | df | Asymp. Sig. |
|--|------------|----|-------------|
| Respondent's age | 2.810 | 2 | .245 |
| Respondent's number of months on current job | .599 | 2 | .741 |
| Respondent's level of education | 2.932 | 2 | .231 |
| Respondent's number of involvement in product and process innovation | 3.050 | 2 | .218 |
| Respondent's number of approval levels to department executive officer | 2.563 | 2 | .278 |
| Type of department | 1.026 | 2 | .599 |

a. Kruskal Wallis Test, b. Grouping Variable: time of responses

4.8 Operationalisation and measurement strategy of the model variables

The measures of model variables in this research were operationalise using meticulous statistical procedures starting with factor analysis moving to internal consistency test, confirmatory factor analysis (CFA), establishing constructs reliability, summated scale procedures and, finally, the outcome variables were analysed using structural equation modeling (SEM). These statistical procedures are common among many researchers, such as Richins and Dawson (1992), Teo and Choo (2001) and Mak and Sockel (2001).

This study adopted the sequence of statistical methods for multivariate data analysis presented in Hair et al. (1995, 1998). A summary of the CFA results, the internal consistency test and the composite reliability test can be seen in table 4.10; discussion about the statistics methods used and their rationale is presented in section 4.10.

The progression of the data analysis

- Explanatory factor analysis using principle components analysis with Varimax rotation to define the underlying dimensions.
- Internal consistency to assesses the reliability of the scale using Cornbach's alpha
- Confirmatory factor analysis to validate further the result of explanatory factor analysis by establishing convergent and discriminate validity.
- Construct reliability to assess the composite reliability of the measurement model resulting from the confirmatory factor analysis.

- Creating a summated scale for all variables loading significantly on one factor by combining several of these variables into one composite measure.
- Developing a structural model based on the composite measures and linking the hypothesised model's constructs.
- Investigating and providing interpretations of the results of the structural equation models.

4.9 Evaluative criteria of the quantitative research

The evaluative measures of the quantitative research are based on a number of criteria of scientific rigours. The first concern of the evaluative measures of the quantitative research is the issue of validity, where validity is manifested as the degree to which a measure(s) correctly represents the concept of the study and where validity is concerned with how well the concept is defined by the measure (Robson, 2002; Hair et al., 1998; Litwin, 1995; Kerlinger, 1986). There is no easy, single way to evaluate a validity of a concept; there is a great variety of methods for establishing the validity of measuring instrument (Robson, 2002; Litwin, 1995).

The following paragraphs represent the most common type of validity that are frequently cited in social research.

Face/Construct Validity

Face validity is also referred to as construct validity, where construct validity has to do with the aptitude of the scale to measure items that are theoretically related to the concept that the scale is intended to measure. Face or construct validity can be

attained through pre-trial procedures (Shannon and Davenport, 2001). This study went through a number of pre-trial stages and a pilot work to ensure an enhanced degree of construct validity.

Content validity

Content validity refers to whether the scale representatively measures the concept it is intended to measure. Sirkin (1995) asserted that the concept of content validity exists when all measures cover all the generally accepted meanings of the concept. Since many items in the questionnaire were derived from relevant literature and existing instruments, and since the overall questionnaire was scrutinized by a panel of experts, this suggested that the content validity of our questionnaire was established

Convergent validity

Convergent validity was evaluated through CFA by investigating both the extent of the factor loadings of the observed variables on their relevant latent variables and whether or not those factor loadings were statistically different from zero. All factor loadings were of an adequate extent and significantly different from zero at the $P = .05$ level.

Discriminant validity

Discriminant validity is assessed by examining the cross-factor loadings of one observed variable onto all latent constructs on which high loadings were not expected to represent a discriminant validity. All cross-factor loading was insignificant and less than 0.5. A confirmatory factor analysis (CFA) was also carried out as a means of

establishing the discriminant validity. All results of the CFA analysis supported the presence of discriminant validity.

The second concern of the evaluative measures of the quantitative research is the issue of reliability. A number of measurers were taken into consideration with regard to this issue. Reliability is defined as the degree to which a group of variables is consistent in what they are intended to measure (Hair et. al., 1998; Robson, 2002; Oppenheim, 2000; Litwin, 1995). The following reliability tests were carried out on the survey measurement (questionnaire).

Internal consistency measures: Cornbach's' alpha

A Cornbach's' alpha measurement of internal consistency was adopted to assess the overall reliability of the measurement scale for each defined construct of the study where alpha is defined as an estimate of the proportion of the total variance that is not due to error (Oppenheim, 2000). The recommended minimum acceptable limit of reliability "alpha" for this measure is 0.6 (Hair et. al., 1998, Robinson et. al., 1991). A test of internal consistency using Cornbach's' alpha was performed on all constructs of this study and the findings can be seen in table 4.10. All constructs have passed the reliability test except for two items where alpha was 0.57, and 0.58 for ITI-F, and ITI-A, receptively. Alpha scores for the two constructs are deemed to be acceptable from explanatory point of view, since the difference between the recommended minimum level of 0.60 and those constructs are significantly in close range. Also these constructs are well supported in the theory of knowledge creation

(Nonaka and Takeuchi, 1995; Nonaka et. al., 1994, 2000b; Leonard-Barton, 1995; Choo, 1998; Huseman and Goodman, 1999). Based on the large extent of theoretical support and the relatively close range of alpha to the recommended minimum level of these two items which represents the ITI-R, ITI-A was retained in the model of this study.

The composite “construct” reliability

Construct reliability is used in assessing the measurement model by testing the composite reliability of each construct (see equation below).

$$\text{Construct reliability} = (\sum SL)^2 / (\sum SL)^2 + \epsilon_j$$

SL is the standardised loading and ϵ is the measurement error for each construct. A commonly used threshold value for accepting reliability is 0.70. According to Hair et al., (1998, p.612) “... *although this is not an absolute standard, the values below 0.70 have been deemed acceptable if the research is explanatory in nature*”. The result of the construct reliability can be seen in table 4.10.

Table 4.10 Summary of the goodness of fit for the CFA and reliability tests

| | Goodness of fit Measures | | | | | Reliability tests | |
|--------|--------------------------|------|-------|------|------|-------------------|------|
| | χ^2 | GFI | RMSEA | TLI | CFI | C. A. | C.R. |
| SK | 16.4 (13) $P=0.22$ | 0.96 | 0.05 | 0.97 | 0.98 | 0.75 | 0.66 |
| CK | 7.43(5) $P=0.20$ | 0.97 | 0.07 | 0.96 | 0.98 | 0.75 | 0.74 |
| OK | 7.34(13) $P=0.88$ | 0.98 | 0.00 | 1.00 | 1.00 | 0.80 | 0.85 |
| SyK | 20.35(18) $P=0.31$ | 0.95 | 0.04 | 0.99 | 0.99 | 0.75 | 0.74 |
| IKT-CB | 0.00(0) $P=1.00$ | N/A | 0.00 | N/A | 1.00 | 0.62 | 0.64 |
| IKT-I | ---- | ---- | ---- | ---- | ---- | 0.60 | ---- |
| IKT-KS | 2.69 (2) $P=0.26$ | 0.97 | 0.02 | 0.95 | 0.98 | 0.59 | 0.64 |
| IKT-IS | 1.81(1) $P=0.28$ | 0.99 | 0.04 | 0.99 | 1.00 | 0.68 | 0.69 |
| ITI-R | 3.82(5) $P=0.49$ | 0.99 | 0.00 | 1.00 | 1.00 | 0.69 | 0.60 |
| ITI-F | 2.06(2) $P=36$ | 0.99 | 0.02 | 1.00 | 1.00 | 0.57 | 0.53 |
| ITI-RV | 1.97(5) $P=0.85$ | 0.99 | 0.00 | 1.00 | 1.00 | 0.64 | 0.62 |
| ITI-A | 0.00(0) $P=1.00$ | N/A | 0.00 | N/A | 1.00 | 0.58 | 0.60 |
| CKT | 26.84(19) $P=0.11$ | 0.94 | 0.06 | 0.96 | 0.97 | 0.85 | 0.85 |

χ^2 , Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; CFI, Comparative fit index; C.A., Cronbach's Alpha; C.R., Construct reliability.

4.10 Statistical methods used in data analysis and their rationale

In order to fulfil the objective of the study, a number of statistical techniques were utilised in the data analysis.

- Descriptive statistics: frequency and mean
- The t-test and Mann Whitney U test
- Explanatory and confirmatory factor analysis
- Structural equation modelling

The following clarification and justification is given for each method in terms of its application to the analysis of the collected research data.

➤ **Descriptive statistics: frequencies and mean**

The frequency and the mean were carried out to investigate and analysed the sample characteristics. Frequency distribution tables were used to categorise the respondent based on a number of criteria, such as involvement in project innovation, respondent's title position, and approval level. The mean was used to classify the respondent's age and the job tenure.

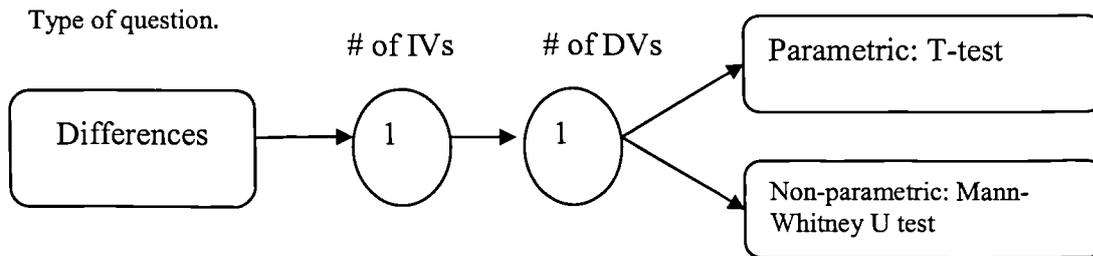
➤ **The t-test and the Mann Whitney U test**

Choosing the appropriate test for any particular set of data depends on a number of factors, such as the research question and the number of dependent and independent variables (Kerr et. al, 2002). Once the previous concerns were answered, a second issue in deciding the correct test is whether the data resembles a parametric or a nonparametric criterion. These two types of statistical tests were used to make different assumptions about the data being examined. The most significant difference between the two types (parametric or nonparametric) is the concern over the normality issue. The first requires the data to be normally distributed, while the second assumes a departure from normality.

In order to determine the appropriate test, each concern was appreciably investigated. The answer to the first concern was to find out whether there is a difference between

the responses from the banks and the responses from the building societies; figure 4.2 explain the decision process.

Figure 4.2 Decision chart of selecting the appropriate test



Examining the difference for the reason of comparison between the two groups requires only one independent and one dependent was required. The t-test was used for variables where the assumption of normality was satisfied and the Mann-Whitney U test was used for variables that did not satisfy the assumption of normality.

➤ Explanatory and confirmatory factor analysis

Factor analysis is a class of multivariate statistical technique whose main objective is to define the underlying structure in the data matrix. It addresses the interrelationships between variables (e.g. questionnaire responses) by defining a set of common underlying dimensions (Hair et. al., 1998). Once these dimensions are determined, two main uses for factor analysis, summarisation and data reduction, can be achieved. The first use refers to the process of describing the data in much smaller number of variables and the latter describes the process of calculating the score for

each underlying dimension and substituting them for the original data. Explanatory factor analysis was used first to define the dimensions of the variables in each specified construct in this study and all variables' loadings were inspected carefully, considering the sample size; a significant loading of 0.5 was used as a cut-off point (Nunnally and Bernstein, 1994; Nunnally, 1979). Hair et al. (1998) indicated that, for a sample of more than 100 and less than 150, all variables should have a minimum of 0.5 loading in order to be considered significant. A confirmatory factor analysis was then utilised to confirm the findings of the explanatory test further. For the underlying dimensions an internal consistency reliability test (Cronbach's alpha) was used to assess the consistency of the scale. Another objective for using factor analysis besides defining the underlying dimensions is to summarise the data by summing all variables that were significantly explained by each dimension into one new single variable. This research employs the principal component factor analysis method that uses Varimax rotation to produce factors which are linearly independent. As indicated by Field (2001), the Varimax rotation provides a clearer and enhanced solution of the underlying factors.

➤ **Structural equation modelling**

Structural equation modeling (SEM) is a entrenched statistical method used in a range of fields and it has been largely utilised in empirical research in marketing, management, information technology and psychology literature for some time and is becoming increasingly popular in many areas of the social sciences (Medsker et al. 1994; Byrne, 1994; Tremblay and Gardner 1996; Raju and Lonial, 2002).

SEM is a statistical method that permits the simultaneous analysis of a sequence of structural equations. It is predominantly helpful when a dependent variable in one equation becomes an independent variable in another equation (Hair et al. 1998). SEM is an all-inclusive statistical tactic to test hypotheses about relationships between observed and unobserved concepts (Hoyle, 1995). Hair et al. (1998) stated that SEM has resulted from an evolution of multiequation modeling developed principally in econometrics and merged with the principles of measurement from psychology and sociology. According to Hair et al. (1995, 1998), SEM is distinguished by two characteristics: first, the estimation of multiple and interrelated dependent relationships between variables and, second, the ability to exemplify unobserved concepts (latent) variables in these relationships while accounting for measurement error that occurs in the estimation process.

Choosing SEM over multiple regression and path analysis

Multiple regression is recommended for research questions where the relationship between two or more variables and one dependent variable (Kerr et. al., 2002). A major limitation of multiple regression is the type of relationship that is encompassed in one single model: one dependent (outcome) variable and a number of independent (predictor) variables, where path analysis comprises the analysis of a number of relationships between variables (number of regression equations), so that the dependent variable in one equation can become an independent variable in another equation. It is a method of employing bivariate correlation to estimate the direct and indirect relationships of independent variables on dependent variables (Hair et. al., 1998). Path analysis also endures some limitations. It assumes unidirectional flow of

relationships between variables (Maruyama 1998). SEM is a multivariate methods that encompasses multiple regressions for examining dependence relationships, employing the techniques of path analysis of multiple relationships and factor analysis which represents unmeasured concepts with multiple variables to estimate a series of interrelated relationships, simultaneously (Hair et al., 1998).

SEM presents the new venture in accommodating some of the limitations of both multiple regression analysis and path analysis. SEM consists of two parts: a measurement model and a structural model (Hair et al., 1995, 1998; Hoyle 1995; Bollen 1989). The measurement model specifies relationships between the observed variables and latent variables (Medsker et al., 1994) where a latent variable is a hypothesized and unobserved concept that can only be estimated by observable variables (Hair et al. 1998). Considering the advantage of SEM technique and to assure that the research objectives will be met, this technique was adopted in this study.

4.11 Summary

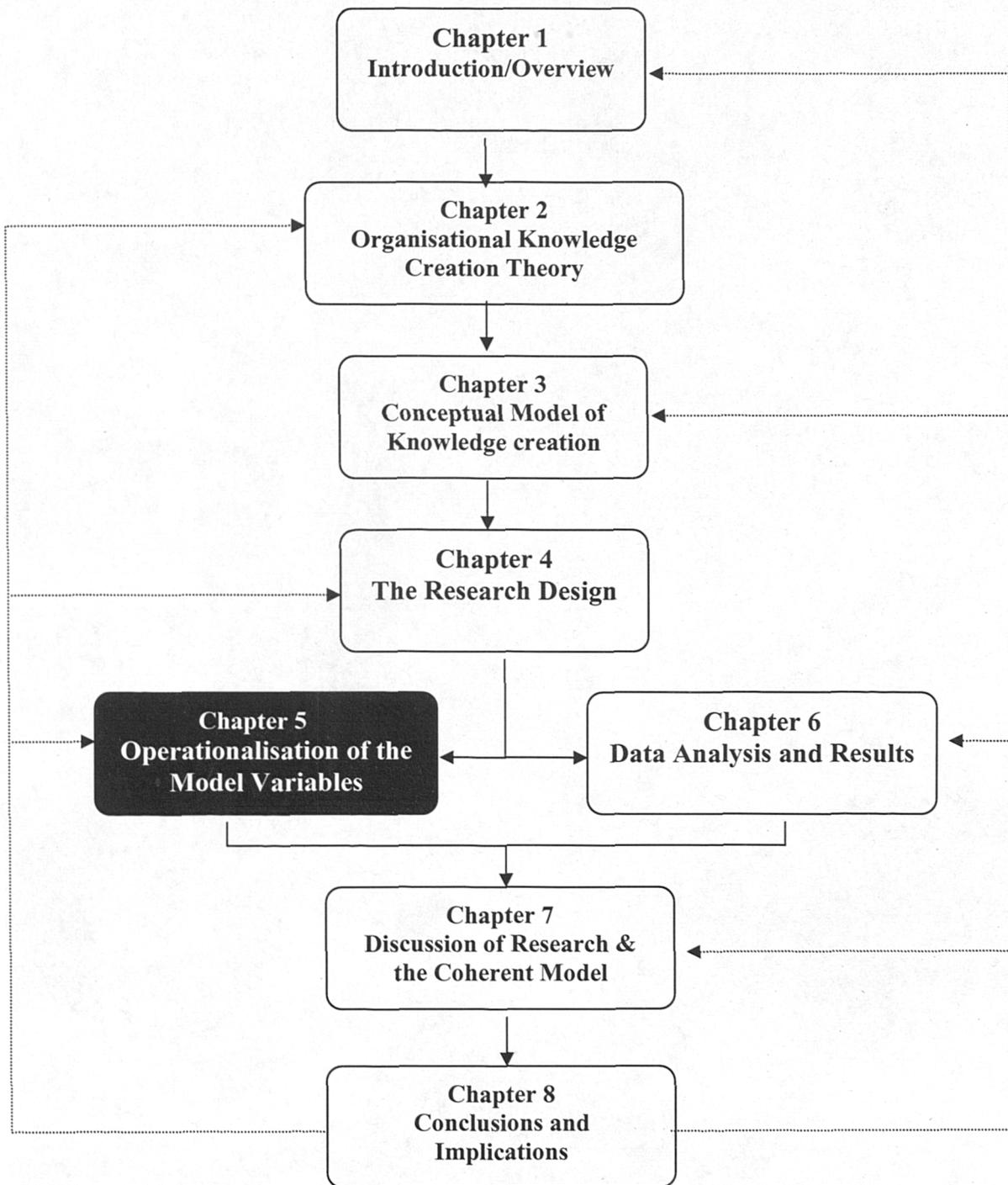
A positivistic approach was adopted to accomplish the objectives of this study. The research question was discussed, and the hypotheses were presented. A questionnaire was used as a method of data collection. Prior to the distributions of the final version of the questionnaire, pre-testing stages and a pilot work for validating the survey instrument (questionnaire) were performed. The contents of the final version of the questionnaire were discussed. Decision and strategies regarding the population and

sample selection were illustrated. The questionnaire was administered largely to middle managers, a response rate was calculated and an enormous effort was undertaken to increase the response rate. Test of rate of response among banks and building societies revealed no significant difference. The result of the non-response bias test also revealed no significant difference between those who responded and those who choose not to participate in the study. The strategy and the process of operationalisation of the measurement variables were thoroughly explained. The evaluative criteria of the research survey were discussed and the measures used to evaluate the construct of this study were explained. Finally, the types of statistic tests were explained and their rationale was meticulously argued.

Chapter Five

Operationalisation and Measurement of The Model Variables

Figure 5.1 Chapter five in the context of the thesis



Chapter 5

Operationalisation and Measurement of The Model Variables

5.0 Means of operationalisation and measurement of model variables

5.1 Factor analysis: explanatory and confirmatory type

As indicated in the pervious chapter, the operationalisation process of the model variables will utilise a set of statistical techniques, such as explanatory factor analysis (EFA), confirmatory factor analysis (CFA) and the summated scale technique. The rationale of these statistical techniques is meticulously discussed in the methodology chapter.

EFA is the technique that is involved with exploring the patterns of relationships among a set of variables. In other words, this technique defines the possible relationships in the most general form, and then allows for multivariate techniques to estimate the relationships (Hair et al, 1998, Field, 2001). These patterns of relationships are represented by the principal components, generally known as factors. The researcher can identify the character of the underlying factor (dimension) by investigating the loadings of the variables on a factor; as variables load significantly on a factor they become descriptors of the underlying dimension (Hair et al, 1998). CFA is commonly known as the measurement model (discussed in details in the next chapter) in the structural equation modelling (SEM). CFA is the use of multivariate techniques to confirm a pre-specified relationship (Gerbing and Hamilton, 1996). The factors are, in a measurement model, called the latent variables, where each variable acts as an indicator of each factor, in that every variable has a loading for each factor. To conclude, EFA is mainly an explanatory technique since the research has no

control over which variables are indicators of which latent variables, contrary to EFA technique, CFA or measurement model in SEM gives the research a complete control over specification for the indicators for each construct. Furthermore, CFA, with the use of SEM, permits for statistical test of the goodness of the fit for the anticipated confirmatory factor solution, which is not achievable with the use of EFA. The CFA explained earlier is referred to as a first order confirmatory factor model.

A higher order (also known as second-order) confirmatory factor model is utilised in this study, since there are a number of dimensions that belong to a higher order factor, as explained later in this chapter. For example, the sympathised knowledge accumulation and the sympathised knowledge transfer demission are both represented in a higher order factor (Nonaka et al., 1994) referred to in this study as the sympathised knowledge creation activities. In the first order factor (CFA) as explained earlier, the researcher identifies just one level of factors (first order) that are correlated. If the researcher were facing a construct with multiple facets (dimensions), as in this study, it would be essential to see whether they are correlated. This can be realised through the specifications of a higher order factor model (March and Hoceuar, 1994; Byrne, 1994; Hair et. al., 1998) which hypothesises that the first order factors are sub-dimensions of a broader and more encompassing construct. According to Hair et. al., (1998), there are two unique characteristics of the higher order factor model.

- 1- The higher order factor becomes the exogenous (independent) construct, where the first order factors are endogenous (dependent). In other words, the higher order factor causes the first order factors.

- 2- There are no indicators of the higher order factors, meaning that higher order is completely latent.

Summated scale technique was utilised in order to merge several individual variables into a single composite measure. Summated scale represents a method where all the variables loading significantly on a factor are combined and the average score of the variables is used as a replacement variable (Hair et. al., 1998).

5.2 Evaluative criteria of the CFA and structural model fit

Studies suggest a set of fit measurements that can be used to evaluate the fitness of the measurement and the structural model, such as the absolute fit indices, the incremental fit indices and parsimonious fit indices (an excellent review can be found in Hair et al., 1998, p. 653-659; Maruyama, 1998, p. 238-246; Muller, 1996, p. 81-92; Bentler, 1995, p. 112-116; Byrne, 1994, p. 53-56; Hu and Bentler, 1995, p. 77-98). For an absolute fit measure such as Chi-square (χ^2) to be accepted, it should be insignificant, where probability (P) must be at least 0.05 or greater. Another fit index, termed goodness of fit (GFI), has a recommended value above 0.90. For the root mean squared error of approximation (RMSEA), the above studies suggested a recommended value of less than 0.08. An indices which belong to the incremental fit measure should be greater than 0.90 to be considered as an accepted indicator of a good fit. Jöreskog and Sörbom (1989) suggested that, for GFI, a value of 0.90 or greater is an indication that the construct is unidimensional. Full details of the overall goodness of fit measures and their related acceptance ranges for CFA and SEM can be found in Hair et. al, (1998, p. 653-659).

5.3 Operationalisation of the dependent variables of the research model

5.3.1 Organisational knowledge creation activities

As indicated in chapter two, previous studies have established, to a certain degree, a general framework of organisational knowledge (OK) in the sense that OK emerges in the form of two distinct types of knowledge: tacit and explicit (Polanyi, 1966, Nonaka, 1994; Leonard-Barton, 1995; Nonaka and Takeuchi, 1995; Von Krogh, 1998; Choo, 1998; Scott, 1998; Nonaka et al., 2000b). Yet there are many disagreements on the classification of the types of emergent knowledge in the organizational context. For the purpose of this study, the researcher adopted the classification of Nonaka and Takeuchi (1995), since it is the most established and more often cited in the literature of organisational knowledge (for more details, see chapters two and three).

Nonaka et al., (1994) conducted the first comprehensive test of the concepts of organisational knowledge creation. Findings confirmed the existence of the four types of knowledge in an organisational knowledge context from an industry's viewpoint. The findings also revealed a number of dimensions for each mode of OK (socialisation, externalisation, internalisation, and combination) creation. The items used by Nonaka et al., (1994, 2000b) were adapted with minor adjustment in wording to some items to fit the service industry context.

Explanatory factor analysis using the principle components method with Varimax rotation was utilised for the each type of organisational knowledge. Items were analysed separately based on a score of frequency. Respondents rated each item on a five-point Likert-type scale ranging from 'never' to 'all the time'.

(a) Sympathised knowledge

The initial factor analysis indicated the existence of dimensions (two-factor solution) of sympathised knowledge (SK) creation activities construct. The first five variables seen in table 6.1 are the principal descriptors of first dimension. The last two variables seen in table 6.1 are the principal descriptors of second dimension. These two dimensions of SK are characterised as SK acquisition activities (SKA), and SK dissemination activities (SKD) respectively. Three items were removed, as loadings were less than 0.5. As recommended by Hair et. al., (1998), with respect to sample size, items that have a loading of less than 0.5 should be removed.

The final factor analysis showed sound discriminant validity. Loadings for the two factors ranges from 0.57 to 0.86. The average loadings for the two factors were 0.72 and 0.85, respectively, and the cross loadings were all less than 0.5, showing a clear discriminant validity. These two factors explained 60.6% of the total variance. All factors have an eigenvalue greater than 1. Items representing the creation of sympathised knowledge through the socialisation mode are displayed in table 5.1.

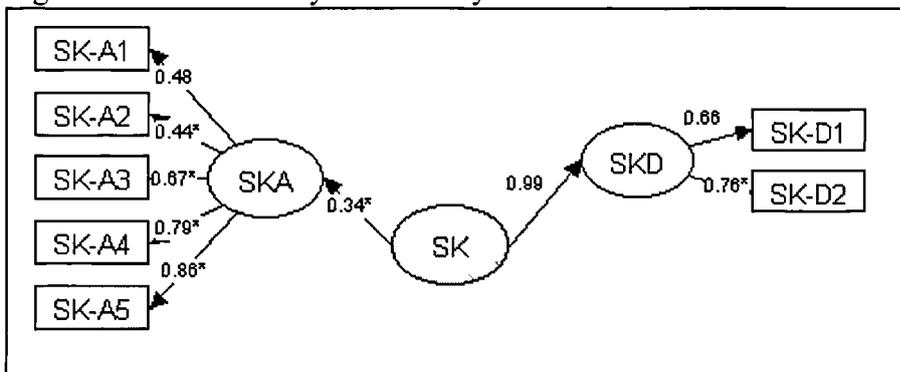
Table 5.1 Factor analysis results of sympathised knowledge

| Items Frequency | SKA | SKD |
|---|--------------|--------------|
| Engaging in dialogue with competitors. | 0.565 | 0.226 |
| Engaging in bodily language through management by wandering about. | 0.590 | 0.005 |
| Getting ideas for corporate strategy from the daily social life. | 0.727 | 0.248 |
| Finding new strategies by wandering inside the firm. | 0.842 | 0.000 |
| Finding new market opportunities by wandering inside the firm. | 0.859 | 0.007 |
| Creating a work environment that allows peers to understand the craftsmanship and expertise through practice (on job training). | 0.099 | 0.851 |
| Creating a work environment that allows peers to understand the craftsmanship and expertise through apprenticeship. | 0.139 | 0.854 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

To confirm the validity of the sympathised knowledge construct further, confirmatory factor analysis (CFA) was executed using structural equation modeling (SEM) by utilizing EQS 5.7 software (Bentler, 1995). The result indicated good discriminant validity as comparative fit index equals (CFI) 0.98 and Lewis Tucker fit index (TLI) 0.97. Studies suggest that an index greater than 0.90 is a good fitting (see Hair et al., 1998, p. 653-659; Maruyama, 1998, p. 238-246; Muller, 1996, p. 81-92; Bentler, 1995, p. 112-116; Byrne, 1994, p. 53-56). Chi-Square (χ^2)= 16.44, with probability (P)=0.23 and general fit index (GFI) equals 0.96 and root mean squared error of approximation (RMSEA) 0.05, where the above studies suggested a recommended value of RMSEA, is an index of less than 0.08 and χ^2 ; in order to be significant a P must be at least 0.05 or greater. The same studies suggested a value of 0.90 or greater for GFI indicating a good fit and a representation of unidimensionality. All coefficients are standardised and all were significant, ranging from 0.34 to 0.86. These all indicated that good discriminant validity was established among the SK creation construct and the two factors of SK, SKA and SKD, represents a one dimension that is the SK creation (see figure 5.2).

Figure 5.2 Confirmatory factor analysis results of the SK construct



Reliability was calculated based on Cronbach's alpha for the main construct SK and the two sub-constructs, SKA and SKD were 0.75, 0.77 and 0.65, respectively. All results showed a reasonable reliability, as the measures greater than 0.6 are thought to reach the usual acceptable range (Hair et al., 1998). As the items loaded significantly on a two dimensions, SKA and SKD, as indicated by EFA and confirmed by CFA, a summed variable was derived for the five items (SK-A1 to SK-A5) representing the SKA construct to represent the SKA variable, and a summed variable was derived for the two items (SK-D1 to SK-D5) representing the SKD construct to represent the SKD variable. Nonaka et al., (1994, 2000b) hypothesised and then confirmed four dimensions for sympathised knowledge construct (SK). These dimensions are tacit knowledge accumulation, intra-firm collection, extra-firm collection and tacit knowledge transfer. The findings of this section for this construct (SK) confirmed the last dimension, integrated the second and the third in one dimension (termed in this study as sympathised knowledge acquisition (SKA)) and rejected the first dimension as loadings were insignificant. Thereby, sympathised knowledge is represented in this section by only two dimensions, sympathised knowledge acquisition and sympathised knowledge dissemination 'transfer' (SKA and SKD).

(b) Conceptual knowledge

The factor analysis showed a one-factor solution of conceptual knowledge (CK) creation construct. The factor analysis showed clear discriminant validity since all items are loaded on one factor. Loadings for the factor ranges from 0.54 to 0.81. The average loading for the factor was 0.701. This factor explains 50% of the total variance. The factor has an eigenvalue greater than 1. Items representing the

creations of conceptual knowledge through externalisation mode are displayed in table 5.2.

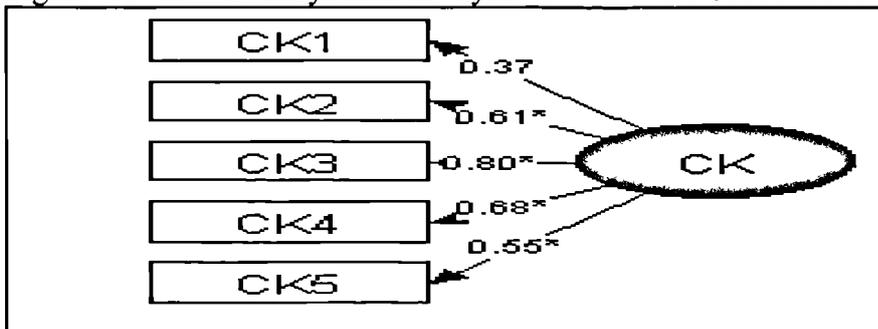
Table 5.2 Factor analysis results of conceptual knowledge

| Items: Frequency | CK |
|--|--------------|
| Facilitating creative and essential dialogue. | 0.541 |
| Using "abductive thinking" to acquire new thoughts and ideas | 0.734 |
| Using analogy, metaphor, and model in dialogue for concept creation. | 0.811 |
| Employing figurative language to creatively brainstorm ideas and concept creation. | 0.741 |
| Executing and trying out tentative designs on a small scale. | 0.678 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

To further confirm the validity of the conceptual knowledge construct, CFA was executed; the results indicated good discriminant validity, as CFI equals 0.98 and TLI equals 0.96. $\chi^2= 7.34$, $P= 0.20$, GFI equals 0.97 and RMSEA equals 0.07. All coefficients are standardised and all were significant, ranging from 0.37 to 0.80. These all indicated that good discriminant validity was established for the CK construct, which represents a single dimension that is the CK creation (see figure 5.3).

Figure 5.3 Confirmatory factor analysis results of the CK construct



Reliability was calculated based on Cronbach's alpha. The measure was 0.75, which shows a reasonable reliability for the CK construct. As all items loaded significantly on a single dimension as indicated by EFA and confirmed by CFA, a summed variable was derived for the five items (CK1-CK5) representing the CK construct to represent the CK variable. Nonaka et al., (1994, 2000b) hypothesised and then confirmed one dimension for conceptual knowledge construct (CK) and it was confirmed by this section as hypothesised. Thus, conceptual knowledge is represented in this study by one dimension; conceptual knowledge creation activities.

(c) Systemic knowledge

The factor analysis showed a three-factor solution of systemic knowledge creation construct (SyK): systemic knowledge acquisition (SyKA), systemic knowledge processing (SyKP) and systemic knowledge dissemination (SyKD). The factor analysis showed clear discriminant validity. Loadings for the three factors ranged from 0.66 to 0.91. The average loadings for the three factors SyKA, SyKP and SyKD, were 0.71, 0.86 and 0.91, respectively and the cross loadings were all less than 0.5 showing a clear discriminant validity. These three factors explained 70% of the total variance. All factors have an eigenvalues greater than 1. Items representing the SyK creation construct through combination mode are displayed table 5.3.

To confirm the validity of the systemic knowledge construct further, confirmatory factor analysis (CFA) was executed using structural equation modelling (SEM) as CFI equals 0.99 and TLI equals 0.99. $\chi^2= 20.35$, $P= 0.31$, GFI equals 0.95 and RMSEA equals 0.04. All coefficients are standardised and all were significant, ranging from

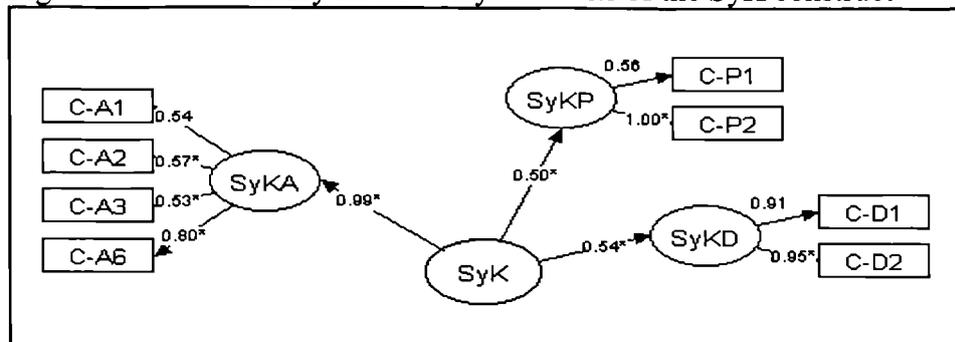
0.53 to 1.00. These all indicated that good discriminant validity was established for the SyK construct, which represents a single dimension that is the SyK creation (see figure 5.4).

Table 5.3 Factor analysis results of systemic knowledge

| Items Frequency | SyKA | SyKD | SyKP |
|---|--------------|--------------|--------------|
| Engaging in planning strategies and operations | 0.676 | 0.250 | -.005 |
| Assembling internal and external data using published literature. | 0.759 | 0.104 | -.005 |
| Utilising computer simulation and forecasting for possible future products or services. | 0.663 | 0.004 | 0.177 |
| Building up materials by gathering management figures and technical information from all over the organisation. | 0.720 | 0.220 | 0.315 |
| Building or creating manuals or user guides for products or services | -.002 | -.003 | 0.891 |
| Documentation and databases on products or services. | 0.219 | 0.182 | 0.836 |
| Engaging in planning of presentations to transmit newly created concepts. | 0.205 | 0.914 | 0.005 |
| Engaging in implementation of presentations to transmit newly created concepts. | 0.176 | 0.908 | 0.008 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

Figure 5.4 Confirmatory factor analysis results of the SyK construct



Reliability was calculated based on Cronbach's alpha for the main construct and the three sub-constructs. The measures were 0.75, 0.70, 0.72 and 0.86, for SyK, SyKA, SyKP and SyKD, respectively. All measures show good to high reliability. Since all the items loaded significantly on three dimensions, SyKA, SyKP and SyKD as indicated by EFA and confirmed by CFA, a summed variable was derived for the five items (C-A1 to C-A4) representing the SyKA construct to represent the SyKA variable, a summed variable was derived for the two items (C-P1 to C-P2) representing the SyKP construct to represent the SyKP variable, and a summed variable was derived for the two items (C-D1 to C-D2) representing the SyKD construct to represent the SyKD variable. Nonaka et al., (1994, 2000b) hypothesised and then confirmed three dimensions for systemic knowledge construct (SyK) and all three dimensions confirmed by the findings of this section as hypothesised. Thereby, systemic knowledge is represented in this study by three dimensions: systemic knowledge acquisition (SyKA), systemic knowledge processing (SyKP) and systemic knowledge dissemination (SyKD).

(d) Operational knowledge

The initial factor analysis indicated the existence of dimensions (two-factor solution) of operational knowledge creation activities construct (OK). The first four variables seen in table 6.4, are the principal descriptors of first dimension. The last four variables seen in table 6.4 are the principal descriptors of second dimension. These two dimensions of OK are characterised as real world knowledge (RWK) and virtual world knowledge (VWK) activities (for more detail see Nonaka et. al., 1994), respectively. One item was removed, as the loadings were less than 0.5.

The final factor analysis showed sound discriminant validity. Loadings for the two factors ranged from 0.61 to 0.82. The average loadings for the two factors, RWK and VWK were 0.76 and 0.72, respectively and the cross loadings were all less than 0.5 showing a clear discriminant validity. These two factors explained 61% of the total variance. All factors have an eigenvalue greater than 1. Items representing the creation of operational knowledge through the internalisation mode are displayed in table 5.4.

Table 5.4 Factor analysis results of operational knowledge

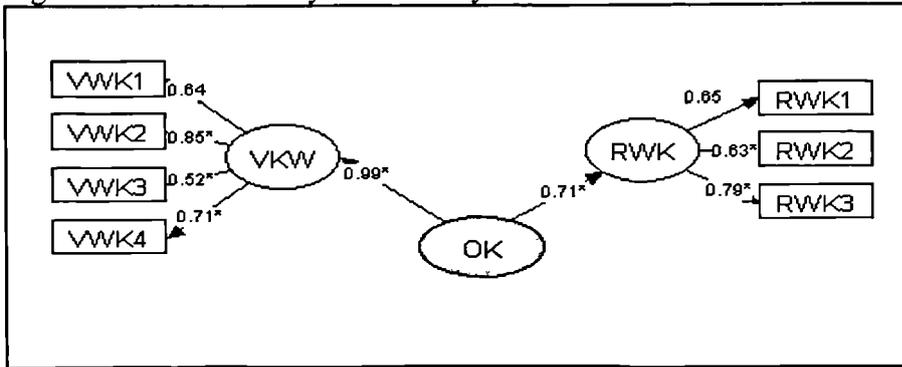
| Items Frequency | VWK | RWK |
|--|--------------|--------------|
| Engaging in "enactive liaison" activities with functional departments through cross-functional development teams. | 0.006 | 0.817 |
| Searching and sharing new values and thoughts. | 0.212 | 0.728 |
| Engaging in overlapping products and services development. | 0.349 | 0.732 |
| Engaging in facilitating prototyping for new products and services. | 0.721 | 0.196 |
| Engaging in benchmarking and testing the market for new products and services. | 0.775 | 0.315 |
| Facilitating the challenging spirit within the organisation. | 0.758 | 0.001 |
| Forming teams and conducting research on ideas for future products and services, and sharing results with the entire department. | 0.614 | 0.370 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

Confirmatory factor analysis (CFA) was executed using structural equation modelling (SEM) to further confirm the validity of the operation knowledge construct, as CFI equals 1.00 and TLI equals 1.00. $\chi^2= 7.34$, $P= 0.88$, GFI equals 0.98 and RMSEA equals 0.00. All coefficients are standardised and all were significant, ranging from 0.52 to 0.99. These all indicated that good discriminant validity was established for

the CK construct, which represents a single dimension that is the OK creation (see figure 5.5).

Figure 5.5 Confirmatory factor analysis results for OK construct



Reliability was calculated based on Cronbach's alpha for the main construct and the two sub-constructs of OK. The measures were 0.80, 0.71 and 0.75 for OK, VKW and RWK, respectively. All measures showed a sound reliability. Since the items loaded significantly on two dimensions, RWK and VKW, as indicated by EFA and confirmed by CFA, a summed variable was derived for the four items (RWK1 to RWK4) representing the RWK construct to represent the RWK variable and a summed variable was derived for the four items (VWK1 to VWK4) representing the VKW construct to represent the VKW variable. Nonaka et al., (1994, 2000b) hypothesised and then confirmed two dimensions for operational knowledge construct (OK) and the two dimensions are confirmed by the findings of this section as hypothesised. Thereby, operational knowledge is represented in this study by two dimensions: real world knowledge (RWK) and virtual world knowledge (VWK) activities.

5.4 Operationalisation and measurement of the independent constructs

5.4.1 Knowledge-enabling environment (KCEE)

5.4.1.1 Infrastructure for knowledge transfer (IKT)

Items representing the innovative work environment (termed in this study as infrastructure for knowledge transfer constructs (IKT)) were adapted from Tang (1998, 1999); the items represented the IKT construct are creative behaviour, integration, knowledge and skills and information systems. All items were analysed based on a score of the extent of practise. Respondents rated each item on a five-point Likert-type scale ranging from '1=strongly disagree' to '5=strongly agree'

Creative behavioural traits (IKT-CB): Items representing this trait were designed to examine the existence of such creative behaviour in the organisation; these items investigated the behavioural traits, creative behaviour and motivation to raise projects and find innovative solutions.

Integration trait (IKT-I): Items representing this trait were designed to examine the existence of such a trait in the organisation; these items investigated the team role and the cross-functional integration.

Knowledge and skills trait (IKT-KS): Items demonstrating this facet of IKT were designed to examine the existence of such trait in the organisation; the items investigated the creativity and intelligence, insights, domain related skills and knowledge creation and, finally, learning and training skills.

Information systems (IKT-IS): Items characterising this aspect of IKT were designed to examine the existence of such aspect in the organisation; these items investigated the flow of information and technology and the use of IT as source of knowledge.

(a) Creative behaviour (IKT-CB)

The initial factor analysis showed a one-factor solution of IKT-CB construct. One item was removed as loadings were less than 0.5. The final factor analysis showed clear discriminant validity. Loadings for the two factors ranged from 0.77 to 0.79. The average loading for the factor was 0.76. This factor explained 57.3% of the total variance. All factors have an eigenvalues greater than 1. Items representing IKT-CB are displayed in table 5.5.

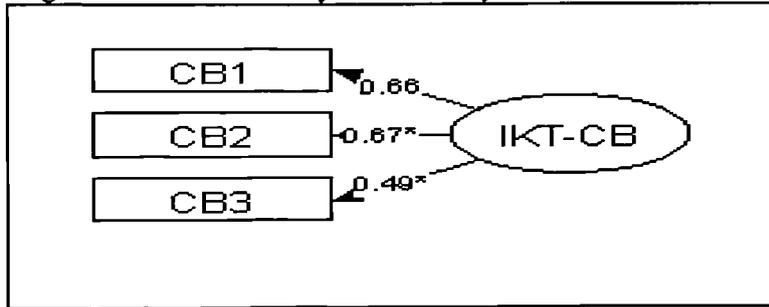
To confirm the validity of the operation knowledge construct further, confirmatory factor analysis was utilised; the results indicated a perfect fit, as CFI equals 1.00. $\chi^2 = 0.00$, $P = 1.00$ and RMSEA equals 0.00. All other indexes do not need to be computed since this model represents a perfect fit. All coefficients are standardised and all were significant, ranging from 0.49 to 0.67. These all indicated that perfect discriminant validity was established for the IKT-CB construct (see figure 5.6).

Table 5.5 Factor analysis results IKT-CB construct

| Items Frequency | IKT-CB |
|--|--------|
| I found my colleagues very helpful in sharing knowledge and information. | .771 |
| I found my colleagues very helpful when I encountered difficulties with my work. | .793 |
| In my organisation people show little interest in each other's work. | .704 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

Figure 5.6 Confirmatory factor analysis results for IKT-CB



Reliability calculated based on Cronbach's alpha IKT-B construct measure, was 0.62, showing an acceptable level of reliability. Since all items loaded significantly on a single dimension as indicated by EFA and confirmed by CFA, a summed variable was derived for the five items (CB1-CB5) representing the IKT-CB construct to represent the IKT-CB variable.

(b) Integration (IKT-I)

The initial factor analysis showed a two-factor solution of IKT-I construct. One item was cross-loaded significantly on two factors, thus it was removed. A second test of factor analysis was carried out and, as a result another item was removed as loadings were less than 0.5. The final factor analysis showed clear discriminant validity. Loadings were 0.76, 0.86 for the first and second; the average loading for the factor was 0.81. This factor explained 50% of the total variance. The factor has an eigenvalue greater than 1. Items representing the creations of IKT-I are displayed in table 5.6.

Table 5.6 Factor analysis results IKT-I construct

| Items Frequency | IKT-I |
|--|-------|
| In my organisation different departments work together harmoniously. | 0.757 |
| In my organisation there is a strong sense of mutual trust. | 0.856 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

Confirmatory factor analysis (CFA) was not executed since the construct has only two items. The use of explanatory factor analysis is deemed reasonable enough to establish the discriminant validity.

Reliability, calculated based on Cronbach's alpha IKT-I construct measure, was 0.60, showing an acceptable level of reliability. Since all items loaded significantly on a single dimension as indicated by EFA, a summed variable was derived for the two items (IKT-I1-IKT-I2) representing the IKT-I construct to represent the IKT-I variable.

(c) Knowledge and skills (IKT-KS)

The factor analysis showed a one-factor solution of IKT-KS. The factor analysis showed clear discriminant validity since all items are loaded on one factor. Loadings for the factor range from 0.59 to 0.73. The average loading for the factor was 0.68. This factor explains 50% of the total variance. The factor has an eigenvalue greater than 1. Items representing IKT-KS are displayed in table 5.7.

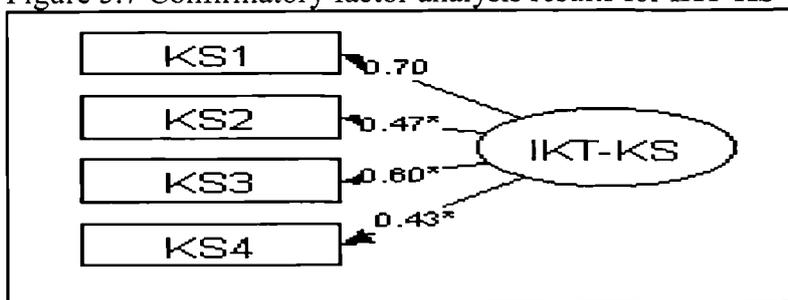
Table 5.7 Factor analysis results of IKT-KS construct

| Items Frequency | IKT-KS |
|---|--------------|
| I have colleagues who help others to turn ideas into action and reality. | 0.707 |
| I have colleagues who impress me with their innovative ideas, energy and resourcefulness. | 0.589 |
| My colleagues and I are able to come up with creative ideas when we face tough problems. | 0.725 |
| My organisation creates its own intellectual assets, e.g. special techniques, patents. | 0.703 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

To confirm the validity of the IKT-KS construct further, CFA was executed; the results indicated good discriminant validity, as CFI equals 0.98 and TLI equals 0.95. $\chi^2 = 2.69$, $P = 0.26$, GFI equals 0.97 and RMSEA equals 0.02. All coefficients are standardised and all were significant, ranging from 0.43 to 0.70. These all indicated that good discriminant validity was established for this construct, which represents a single dimension that is the IKT-KS creation (see figure 5.7).

Figure 5.7 Confirmatory factor analysis results for IKT-KS



Reliability, calculated based on Cronbach's alpha IKT-KS construct measure, was 0.59, close enough to an acceptable level of 0.60 of reliability. Given that all items loaded significantly on a single dimension as indicated by EFA and confirmed by

CFA, a summed variable was derived for the four items (KS1-KS4) representing the IKT-KS construct to represent the IKT-KS variable.

(d) Information systems (IKT-IS)

The factor analysis showed a one-factor solution of the IKT-IS construct. The factor analysis also showed clear discriminant validity since all items are loading on one factor. Loadings for the factor ranges from 0.61 to 0.80. The average loading for the factor was 0.72. This factor explains 52% of the total variance. The factor has an eigenvalue greater than 1. Items represent the IKT-IS are displayed table 5.8.

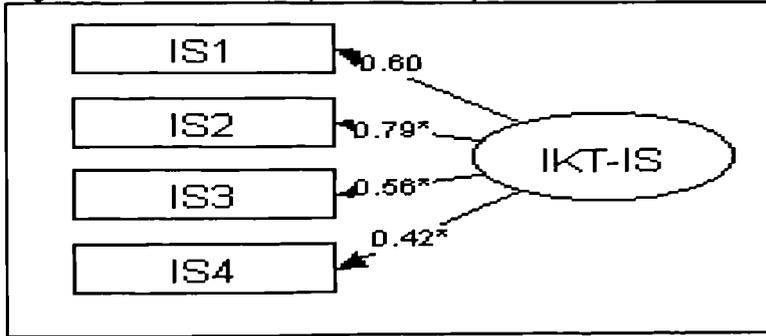
To further confirm the validity of the information systems (IKT-IS) construct, CFA was executed; the results indicated good discriminant validity, CFI equals 1.00 and TLI equals 0.99. $\chi^2= 1.81$, $P= 0.28$, GFI equals 0.99 and RMSEA equals 0.04. All coefficients are standardised and all were significant, ranging from 0.42 to 0.79. These all indicated that good discriminant validity was established for this construct, which represents a single dimension that is the IKT-IS (see figure 5.8).

Table 5.8 Factor Analysis results of IKT-IS construct

| Items Frequency | IKT-IS |
|--|--------------|
| Documentation, information and databases are well managed in my organisation | 0.605 |
| In my organisation the dissemination of information relevant to work is excellent. | 0.732 |
| My organisation captures information diligently from external sources, e.g. customers. | 0.795 |
| My organisation information system is a great aid to finding ideas and opportunities. | 0.728 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

Figure 5.8 Confirmatory factor analysis results for IKT-IS



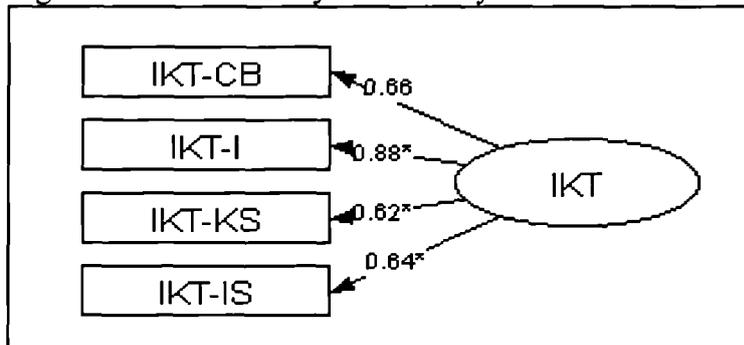
Reliability, calculated on Cronbach's alpha IKT-IS construct measure, was 0.68, showing an acceptable level of reliability. Since all items loaded significantly on a single dimension as indicated by EFA and confirmed by CFA, a summed variable was derived for the four items (IS1-IS4) representing the IKT-IS construct to represent the IKT-IS variable.

Operationalisation of IKT

Having identified in the previous section the underlying dimension of the variables and constructs (IKT-CB, IKT-I, IKT-K&S and IKT-IS) that constitutes the infrastructure of knowledge transfer, and having confirmed the reliability and validity of these dimension through the use of EFA and CFA, the summated variables were then used to form the IKT construct, where IKT here represents a latent variable. A model for IKT was constructed and CFA was executed to test for the overall goodness of fit for the proposed IKT construct. The results indicated good fit, as CFI equals 1.00, and TLI equals 0.97. $\chi^2 = 1.66$, $P = 0.20$, GFI equals 0.99 and RMSEA equals 0.00. All coefficients are standardised and all were significant, ranging from 0.62 to 0.88. These all indicated that good discriminant and convergent validity was

established for the IKT construct, unidimensionality was assured as GFI is greater than 0.90. Confirmatory analysis result for IKT construct can be seen in figure 5.9.

Figure 5.9 Confirmatory factor analysis results for IKT



Reliability of the internal consistency for the IKT construct was calculated using the construct “composite” reliability measures construct. The result shows that reliability is equal to 0.80, which is an indication of a high and acceptable level of reliability.

5.4.1.2 Information technology infrastructure that supports the knowledge creation factors (ITISKCFs).

Information technology can play a significant role in promoting and supporting the knowledge creation enabling factors identified by Nonaka and Takeuchi (1995). Yet this role cannot be realised unless organisations define the dimensions of information technology infrastructure capability that can enable the creation of a conducive knowledge environment. Nonaka and Takeuchi identified a number of enabling conditions (redundancy, fluctuation, requisite variety, autonomy and vision) for the organisational knowledge to be created. This study selected the first four condition

were the belief is that ITI can deliver the needed enhancement for the knowledge creation conditions (see the argument presented in chapter three). The study proposes four dimensions of ITI that can enhance the knowledge creation. These dimensions are

- Information technology infrastructure supporting redundancy.
- Information technology infrastructure supporting fluctuation.
- Information technology infrastructure supporting requisite variety.
- Information technology infrastructure supporting work related autonomy.

Items were developed mainly from Nonaka and Takeuchi (1995) and from other literature on the theory of organisational knowledge creation (Scott 1998; Choo 1998; Leonard-Barton 1995 and Khalil 1996). These items measure the perception of respondents based on their agreement or disagreement. Respondents were asked to rate each item on a five-point Likert-type scale, ranging from '1=strongly disagree' to '5=strongly agree'.

(a) Information technology infrastructure that supports redundancy

The factor analysis showed a one-factor solution of the information technology infrastructure supporting redundancy (ITI-R). The factor analysis showed clear discriminant validity since all items are loaded on one factor. Loadings for the factor range from 0.56 to 0.75. The average loading for the factor was 0.67. This factor

explains 45% of the total variance. The factor has an eigenvalue greater than 1. Items representing the ITI-R are displayed in table 5.9.

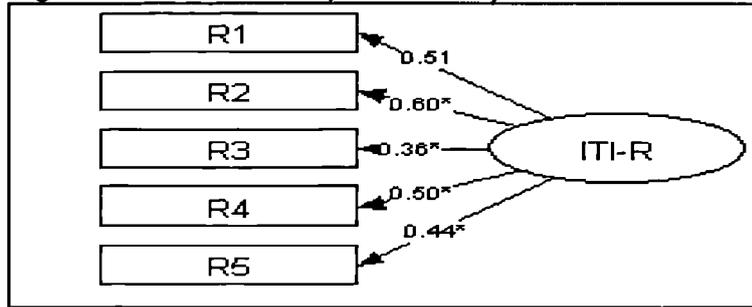
Table 5.9 Factor analysis results of ITI-R construct

| Items | ITI-R |
|--|--------------|
| Computer supports the availability of variety of information, such as information about the business activities, management responsibilities and the organisation as a whole. | 0.745 |
| Overlapping information enabled by computer allows me to sense what my colleagues are trying to articulate. | 0.681 |
| Overlapping information facilitated by computer enables me to surpass functional boundaries to offer advice or provide information from a different perspective to other organisational members. | 0.559 |
| Overlapping information facilitated by computer helps me to understand my role in the organisation. | 0.632 |
| Overlapping information enabled by computer promotes the sharing of information across functions. | 0.718 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

To confirm the validity of the ITI-R construct further, CFA was executed, the results indicated good discriminant validity, as CFI equals 1.00 and TLI equals 1.00. $\chi^2=3.82$, $P=0.49$, GFI equals 0.99 and RMSEA equals 0.00. All coefficients are standardised and all were significant, ranging from 0.36 to 0.60. These all indicated that good discriminant validity was established for this construct, which represents a single dimension that is the ITI-R (see figure 5.10).

Figure 6.10 Confirmatory factor analysis results for ITI-R



Reliability, calculated based on Cronbach's alpha for the ITI-R construct, measure was equal to 0.69, showing an acceptable level of reliability. Since all items loaded significantly on a single dimension as indicated by EFA and confirmed by CFA, a summed variable was derived for the five items (R1-R5) representing the ITI-R construct to represent the ITI-R variable.

(b) Information technology infrastructure that supports fluctuations

The factor analysis showed a one-factor solution of the information technology infrastructure supporting fluctuations (ITI-F). The factor analysis showed clear discriminant validity since all items are loaded on one factor. Loadings for the factor ranged from 0.57 to 0.75. The average loading for the factor was 0.66. This factor explains 44% of the total variance. The factor has an eigenvalue greater than 1. Items representing the ITI-F are displayed in table 5.10.

To confirm the validity of the ITI-F construct further, CFA was executed; the results indicated good discriminant validity, as CFI equals 0.99 and TLI equals 0.99. $\chi^2=2.06$, $P=0.36$, GFI equals 0.99 and RMSEA equals 0.02. All coefficients are standardised and all were significant, ranging from 0.35 to 0.56. These all indicated

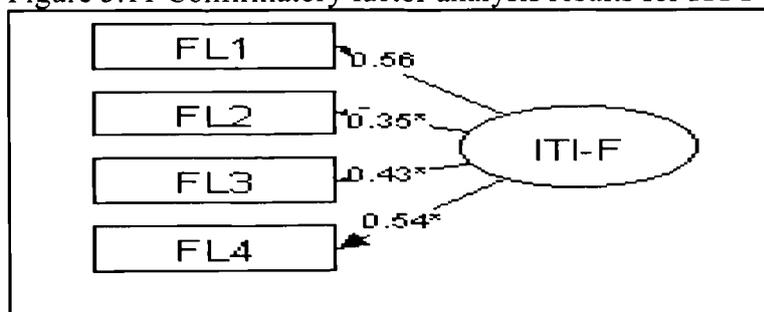
that good discriminant validity was established this construct, which represents a single dimension that is the ITI-F (see figure 5.11).

Table 5.10 Factor analysis results of ITI-F construct

| Items | ITI-F |
|---|-------|
| Constantly changing information facilitated by the computer enables me to relate old information to new ones to form new concept or idea. | 0.746 |
| Frequent changes in information facilitated by the computer triggers a breakdown of routines. | 0.574 |
| Information changes frequently, enabled by the ease of making changes with the computer. | 0.585 |
| Computer enable the making of changes in the way information is processed to react to new developments. | 0.731 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

Figure 5.11 Confirmatory factor analysis results for ITI-F



Reliability, calculated using Cronbach's alpha ITI-F construct, measure was 0.57; close enough to an acceptable level of 0.60 of reliability. As all items loaded significantly on a single dimension as indicated by EFA and confirmed by CFA, a summed variable was derived for the four items (FL1-FL4) representing the ITI-F construct to represent the ITI-F variable.

(c) Information technology infrastructure that supports requisite variety

The factor analysis showed a one-factor solution of the information technology infrastructure supporting requisite variety (ITI-RV). The factor analysis showed clear discriminant validity since all items are loaded on one factor. Loadings for the factor range from 0.57 to 0.73. The average loading for the factor was 0.64. This factor explains 42% of the total variance. The factor has an eigenvalue greater than 1. Items represent the ITI-RV are displayed table 5.11.

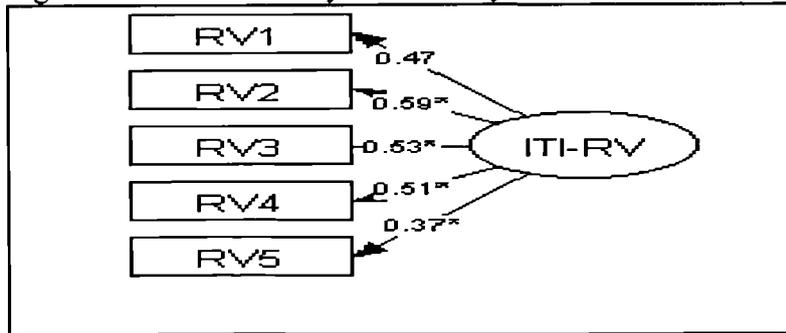
Table 5.11 Factor analysis results of ITI-RV construct

| Items | ITI-RV |
|---|--------------|
| Computer helps me to identify the subject matter expert. | 0.666 |
| Computer ensures me a fast access to the broadest variety of necessary and relevant information, going through fewest steps. | 0.725 |
| Computer enabled the construction of information process channels that match the information loads impose by the environment. | 0.671 |
| Computer enables me to combined information differently, flexibly and quickly. | 0.573 |
| Computer enabled me to identify where about information is located and accumulated. | 0.584 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

To confirm the validity of the ITI-RV construct further, CFA was executed; the results indicated good discriminant validity, as CFI equals 1.00 and TLI equals 1.00. $\chi^2 = 1.97$, $P = 0.85$, GFI equals 0.99 and RMSEA equals 0.00. All coefficients are standardised and all were significant, ranging from 0.43 to 0.70. These all indicated that good discriminant validity was established for this construct, which represents a single dimension that is the ITI-RV (see figure 5.12).

Figure 5.12 Confirmatory factor analysis results for ITI-RV



Reliability, calculated using Cronbach's alpha ITI-RV construct, measure was 0.64, showing an acceptable level of reliability. Given that all items loaded significantly on a single dimension as indicated by EFA and confirmed by CFA, a summed variable was derived for the five items (RV1-RV5) representing the ITI-RV construct to represent the ITI-RV variable.

(d) Information technology infrastructure that supports work related autonomy

The factor analysis showed a two-factor solution of the information technology infrastructure supporting work related autonomy (ITI-A). One of the two dimensions had a very low reliability less than 0.2 and, hence, it was removed from the analysis. The remaining dimension shows clear discriminant validity since all items are loaded on one factor. Loadings for the factor range from 0.67 to 0.81. The average loading for the factor was 0.74. This factor explains 42% of the total variance. The factor has an eigenvalue greater than 1. Items representing the ITI-A are displayed in table 5.12.

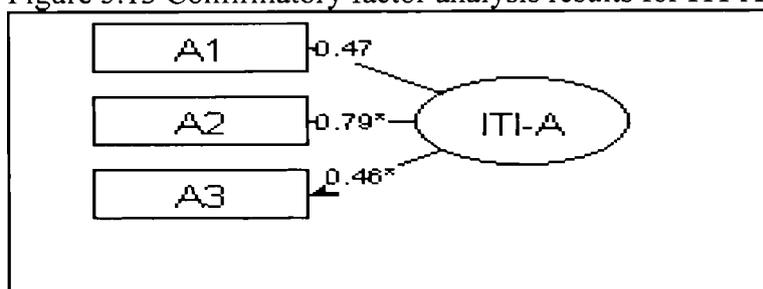
To confirm the validity of the ITI-A construct further, confirmatory factor analysis (CFA), as CFI equals 1.00. $\chi^2 = 0.00$, $P = 1.00$ and RMSEA equals 0.00. All other indexes will not be computed since this model represents a perfect fit. All coefficients are standardised and all were significant, ranging from 0.46 to 0.79. These all indicated that perfect discriminant validity was established for the ITI-A construct (see figure 5.13).

Table 5.12 Factor analysis results of ITI-A construct

| Items | ITI-A |
|---|--------------|
| A great deal of necessary information to accomplish my tasks is coming from the computer. | 0.737 |
| Information needed to perform my task is stored in the computer enabling me to act independently when facing a problem or an inquiry. | 0.805 |
| With the use of computers my level of freedom for undertaking tasks has been expanded. | 0.669 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

Figure 5.13 Confirmatory factor analysis results for ITI-A



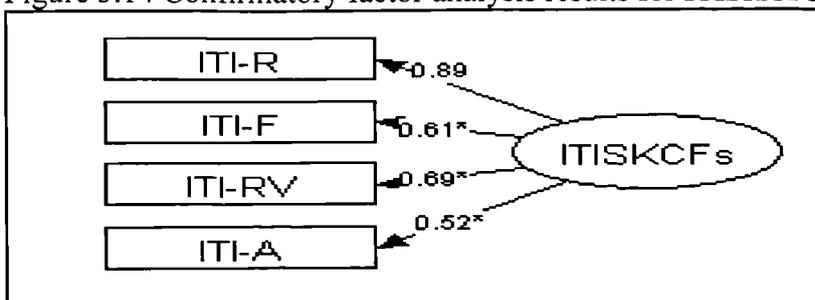
Reliability, calculated based on Cronbach's alpha ITI-A construct, measure was 0.58, close enough to an acceptable level of reliability. As all items loaded significantly on a single dimension as indicated by EFA and confirmed by CFA, a summed variable

was derived for the three items (A1-A3) representing the ITI-A construct to represent the ITI-A variable.

Information technology infrastructure that supports knowledge creation factors (ITISKCFs)

After identifying in the previous section the underlying dimension of the variables and constructs (ITI-R, ITI-F, ITI-RV and ITI-A) that constitutes the information technology infrastructure that supports knowledge enabling factors, and having confirmed the reliability and validity of these dimension through the use of EFA and CFA, the summated variables were then employed to form the ITISKCFs construct, where ITISKCFs were characterised as a latent variable. A model for ITISKCFs was constructed and CFA was executed to test for the overall goodness of fit for the proposed IKT construct. The results indicated good fit, as CFI equals 1.00, TLI equals 1.00, $\chi^2 = 0.14 (1)$, $P = 0.70$ and RMSEA equals 0.00. All other indexes will not be calculated as this model represents a perfect fit. All coefficients are standardised and all were significant, ranging from 0.52 to 0.89. These all indicated that good discriminant and convergent validity was established for the ITISKCFs construct, unidimensionality was assured as GFI is greater than 0.90. Confirmatory analysis results for ITISKCFs construct can be seen in figure 5.14.

Figure 5.14 Confirmatory factor analysis results for ITISKCFs



Reliability of the internal consistency for the ITISKCFs construct was calculated using the construct “composite” reliability measures construct. The result shows that reliability equal to 0.78, which is an indication of a sound and acceptable level of reliability.

5.4.1.3 Culture of knowledge transfer

The culture of knowledge transfer is deemed as one of the most influential factor that could leads to an improvement in the activity of knowledge dissemination. As an enabling factor, knowledge can be smoothly disseminated between individuals leading to more innovation as a result of the accumulated work related knowledge. In a survey conduct by Davenport and Prusak (1998), on the factors leading to knowledge project success, a culture of knowledge transfer was named the most consequential condition.

Items representing the culture of knowledge transfer construct (CKT) were developed from the findings of Davenport and Prusak (1998), regarding the most common frictions that inhabit and prevent knowledge transfer (KT). The recommendations to overcome inhibitors of KT were taken and developed into items that reflect the aspect of CKT. All items were analysed based on a score of the extent of practise. Respondents rated each item on a five-point Likert-type scale ranging from ‘1=strongly disagree’ to ‘5=strongly agree’.

Two sub-constructs were hypothesised: the first sub-construct covers the socialisation aspect of CKT (SCKT), where trust and common grounds are supported and encouraged; the second sub-construct reflects the management practices regarding activities of knowledge transfer (PCKT), where the management plays a significant role by conveying their vision of the type of knowledge to be developed, practising more open-minded attitude regarding flexibility and creative errors and rewarding individuals for their efforts in sharing knowledge. The initial factor analysis showed a two-factor solution of CKT: SCKT and PCKT. Two items were removed; the first item was cross loading significantly on both factor; the second item was removed, as loadings were less than 0.5.

The final factor analysis showed sound discriminant validity. Loadings for the two factors PCKT and SCKT range from 0.65 to 0.86. The average loadings for the two factors were 0.71 and 0.80, respectively, and the cross loadings were all less than 0.5 showing a clear discriminant validity. These two factors explained 64% of the total variance. All factors have eigenvalue greater than 1. Items representing the CKT are displayed in table 6.13.

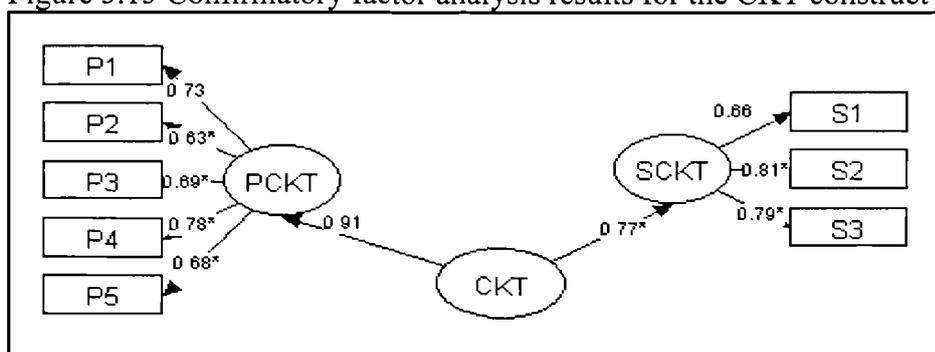
To confirm the validity of the CKT construct further, confirmatory factor analysis (CFA) was executed using structural equation modelling (SEM). CFI equals 0.97 and TLI equals 0.96. $\chi^2= 26.84$, $P= 0.11$, GFI equals 0.94 and RMSEA equals 0.06. All coefficients are standardised, and all were significant, ranging from 0.63 to 0.99. These all indicated that good discriminant validity was established for the CKT construct, which represents a single dimension. (See figure 5.15).

Table 5.13 Factor analysis results of CKT

| Items Frequency | PCTK | SCKT |
|--|--------------|--------------|
| My organisation encourages building relationships and trusts through face-to-face. | 0.243 | 0.724 |
| My organisation supports establishing common ground through education, discussion, publication, teaming and job rotation. | 0.163 | 0.862 |
| My organisation supports establishing time and space for knowledge transfer through fairs, talk room and conference reports. | 0.237 | 0.813 |
| My organisation educates employees for flexibility. | 0.650 | 0.324 |
| My organisation encourages a non-hierarchical approach to knowledge. i.e. knowledge is appreciated no matter the hierarchical-level of the source. | 0.775 | 0.008 |
| Leadership and top management conveys their vision regarding what kind of knowledge should be developed. | 0.810 | 0.128 |
| My organisation hires for the openness of ideas. | 0.662 | 0.457 |
| In my organisation management accepts and rewards creative error and collaboration. | 0.651 | 0.375 |

Principal Component Extraction and Varimax Rotation with Kaiser Normalization.

Figure 5.15 Confirmatory factor analysis results for the CKT construct



Reliability was calculated based on Cronbach's alpha for the main construct and the two sub-constructs; measures were 0.85, 0.77 and 0.85 for CKT, SCKT, PCKT, respectively. All measures demonstrate high reliability. Since the items loaded significantly on a two dimensions, PCKT and SCKT as indicated by EFA and

confirmed by CFA, a summed variable was derived for the five items (P1-P5) representing the PCKT construct to represent the PCKT variable and a summed variable was derived for the three items (S1-S3) representing the SCKT construct to represent the SCKT variable.

To conclude this chapter four major dependent constructs representing OKC modes (SK, CK, SyK and OK) and three independent constructs representing the enablers of knowledge creation (ITISKCFs, IKT and CKT) were defined through EFA and then confirmed by CFA. All of the dependent and independent contracts are a representation of the first order latent variables. These constructs were tested for reliability using the composite reliability test and all were sound and acceptable. These new latent variables will be further analysed and used in the next chapter.

5.5 Summary

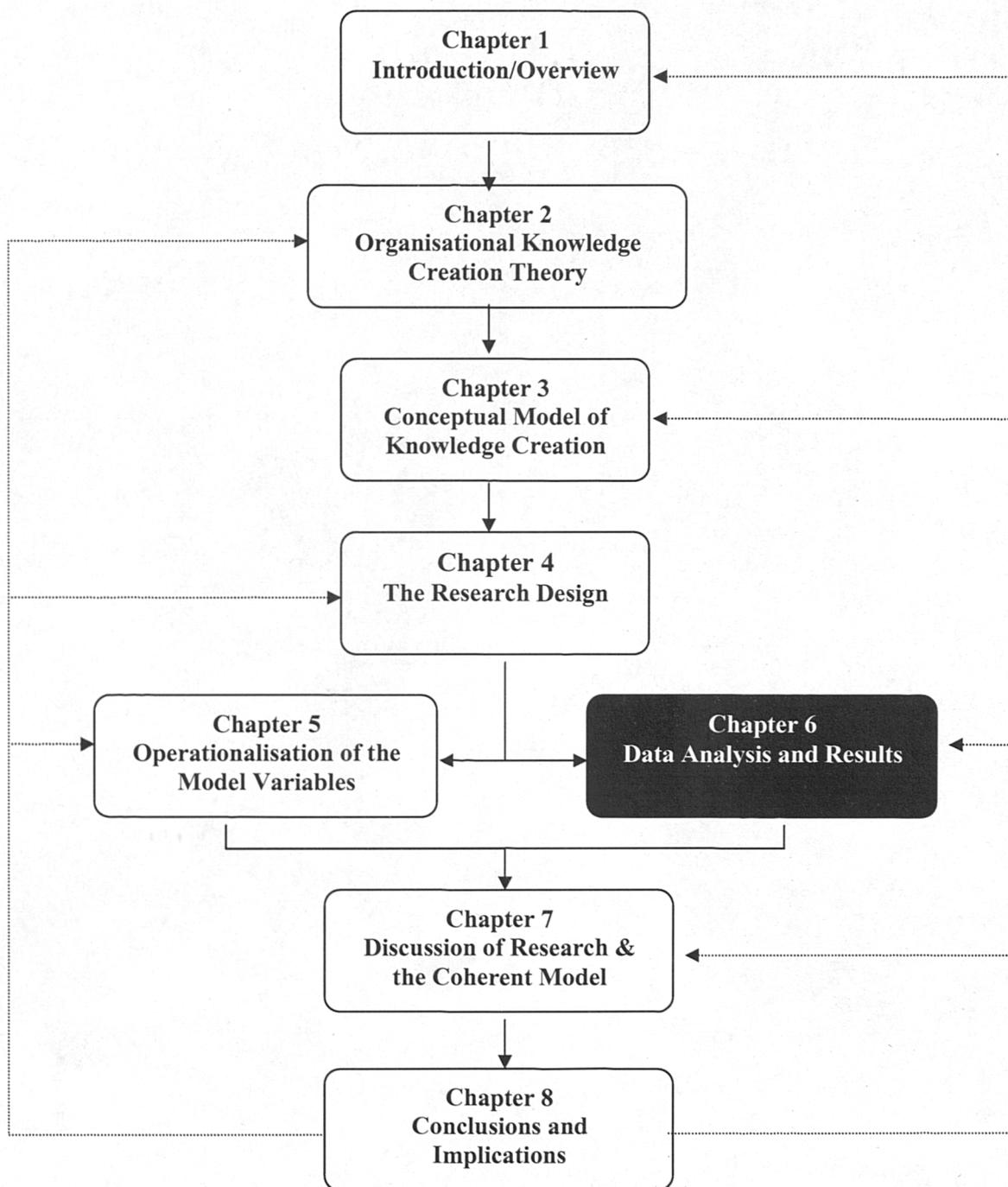
Explanatory factor analysis was utilised to identify the underlying dimension for the proposed constructs of the model variables. A first order and higher order confirmatory factor analysis model was exploited. First order CFA was used to further the validity of the findings of the explanatory factor analysis. The higher order factor analysis was used to detect for a higher order factor solution model. A summated scale was used to reduce the number of indicators (variables) that are loaded on a single dimension. Measurement of internal consistency (Cronbach's alpha) for most constructs indicates an acceptable reliability. The overall goodness

of fit measures for the measurement models indicates a good and acceptable fit. Discriminant, convergent validity, and unidimensionality were assured by the goodness of fit indices. The next chapter, the data analysis, will utilise the findings of this chapter for the purpose of solving the proposed research model.

Chapter Six

Data Analysis and Results

Figure 6.1 Chapter six in the context of the thesis



Chapter Six

Data Analysis and Results

6.1 Preliminary data analysis and descriptive statistics

6.1.1 Research sample characteristics

The respondents' average age was 38 years ranging from 23 to 55 and they have been at the present job for an average of 2.9 years but demonstrate an immense variation, ranging from 2 months to 12 years. The most frequent number of decision levels from the final approval was reported as 1 or 2 levels (63.7%) and the next frequent was 3 or 4 level (16.7%). Most of the respondents' titles were managers 62.7%, and the next frequent position was senior managers 9.8%. The most frequent number of involvement in project innovation was 1-5 projects, which constitutes 35.3%. The next frequent number of involvement was more than a 15 projects, which represent 33.3%. The most frequent level of education was reported as postgraduate degree, 39.2% and the next frequent level of education was Bachelor's degree at 32.4%. Approximately 72% were line managers, mostly in marketing and sales, and product development departments, and the remaining were engaged in accounting and finance, information technology and customer services. The mean statistics for the main constructs of the study reveal that, on average, most respondents have agreed on the existence of information technology infrastructure that support the knowledge creation factors (ITISKCFs). The respondents also agreed, on average, on the existence of infrastructure traits that can support the knowledge transfer. The respondents revealed that the culture of knowledge transfer and the knowledge

creation activities were moderately practised. A summary of the descriptive statistics can be seen in tables 6.1 to 6.7.

Table 6.1 Age and job tenure distribution of respondents

| Age and Job Tenure | Min | Max | Mean | S.D. |
|--------------------|-----|-----|-------|-------|
| Age | 23 | 55 | 37.95 | 7.53 |
| Job tenure (month) | 2 | 144 | 31.61 | 29.70 |

Table 6.2 Distribution of respondents' level of education

| Level of Education | Frequency | Percent |
|--|-----------|-------------|
| HND | 10 | 9.8 |
| Bachelors | 33 | 32.4 |
| Postgraduates | 40 | 39.2 |
| Other qualifications (none of the above) | 19 | 18.6 |
| Total | 102 | 100.0 |

Table 6.3 Distribution of The number of innovating projects the respondent is involved in

| Number of involvement in innovative projects | Frequency | Percent |
|--|-----------|-------------|
| None | 2 | 2.0 |
| 1-5 | 36 | 35.3 |
| 6-10 | 17 | 16.7 |
| 11-15 | 13 | 12.7 |
| More than 15 | 34 | 33.3 |
| Total | 102 | 100.0 |

Table 6.4 Distribution of approval levels

| Approval Level | Frequency | Percent |
|----------------|-----------|-------------|
| 0 level | 15 | 14.7 |
| 1-2 levels | 65 | 63.7 |
| 3-4 levels | 17 | 16.7 |
| 6-5 levels | 5 | 4.9 |
| Total | 102 | 100.0 |

Table 6.5 Distribution of title of respondents

| Current Title | Frequency | Percent |
|-------------------------------------|-----------|-------------|
| Chief Executive Officer or Director | 8 | 7.8 |
| General Manager | 7 | 6.9 |
| Senior Manager | 10 | 9.8 |
| Managers | 64 | 62.7 |
| Assistant Manager | 7 | 6.9 |
| Other management position | 6 | 5.9 |
| Total | 102 | 100.0 |

Table 6.6 Distributions of respondents among different departments

| Department | Frequency | Percent |
|-------------------------|-----------|-------------|
| Sales and Marketing | 48 | 47.1 |
| Information Technology | 3 | 2.9 |
| Accountancy and Finance | 3 | 2.9 |
| Products Development | 26 | 25.5 |
| Customer Service | 3 | 2.9 |
| Head Management | 15 | 14.7 |
| Other | 4 | 3.9 |
| Total | 102 | 100.0 |

Table 6.7 The mean statistics for the main constructs of the study

| | ITISKCFs | IKT | CKT | SK | CK | SyK | OK |
|------|----------|--------|--------|--------|--------|--------|--------|
| Mean | 3.5750 | 3.5571 | 3.2576 | 2.7461 | 3.1196 | 2.9575 | 3.0801 |

6.1.2 Comparison of variables across banks and building societies

Since the level of analysis as individual and all variables, except the organisational culture of knowledge transfer (CKT), were pooled between the two groups (retail banks and building societies), it was imperative to discern the difference in variable means between sectors.

The t-test was used for variables where the assumption of normality was satisfied and the Mann-Whitney U test was used for variables that did not satisfy the assumption of normality. It can be seen from table 6.7 and 6.8 that all four sub-dimensions of ITISKCFs: ITI-fluctuation, ITI-requisite variety, IT-task orient autonomy and ITI-redundancy were different between groups, where ITI that support redundancy was much less than other ITI support and ITI that supports the task oriented autonomy was the highest, regardless of groups. *t*-test for the first three variables and the Mann Whitney U-test for the last variable (ITI-redundancy) showed that the extent of support was significantly different between the two groups.

Findings from t-test also showed that there is no significant difference between the banks and building societies on time spent on all types of knowledge creation activities and their sub-dimensions. In other words, the extent to which individuals, in both groups,

spent time in knowledge creation activities was similar. The time spent on sympathised knowledge was the least among other types of knowledge creating activities and the time spent on concept knowledge creation activities was the highest, regardless of the groups. *t*-test also showed an insignificant difference on the extent of practices of the management policies' aspects of culture of knowledge transfer (PCKT), suggesting that similar practices were adopted for both groups, while *t*-test also showed that there is a significant difference between the two groups on the socialisation aspect of the culture of knowledge transfer (SCKT). Two of the four infrastructures for knowledge transfer (IKT) sub-dimensions (IKT-I, IKT-IS) were different across the groups, indicating that depending on the group (banks, or building societies), individuals tend to have different level of integration, different usage level of information and communications. The two remaining sub-dimensions of IKT: IKT-CB and IKT-KS were similar between the banks and building societies. This is supported by *t*-test, which showed no significant difference. Findings can be seen in tables 6.8, 6.9 and 6.10.

Table 6.8 F-test and *t*-test results of variables

| Variable | F-test | Sig. | T-test | df | Sig. (2-tailed) |
|----------|--------|------|--------|-----|-----------------|
| ITI-F | .159 | .691 | -2.097 | 100 | .039** |
| ITI-RV | .004 | .952 | -2.464 | 100 | .015** |
| ITI-A | 2.245 | .137 | -2.636 | 100 | .010* |
| SKA | .737 | .393 | .339 | 100 | .736 |
| IKT-I | 7.911 | .006 | -1.100 | 100 | .274 |
| IKT-KS | .588 | .445 | -2.716 | 100 | .008* |
| IKT-IS | 1.969 | .164 | -1.351 | 100 | .180 |
| SCKT | .299 | .586 | -2.046 | 100 | .043** |
| PCKT | .037 | .848 | -.614 | 100 | .541 |
| SKT | .088 | .768 | -1.667 | 100 | .099 |
| CK | .010 | .922 | -.682 | 100 | .497 |
| SYKA | .534 | .467 | -1.901 | 100 | .060 |
| SYKP | .117 | .733 | .393 | 100 | .695 |
| SYKD | .019 | .890 | -1.849 | 100 | .067 |
| OK-RWK | 1.465 | .229 | -1.231 | 100 | .221 |
| OK-VWK | 4.877 | .029 | -.361 | 100 | .719 |

*Significant at 1%, ** Significant at 5%

Table 6.9 Mann-Whitney test of significance for variables that did not satisfy the normality assumption

| | ITI-R | IKT-CB |
|------------------------|----------|----------|
| Mann-Whitney U | 678.500 | 1004.000 |
| Wilcoxon W | 1713.500 | 2039.000 |
| Asymp. Sig. (2-tailed) | .000* | .056 |

Grouping Variable: type of organisation (banks, and building societies), *Significant at 1%

Table 6.10 Mean and standard deviation of variables for each group.

| | TYPE | Mean | Std. Deviation |
|---|-------|--------|----------------|
| ITI-Fluctuation (ITI-F) | B.S. | 3.2944 | .5918 |
| | Banks | 3.5263 | .5233 |
| ITI-Requisite variety (ITI-RV) | B.S. | 3.4844 | .5518 |
| | Banks | 3.7474 | .5217 |
| ITI- Task oriented autonomy (ITI-A) | B.S. | 3.6000 | .7707 |
| | Banks | 3.9708 | .6494 |
| ITI-Redundancy (ITI-R) | B.S. | 3.1822 | .5890 |
| | Banks | 3.6386 | .5284 |
| IKT-behavior (IKT-CB) | B.S. | 3.4111 | .8679 |
| | Banks | 3.5728 | .6153 |
| IKT-knowledge & skills (IKT-KS) | B.S. | 3.4944 | .4899 |
| | Banks | 3.7632 | .5009 |
| IKT-information systems (IKT-IS) | B.S. | 3.1000 | .7079 |
| | Banks | 3.2711 | .5707 |
| IKT-integration (IKT-I) | B.S. | 3.7111 | .6985 |
| | Banks | 4.0257 | .4853 |
| Culture of knowledge transfer-socialisation (SCKT) | B.S. | 3.1185 | .6748 |
| | Banks | 3.4034 | .7164 |
| Culture of knowledge transfer-management Policies (PCKT) | B.S. | 3.1911 | .6687 |
| | Banks | 3.2742 | .6868 |
| Sympathetic knowledge collection (SKC) | B.S. | 2.4222 | .6595 |
| | Banks | 2.3719 | .8057 |
| Sympathetic knowledge transfer (SKT) | B.S. | 2.9222 | .9709 |
| | Banks | 3.2368 | .9263 |
| Systematic knowledge accumulation (SyKA) | B.S. | 2.9500 | .7970 |
| | Banks | 3.2675 | .8684 |
| Systematic knowledge processing (SyKP) | B.S. | 2.7000 | 1.094 |
| | Banks | 2.6140 | 1.098 |
| Systematic knowledge dissemination (SyKD) | B.S. | 2.9000 | .9391 |
| | Banks | 3.2456 | .9360 |
| Operational knowledge –real world knowledge (OK-RWK) | B.S. | 3.0519 | .7912 |
| | Banks | 3.2632 | .9123 |
| Operational knowledge –virtual world Knowledge (OK-VWK) | B.S. | 2.9556 | .7236 |
| | Banks | 3.0175 | .9541 |

6.2 Structural equation modelling (SEM)

6.2.1 Assumptions of SEM and other related issues

SEM diverges from other multivariate data analysis methods in that it utilises only the variance-covariance or correlation matrix as input data, where individual observations are transformed by the SEM program into one of these types of matrices before estimation. According to Hair et. al., (1998), the focus of SEM is not the individual observations but the precedent of relationship across respondents. SEM for data analysis requires certain assumptions: independent observations, random sampling, and linearity of all relationship. SEM is considered to be more sensitive to the distribution of characteristics data especially the departure of multivariate normality. A strong departure of multivariate normality such as strong kurtosis in the data, can increase the value chi-square (χ^2) and create a great deal of bias in critical values for determining the coefficient significance (Hu. et. al, 1992; Byrne, 1994; Wang et. al., 1996).

The three conditions of SEM were satisfied and a data diagnosis was conducted first to ensure that no departure from normality.

Normality

Normality is the assumption about the degree to which the distributions of the sample data correspond to a normal distribution, where normal distribution is a theoretical distribution, that is symmetrical, in which the horizontal axis represents all possible values of a variable and the vertical axis represents the probability of those values occurring (Kerr et. al., 2002; Hair et. al., 1998). In addition to examining the normality

plots, each variable was thoroughly checked using the skewness and kurtosis values. Based on formulas suggested by Hair et. al., (1998, p.72), West et. al., (1995, p.60-61) and Kerr et. al., (2002, p. 50-52) to calculate Z_{skewness}^1 and Z_{kurtosis}^2 in light of the sample size of this study, a critical value for both was established. For Z_{skewness} a value of 0.625 or less and a Z_{kurtosis} value of 1.25 or less indicates that we can accept the assumption about the normality of the distribution at the 0.01 probability level. All variables passed the normality test except ITI-R and IKT-CB, which seemed to be moderately skewed and kurtotic. Measures of data correction for non-normality were carried out, such as the inverse of the variable, the squared root and the log transformation. In the case of these two variables, none of the transformation could improve the normality. These variables have to be used in their original form. These variables must not be used in the analysis in their original values unless there is an estimation method that has robustness to depart from normality and, then, the original variable may be preferred for the comparability in the interpretation phase (Hair et al., 1998). The outcome of a strong kurtotic variables may be adequate for the distribution to be multivariately nonnormal, thereby, infringe the assumption of normality (Byrne, 1994).

To address this problem of non-normality, Chou et. al., (1991), Hu et. al., (1992), Byrne, (1994) Satorra and Bentler (1994) and West et. al., (1995) suggested that, if there is evidence that the sample is not normally distributed, one the following actions will yield more valid results.

¹ $Z_{\text{skewness}} = \text{Skewness} / \sqrt{(6/N)}$, where N is the sample size.

² $Z_{\text{kurtosis}} = \text{Kurtosis} / \sqrt{(24/N)}$.

1. To use the estimation method that assumes the underlying nonnormal distribution of the sample data and based on the evaluation of the model fit of the corresponding X^2 statistic, or
2. To use the estimation method that assumes the underlying normal distribution but bases evaluation of the model on a test statistic that has been corrected to take non-normality into account.

According to Byrne (1994) recent research has provided strong evidence to confirm the second methods. Based on this evidence this study adopted the second method and the maximum likelihood with robust estimation was used. A scaled test statistic proposed by Satorra and Bentler (1994) performed even better than the standard statistics (Chou et al., 1991; Hu et al., 1992) and, according to Byrne (1994), the S-B X^2 is the most reliable test statistic for use of SEM when there is a departure from normality.

Satorra-Bentler scaled statistic (S-B X^2) has been shown to be the most reliable test statistic for evaluating Covariance structural models under various distributions and sample sizes (Byrne, 1994, p.86).

Thus, the Satorra and Bentler scaled statistics (S-B X^2) were used for the evaluation of the model fit when there is a departure from normality.

Identifying influential observation (outliers)

A small set of observations can have uneven influence on the test statistic of the model. These observations, which are labelled as outliers, are extreme data points that may affect the results of SEM (Byrne, 1994; Hair et. al., 1998). In determining possible multivariate outliers in the data, EQS 5.7 program selects five cases in each run as contributing most to multivariate kurtosis. Relative to estimates of other case the researcher must decide on which of the subjects is regarded as an outlier and, thus, eligible for deletion. For each model analysed a number of subjects were regarded as an outlier and thus were deleted. Details are provided in analysis of each model. In the course of analysing the models of this study, the deletion of an outlier subject has reduced the difference between the original X^2 statistic and the correct X^2 statistic (S-B X^2). This is an apparent intimation that kurtosis is, in a large part, accountable for the moderate deviation from normality in the data.

Missing data

Missing data is rarely avoidable and the existence of it can have an intense consequence on the computation of the data matrix and its aptitude used in the estimation process (Hair et al., 1998). In dealing with this issue a number of approaches can be used to solve for missing data, such as listwise deletion procedure and mean substitution. A listwise deletion procedure is known to perform well if the proportion of missing data is not too great, while it has a drawback that may seriously reduce the sample size (Brown, 1994). Mean substitution is considered one of the more widely used methods (Hair et al.,

1998). It uses the mean value of all valid responses to calculate the replacement value. The rationale of this approach is that the mean is the best single replacement value (Hair et. al., 1998; Little and Rubin, 1987).

The fact is that the first methods can reduce the sample size, which is a key concern for this study, considering the need to preserve at least the minimum required sample size (discussion about the sample size required for SEM is provided on the next page) to ensure appropriate use of the estimation procedure.

Taking into consideration the above argument, the study has adopted the second method (mean substitution). The original data has a few missing variables, precisely six cases were identified with missing data, all of which came from one single source where, based on the advice of their research and legal department, they were asked to ignore one section of the questionnaire. The justification that was given to the researcher suggested that the section in question was about a sensitive issue and they preferred not to answer it. Factor analysis using listwise procedure was run first, yielding a certain result, then a second run of estimation with a mean substitution installed in the original data yielded similar results with no significant difference.

With this finding the researcher drew a conclusion that the data are stable, no matter the type of missing data procedures used and, since another objective was to maintain the sample size, the mean substitution was the right choice for dealing with missing data in the case of this study.

Covariance verses correlation matrix

SEM uses only a variance-covariance or correlation matrix as input; any individual observations will automatically be converted into one of these two input matrix (Benter, 1995). SEM was initially formulated for use with variance-covariance matrix. Recently the correlation matrix has gained widespread use in many applications (Hair et. al., 1998). Variance-covariance matrix is useful when the objectives of the research are to test the theory and to explain the total variance of the constructs, while the correlation matrix in best used when the objective of the research is only to understand the pattern of relationships between construct and not to explain the total variance (Maruyama, 1997). This matrix is limited to the sample, while the variance-covariance has an advantage of providing a valid comparison across population and samples. When correlation matrix is used as an input it is advised that the results should be cautiously interpreted and the generalisation of different situations. The fact that the objective of this study is to test a theory and to explain total variance of the constructs, the choice was to adopt the variance-covariance matrix as an input of the SEM.

Sample size

As indicated earlier, SEM does not take an individual observation as an input matrix, but the sample size plays a significant role in the estimation of the constructs and models, and in the interpretation of the results. The critical question is how large a sample is needed for SEM to provide valid results. According to Hair et. al., (1998), there is no single decisive factor that dictates the required sample size, yet there is a number of factors that

play a crucial role in determining the sample size requirements: (1) the model size and its complexity, (2) the departure from normality and, (3) the estimation procedure adopted.

Considering the model size, the definite minimum sample size must be at least greater than the number of covariance in input matrix but, as the rule of thumb, a typical minimum of five observations for each estimated parameter (Hair et. al., 1998). This ratio would increase as the model complexity increased. As for the departure from normality, a researcher is always encouraged to increase the sample size, yet there is a number of estimation procedures designed to deal with non-normal distributions. Some estimation procedures can provide valid estimates with a very low sample size (Hair et. al., 1998).

Maximum likelihood estimation (MLE), the most common estimation procedure, has been found to provides a valid results with sample sizes as small as 50. (Hair et al., 1998, p. 605)

Yet, this small number of 50 observations is not recommended and the generally accepted minimum number of the sample size, considering the use of MLE with robust statistics as estimation procedures, is 100 individual observations. A suggested rule of thumb is a recommended minimum sample size for SEM of 100 (Medsker et. al., 1994). This view is supported by a number of researchers, such as Hayduk (1980) where he suggested a sample size of 100 normally provided stable estimates. March et. al., (1988), Tanaka (1987), Ding et. al., (1995) and Hair et. al., (1998) all considered a minimum sample size

of 100 individual observations is adequate for the use of MLE; and the recommended sample size ranges from 100 to 200.

Estimation procedure

The characteristics of the data and the moderate departure from normality dictate the type of estimation procedure used for estimating the constructs and the model. MLE is the default estimation method in most SEM software packages; it is an estimation technique that provides efficient estimates for data controlled by a multivariate normal distribution. Conversely, the MLE technique cannot deal with anything more than moderate departures from multivariate normality. MLE is highly recommended (Byrne, 1994; Hair, 1998; Bentler, 1988) and it is most frequently used by researchers, such as Garyson et. al., (1997), Teo and Choo (2001), Yoon et. al., (2001), Chang and Cheung (2001) and Smith et. al., (2002). MLE, supported with a robust statistics to adjust for the moderate departure from normality was adopted in this study to estimate the model relationships.

Computer programs

For the use of SEM there is some computer software available for researchers to choose from, such as LISREL, EQS, AMOS and PROC CALL. A demo version of most SEM software can be downloaded free on the internet and the researcher can decide which software is suitable for the data analysis. This study utilises EQS 5.7 as the software to be used for data analysis. EQS is highly recommended for a number of reasons, such as EQS places less stringent assumptions on the multivariate normality of the data (Bentler

1995, Byrne 1994, Hair et al., 1998), it is user friendly and easy to learn in a relatively short time. The most important factor is the availability of robust measures, where EQS allow users to request robust statistics associated with the most selected methods of estimation. The availability of this feature is considered extremely valuable and, according to Byrne (1994) this feature is unique to the EQS program.

“The availability of these robust statistics is an extremely valuable feature that is unique to the EQS program.” (Byrne, 1994, p. 27)

One importance notice that when EQS draw the diagram one variable will not be labelled with a star (*) this due to the process of identification problem where the star (*) mean that the coefficient is at least significant at 0.05 significance level (for more detail see Benter, 1995).

The model variables

Independent construct: knowledge creation enabling environment construct (KCEE)

KCEE consist of the following sub-constructs.

(A) Information technology supporting knowledge creation factors construct (ITISKCFs)

1. ITI support redundancy (ITI-R)
2. ITI support fluctuation (ITI-F)
3. ITI support requisite variety (ITI-RV)
4. ITI support work related autonomy (ITI-A)

(B) Culture of knowledge transfer construct (CKT)

1. Socialisation oriented culture of knowledge transfer (SCKT)
2. Management policy oriented culture of knowledge transfer (PCKT)

(C) Infrastructure for knowledge transfer construct (IKT)

1. Creative behaviour (IKT-CB)
2. Integration and team work (IKT-I)
3. Knowledge and skills (IKT-KS)
4. Information system (IKT-IS)

Dependent construct: organisational knowledge creation activities (OKC)

OKC consist of the following constructs.

1. *Sympathised knowledge creation activities (SK)*
 - a. Sympathised knowledge acquisition (SKA)
 - b. Sympathised knowledge dissemination 'transfer' (SKD)
2. *Conceptual knowledge creation activities (CK)*
3. *Systemic knowledge creation activities (SyK)*
 - a. Systemic knowledge accumulation (SyKA)
 - b. Systemic knowledge processing (SyKP)
 - c. Systemic knowledge dissemination (SyKD)

4. *Operational knowledge creation activities (OK)*
 - a. Operational knowledge-real work knowledge (OK-RWK)
 - b. Operational knowledge-virtual work knowledge (OK-VWK)

6.2.2 Structural equation modelling strategy

The hypothesised models were analysed using SEM. The confirmatory modelling approach was carried out to examine the significant of the research model empirically. EQS 5.7 was used because of the many advantages that this program can offer (see pages 166-67). Prior to running EQS, all constructs were tested for validity through factor analysis principal components analysis with Varimax rotation (Field, 2001). Nine constructs loaded on one factor, three construct loaded on two factors and one construct loaded on three factors. Items loading on all factors for each construct were higher than the cut-off point of 0.50 as recommended by Hair et. al., (1998). A reliability test was carried out using Cronbach's alpha, which measures the internal consistency of a construct. The results can be seen in table 6.11. The number of indicators (variables) relative to the sample size is large and the complexity of the hypothesised model lead the study to adopt the summated scale approach, where the researcher computed the average of composite indicators. The average value of each composite indicator was used in testing the measurement and the structural model. This approach has an advantage in addition to reduction of the number of variables; it has the ability to portray complex concepts in a single measure and it increases the stability of the parameter estimates by

reducing the measurement error³ (Hair et. al., 1998). This is a valid approach and has strong support among researchers, as mentioned in chapters four and five.

Table 6.11 Reliability analyses

| Constructs | No. of items | Loadings | α -value |
|---------------------------|--------------|-----------|-----------------|
| ITI-R* | 5 | 0.56-0.75 | 0.69 |
| ITI-F* | 4 | 0.57-0.75 | 0.57 |
| ITI-RV* | 5 | 0.57-0.73 | 0.64 |
| ITI-A* | 3 | 0.68-0.81 | 0.58 |
| IKT-CB* | 3 | 0.70-0.79 | 0.62 |
| IKT-I* | 2 | 0.76-0.86 | 0.60 |
| IKT-KS* | 4 | 0.59-0.73 | 0.60 |
| IKT-IS* | 4 | 0.60-0.80 | 0.68 |
| CKT** (SCKT, PCKT) | 8 | 0.65-0.86 | 0.85 |
| SK** (SKA, SKT) | 7 | 0.57-0.85 | 0.75 |
| CK* | 5 | 0.54-0.81 | 0.75 |
| OK** (RWK, VWK) | 7 | 0.72-0.82 | 0.80 |
| SyK*** (SyKA, SyKP, SyKD) | 8 | 0.66-0.91 | 0.75 |

* Constructs loaded on one factor; ** Constructs loaded on two factors, ***Constructs loaded on three factors

6.3 Structural equation models: microanalysis (the independent effect)

This section is aimed at investigating and examining the relationships between constructs in the hypothesised research model at the micro level. In other words, microanalysis is designed to test the relationship between the individual independent constructs, such as

³ Measurement error is the extent to which the observed values do not correspond to the true value due to various reasons ranging from errors of data entry to the lack of ability of the individual to provide accurate information

ITISKCFs, CKT and IKT, and their autonomous impacts on the dependent construct (the modes of organisational knowledge creation).

Analytical design for the microanalysis

For simplicity, the proposed relationships between the independent and the dependent constructs can be viewed in the form of regression equations, as displayed below.

1. Independent construct ITISKCFs and OKC constructs, where these relationships are designed to test hypotheses H1a through H1d

$$1.1 \text{ ITISKCFs and SK: } SK = f(\text{ITISKCFs}) \rightarrow SK = \alpha \text{ ITISKCFs} + \varepsilon$$

$$1.2 \text{ ITISKCFs and CK: } CK = f(\text{ITISKCFs}) \rightarrow CK = \alpha \text{ ITISKCFs} + \varepsilon$$

$$1.3 \text{ ITISKCFs and SyK: } SyK = f(\text{ITISKCFs}) \rightarrow SyK = \alpha \text{ ITISKCFs} + \varepsilon$$

$$1.4 \text{ ITISKCFs and OK: } OK = f(\text{ITISKCFs}) \rightarrow OK = \alpha \text{ ITISKCFs} + \varepsilon$$

2.0 Independent construct IKT and OKC constructs, where these relationships are designed to test hypotheses H2a through H2d

$$2.1 \text{ IKT and SK: } SK = f(\text{IKT}) \rightarrow SK = \alpha \text{ IKT} + \varepsilon$$

$$2.2 \text{ IKT and CK: } CK = f(\text{IKT}) \rightarrow CK = \alpha \text{ IKT} + \varepsilon$$

$$2.3 \text{ IKT and SyK: } SyK = f(\text{IKT}) \rightarrow SyK = \alpha \text{ IKT} + \varepsilon$$

$$2.4 \text{ IKT and OK: } OK = f(\text{IKT}) \rightarrow OK = \alpha \text{ IKT} + \varepsilon$$

3.0 Independent construct CKT and OKC constructs, where these relationships are designed to test hypotheses H3a through H3d

3.1 CKT and SK: $SK f (CKT) \rightarrow SK = \alpha CKT + \varepsilon$

3.2 CKT and CK: $CK f (CKT) \rightarrow CK = \alpha CKT + \varepsilon$

3.3 CKT and SyK: $SyK f (CKT) \rightarrow SyK = \alpha CKT + \varepsilon$

3.4 CKT and OK: $OK f (CKT) \rightarrow OK = \alpha CKT + \varepsilon$

6.3.1 Independent construct ITISKCFs and dependent OKC constructs,

Testing hypotheses H1a to H1d.

H1a: ITISKCFs and SK: $SK f (ITISKCFs) \rightarrow SK = \alpha ITISKCFs + \varepsilon$

Measurement model

The measurement model fit and the composite reliability both show that the model is a good fit and reliable. Details of the finding of the measurement model will not be discussed here since the operationalisation of ITISKCFs has already established in the pervious chapter. The analysis will proceed by discussing the findings of the structural model for all four models of ITISKCFs. For the same reasons, the analysis will also start with the evaluation of the structural model for both IKT and CKT constructs in the following sections.

The structural model

Goodness-of-fit measures the degree to which the actual or observed input matrix is predicted by the proposed model. Goodness-of-fit measures are classified under three types.

- *Absolute fit measures* (AFM): assess the overall model fit (both structural and measurement model collectively). For example, these measures encompass indices such as Chi-square χ^2 accompanied by the model's degree of freedom and the it's probability, goodness of fit index (GFI), and the root mean square error of approximation (RMSEA).
- *Incremental fit measures* (IFM): allow the comparison between the proposed model and the competing models and it used to assess the incremental fit of the model compared to the null model. For example, these measures include indices such as Tucker-Lewis index (TLI), comparative fit index (CFI), and the incremental fit index (IFI).
- *Parsimonious fit measures* (PFM): “adjust” the measures of fit to compare between models with different numbers of estimated coefficients so that the amount of fit achieved by each estimated coefficient can be determined. For example, these measures include indices such as normed fit index χ^2/df (the adjusted Chi-square by the degree of freedom).

The estimated coefficients can be analysed and tested after the structural model has been evaluated. The first means of evaluation and testing hypotheses is the overall coefficient of determination (R^2) which is a measure of the entire structural equation, as R^2 can provide a relative measure of fit for each structural equation. The second means of

evaluation is the standardized estimation coefficients (*beta*). This beta can closely approximate the magnitude of the effect. A *beta* close to zero has little, if any, substantive effect, while an increase in value corresponds to increased importance in the causal relationships.

The results of the SEM

Two cases were identified as a multivariate outlier, thus they were deleted. As shown in table 6.12, Chi-square value is not significant at 0.05 significance level, ($X^2(8) = 12.16, P = 0.14$), the scaled Chi-square value is also not significant at 0.05 significance level ($S-B X^2(8) = 11.90, P = 0.16$) and all other fit indices indicate that the hypothesised model is acceptable as GFI = 0.96, RMSEA = 0.07, TLI = 0.94, IFI = 0.97, CFI = 0.97, $R^2CFI = 0.97$ and $X^2/df = 1.52$. Therefore, the hypothesised model was accepted and adopted for testing the hypothesis H1a of this study. The result of the structural model is displayed in table 6.12. Figure 6.2 shows the SEM diagram for the accepted hypothesised model.

Figure 6.2 Hypothesised model of ITISKCFs supporting SK activities

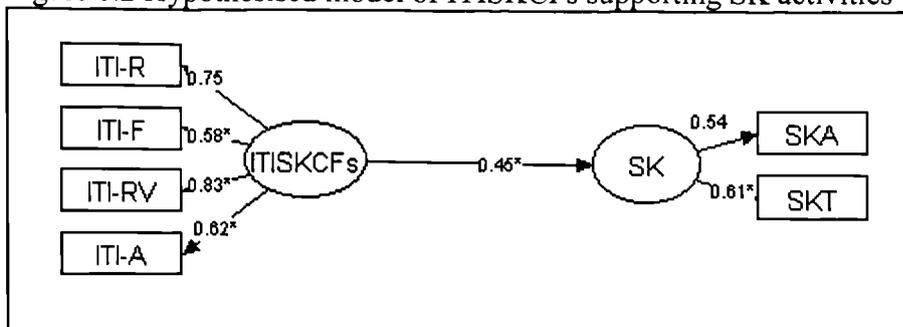


Table 6.12 Goodness of fit for the structural equation model of ITISKCFs supporting SK

| | AFM | | | | IFM | | | | PFM |
|--------------------|------------------|------------------|----------|-------|------|------|------|------------------|-------------|
| | χ^2 | S-B χ^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI | χ^2/df |
| Hypothesised Model | 12.16(8) P=14 | 11.90(8) P=16 | 0.9 6 | 0.07 | 0.94 | 0.97 | 0.96 | 0.97 | 1.52 |

χ^2 , Chi-square; S-B χ^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index; χ^2/df , Normed Chi-square. ($N=100$)

Testing hypothesis and analysis of the structural model

The review of the hypothesised model reveals that the t -value ($t=2.2$) of the completely standardised coefficient of ITISKCFs \rightarrow SK regression path is significant. The structural model was estimated with two latent variables (ITISKCFs and SK), and one path. The structural equation fit of the endogenous construct is as follows.

- The coefficient of determination R^2 of the SK (regression path: ITISKCFs \rightarrow SK) = 0.21 shows that 21% of the total variance in SK creation activities was accounted for by the ITISKCFs.

(a) Findings of the direct significant relationships

- SK f (ITISKCFs), a positive significant relationship ($beta = 0.45$), was found between ITISKCFs and the SK creation activities. This indicated that knowledge enabling factors supported by information technology infrastructure (ITI) will promote the time spent on sympathised knowledge creation and transfers activities where the activities of this phase of knowledge creation is concentrated on sharing tacit knowledge through shared problem solving activity. This relationship predicts that a direct

relationship between ITISKCFs and the time spent on SK creation activities is accepted at 0.05 significance level.

(b) Findings of the indirect significant relationships

The SEM can be also used to identify any indirect relationship of the model that might be present; the following are two indirect relationships.

➤ Indirect regression path: $SKA \ f(ITISKCFs)$: a positive significant relationship ($\beta = 0.24$) was found between the enabling factors of knowledge creation supported by ITI and the sympathised knowledge acquisition activities (SKA). This implies that ITISKCFs will lead to more time being spent on SKA activities. This indirect relationship is significant at 0.05 significance level.

➤ Indirect regression path: $SKT \ f(ITISKCFs)$: a positive relationship ($\beta = 0.28$) was found between the enabling factors of knowledge creation supported by ITI and the sympathised knowledge transfer activities (SKT). This implies that ITISKCFs will lead to more time being spent on SKT activities. This indirect relationship is significant at 0.05 significance level. The statistics on the direct and indirect relationships are presented in table 6.16.

H1b: ITISKCFs and CK: CK f (ITISKCFs) \rightarrow CK = α ITISKCFs + ϵ

As indicated in the beginning of this section, the measurement model will not be discussed, since both its reliability and goodness of fit was established in the previous chapter.

The results of the SEM

The structural model was estimated with one latent variable (ITISKCFs) and one path. Two cases were identified as multivariate outliers, so they were deleted. As shown in table 6.13, Chi-square value is not significant at 0.05 significance level, ($X^2(5) = 7.2, P = 0.20$), the scaled Chi-square value is also not significant at 0.05 significance level ($S-B X^2(5) = 7.3, P = 0.20$) and all other fit indices indicate that the hypothesised model is acceptable as GFI = 0.97, RMSEA = 0.07, TLI = 0.96, IFI = 0.98, CFI = 0.98, $R^2_{CFI} = 0.98$ and $X^2/df = 1.44$. Therefore, the hypothesised model was accepted and adopted to test the hypotheses for this study. The result of the structural model is displayed in table 6.13. Figure 6.3 shows the SEM diagram for the accepted hypothesised model.

Figure 6.3 Hypothesised model of ITISKCFs supporting CK activities

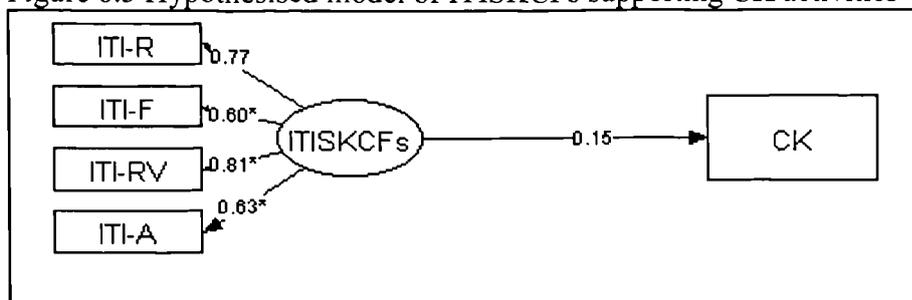


Table 6.13 Goodness of fit for the structural equation model of ITISKCFs supporting CK

| | AFM | | | | IFM | | | | PFM |
|--------------------|----------------|-----------------|------|-------|------|------|------|------------------|-------------|
| | χ^2 | S-B χ^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI | χ^2/df |
| Hypothesised Model | 7.2(5) P=20 | 7.3(5) P=2.0 | 0.97 | 0.07 | 0.96 | 0.98 | 0.98 | 0.98 | 1.44 |

χ^2 , Chi-square; S-B χ^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index; χ^2/df , Normed Chi-square. ($N=100$)

Testing hypothesis and analysis of the structural model

Reviewing the hypothesised model revealed that the t -value ($t=1.38$) of the completely standardised coefficient of ITISKCFs \rightarrow CK regression path is not significant.

Findings of the direct insignificant relationships:

CK f (ITISKCFs): an insignificant relationship ($beta = 0.15$) was found between ITISKCFs and the CK creation activities. This indicates that knowledge enabling factors supported by information technology infrastructure (ITI) will not promote the time spent on conceptual knowledge creation and transfers activities, where activities are focused on creating a concept from new ideas. The statistics on the hypothesised relationship are presented in table 6.16.

H1c: ITISKCFs and SyK: SyK f (ITISKCFs) \rightarrow SyK = α ITISKCFs + ϵ

The result of the SEM

Two cases were identified as a multivariate outlier, so they were deleted. The structural model fit was accepted as Chi-square value is not significant at 0.05 significance level, ($\chi^2 (13) = 18.1, P = 0.15$), the scaled Chi-square value is also not significant at 0.05

significance level ($S-B \chi^2(13) = 17.4, P = 0.18$) and all other fit indices indicated that the hypothesised model was acceptable as $GFI = 0.95, RMSEA = 0.06, TLI = 0.95, IFI = 0.97, CFI = 0.97, R^2CFI = 0.97$ and $\chi^2/df = 1.39$. Therefore, the hypothesised model was accepted as the best model and adopted for testing the hypothesis H1c of this study. The result of the structural model is displayed in table 6.14. Figure 6.4 shows the SEM diagram for the accepted hypothesised model.

Figure 6.4 Hypothesised model of ITISKCFs supporting SyK activities

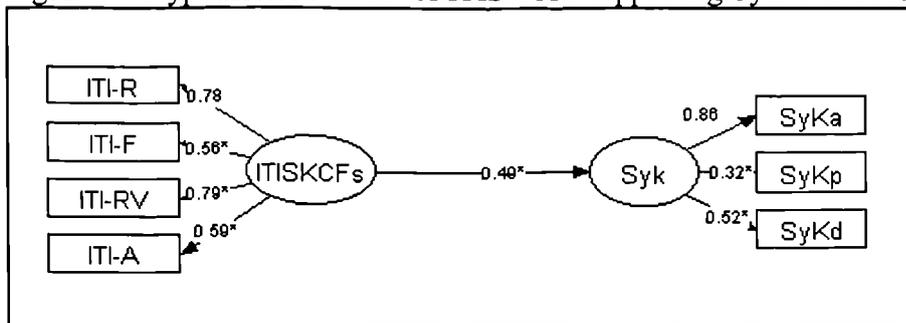


Table 6.14 Goodness of fit for the structural equation model of ITISKCFs supporting SyK

| | AFM | | | | IFM | | | | PFM |
|--------------------|------------------|------------------|------|-------|------|------|------|----------|-------------|
| | χ^2 | $S-B \chi^2$ | GFI | RMSEA | TLI | IFI | CFI | R^2CFI | χ^2/df |
| Hypothesised Model | 18.1(13) P=15 | 17.4(13) P=18 | 0.95 | 0.06 | 0.95 | 0.97 | 0.97 | 0.97 | 1.39 |

χ^2 , Chi-square; $S-B \chi^2$, Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; R^2CFI , Robust comparative fit index; χ^2/df , Normed Chi-square. ($N=100$)

Testing hypothesis and analysis of the structural model

The review of the hypothesised model revealed that the t -value ($t=4.0$) of the completely standardised coefficient of $ITISKCFs \rightarrow SyK$ regression path is significant. The structural

model was estimated with two latent variables (ITISKCFs and SyK) and one path. The structural equation fit of the endogenous construct is as follows.

- The coefficient of determination R^2 of the SyK (regression path: ITISKCFs→SyK) = 0.25 shows that 25% of the total variance in SK creation activities was accounted for by the ITISKCFs.

(a) Findings of the direct significant relationships

- Direct regression path SyK f (ITISKCFs): a positive relationship ($beta = 0.49$) is found between ITISKCFs and the SyK creation activities. This indicates that ITISKCFs will promote the time spent on systemic knowledge creation and transfers activities. This relationship is significant at 0.01 significance level.

(b) Findings of the indirect significant relationships

- Indirect regression path SyKA f (ITISKCFs): a positive relationship ($beta = 0.43$) was found between the ITISKCFs and the systemic knowledge accumulation activities (SyKA). This implies that ITISKCFs will lead to more time being spent on SKA activities. This indirect relationship is significant at 0.01 significance level.
- Indirect regression path: SyKP f (ITISKCFs): a positive relationship ($beta = 0.16$) was found between the ITISKCFs and the systemic knowledge processing activities

(SyKP). This indicates that ITISKCFs will lead to more time being spent on SyKP activities. This indirect relationship is significant at 0.05 significance level.

➤ Indirect regression path SyKD f (ITISKCFs): a positive relationship ($\beta = 0.26$) was found between the ITISKCFs and the systemic knowledge dissemination activities (SyKD). This denotes that ITISKCFs will lead to more time being spent on SyKD activities. This indirect relationship is significant at 0.01 significance level.

The findings of this model revealed that hypothesis H1c which predicts a direct positive relationship between ITISKCFs and SyK creation activities, is supported. The statistics on the hypothesised relationship are presented in table 6.16.

H1d: ITISKCFs and OK: $OK f$ (ITISKCFs) \rightarrow $OK = \alpha$ ITISKCFs + ϵ

The results of the SEM

The structural model was estimated with two latent variables (ITISKCFs and OK) and one regression path. Two cases were identified as multivariate outliers and, hence, they were deleted. As shown in table 6.15, Chi-square value is not significant at 0.05 significance level, ($\chi^2 (9) = 10.8, P = 0.29$), the scaled Chi-square value is also not significant at 0.05 significance level ($S-B \chi^2 (9) = 9.5, P = 0.38$) and all other fit indices indicated that the hypothesised model was acceptable as GFI = 0.96, RMSEA = 0.05, TLI = 0.98, IFI = 0.99, CFI = 0.99, $R^2CFI = 0.99$ and $\chi^2/df = 1.20$. Therefore, the hypothesised model was accepted and adopted for testing the hypothesis H1d of this

study. The result of the structural model is displayed in table 6.15. Figure 6.5 shows the SEM diagram for the accepted hypothesised model.

Figure 6.5 Hypothesised model of ITISKCFs supporting OK activities

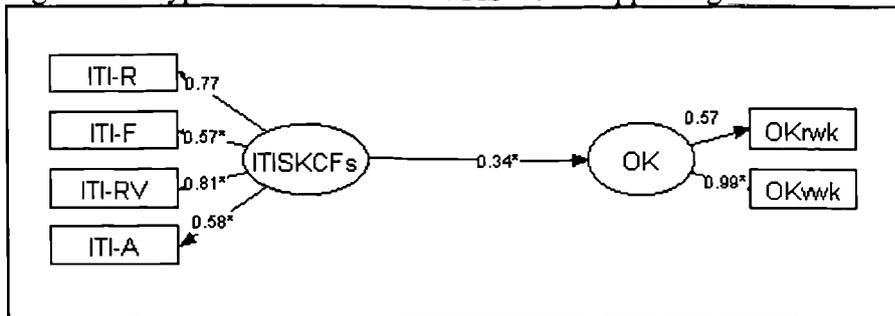


Table 6.15 Goodness of fit for the structural equation model of ITISKCFs supporting OK

| | AFM | | | | IFM | | | | PFM |
|--------------------|-------------------|------------------|------|-------|------|------|------|------------------|-------------|
| | χ^2 | S-B χ^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI | χ^2/df |
| Hypothesised Model | 10.8(9) P=0.29 | 9.5(9) P=0.38 | 0.96 | 0.05 | 0.98 | 0.99 | 0.99 | 0.99 | 1.20 |

χ^2 , Chi-square; S-B χ^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index; χ^2/df , Normed Chi-square. (N=100)

Testing the hypothesis and analysis of the structural model

The review of the hypothesised model revealed that the *t*-value (*t*=2.7) of the completely standardised coefficient of ITISKCFs →OK regression path is significant. The structural model was estimated with two latent variables (ITISKCFs and OK) and one path. The structural equation fit of the endogenous construct is as follows.

- The coefficient of determination R^2 of the OK (regression path: ITISKCFs →OK) = 0.12 shows that 12% of the total variance in OK creation activities was accounted for by the ITISKCFs.

(a) Findings of the direct significant relationships

The review of the hypothesised model revealed that the t -value ($t=2.7$) of the completely standardised coefficient of ITISKCFs →OK regression path is significant. The structural model was estimated with two latent variables (ITISKCFs and OK) and one path.

- OK f (ITISKCFs): a positive significant relationship ($beta = 0.34$) was found between ITISKCFs and the OK creation activities. This indicates that knowledge enabling factors supported by information technology infrastructure (ITI) will promote the time spent on operational knowledge creation and transfers activities where the activities of this phase of knowledge creation is centred around justifying the newly created concept. This relationship is accepted at 0.01 significance level.

(b) Indirect significant relationships

- Indirect regression path: OK-RWK f (ITISKCFs): a positive significant relationship ($beta = 0.20$) was found between the enabling factors of knowledge creation supported by ITI and the operational knowledge-real world knowledge. This implies that ITISKCFs will lead to more time being spent on RWK activities. This indirect relationship is significant at 0.01 significance level.

➤ Indirect regression path OK-VWK f (ITISKCFs): a positive relationship ($\beta = 0.34$) was found between the enabling factors of knowledge creation supported by ITISKCFs and the operational knowledge-virtual world knowledge. This implies that ITISKCFs will lead to more time being spent on VWK activities. This indirect relationship is significant at 0.01 significance level.

The findings of this model revealed that the hypothesis H1d, that predicts a direct positive relationship between ITISKCFs and OK creation activities, is supported. The statistics on the hypothesised relationship are presented in table 6.16.

Table 6.16 Summary of SCs (β), t -value and R^2 of ITISKCFs and OKC

| Regression Path | Standardised coefficient (β) | t -value | R^2 |
|------------------------|--------------------------------------|-------------|-------|
| Direct effect | | | |
| SK = f (ITISKCFs) | 0.45* | 2.2 | 0.21 |
| CK = f (ITISKCFs) | 0.15 ⁺ | <u>1.38</u> | 0.02 |
| SyK = f (ITISKCFs) | 0.49** | 4.0 | 0.25 |
| OK = f (ITISKCFs) | 0.34** | 2.7 | 0.12 |
| Indirect effect | | | |
| SKA = f (ITISKCFs) | 0.24* | 2.2 | N/A |
| SKT = f (ITISKCFs) | 0.28* | 2.5 | N/A |
| SyKA = f (ITISKCFs) | 0.43** | 3.9 | N/A |
| SyKP = f (ITISKCFs) | 0.16* | 2.1 | N/A |
| SyKD = f (ITISKCFs) | 0.26** | 2.6 | N/A |
| OKrkw = f (ITISKCFs) | 0.20** | 2.8 | N/A |
| OKvkw = f (ITISKCFs) | 0.34** | 3.1 | N/A |

**Significant at 0.01 probability level

* Significant at 0.05 probability level

+ Insignificant relationship

6.3.2 Independent construct IKT and dependent OKC constructs

Testing hypotheses H2a to H2d

H2a: IKT and SK: $SK f(IKT) \rightarrow SK = \alpha IKT + \varepsilon$

As indicated in the beginning of the previous section, the measurement model (IKT) will not be discussed, since both its reliability and goodness of fit was established in the previous chapter and the analysis will proceed with the structural model.

The results of the SEM

The structural model was estimated with two latent variables (IKT and SK) and one path. Two cases were identified as multivariate outliers and, hence, they were deleted. As shown in table 6.17 Chi-square value is insignificant at 0.05 significance level, ($\chi^2(8) = 14.0, P = 0.05$), the scaled Chi-square value is also not significant at 0.05 significance level ($S-B \chi^2(9) = 11.6, P = 0.11$) and all other fit indices indicated that the hypothesised model is acceptable as GFI = 0.95, RMSEA = 0.10, TLI = 0.89, IFI = 0.95, CFI = 0.95, $R^2CFI = 0.96$ and $X^2/df = 1.75$. Therefore, the hypothesised model was accepted as the best model. The result of the structural model is displayed in table 6.17. Figure 6.6 shows the SEM diagram for the accepted hypothesised model.

Figure 6.6 Hypothesised model of IKT supporting SK activities

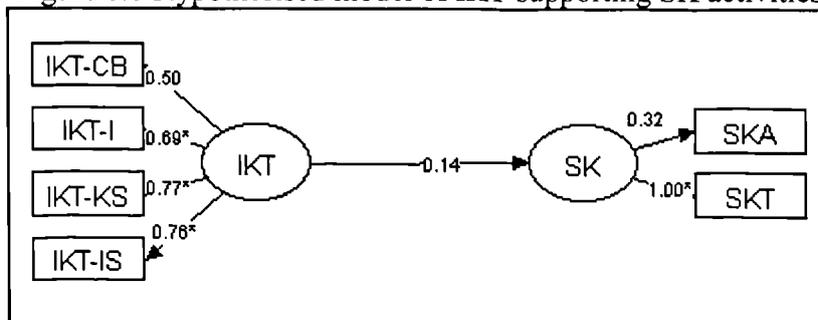


Table 6.17 Goodness of fit for the structural equation model of IKT supporting SK

| | AFM | | | | IFM | | | | PFM |
|--------------------|-------------------|-------------------|------|-------|------|------|------|------------------|-------------|
| | χ^2 | S-B χ^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI | χ^2/df |
| Hypothesised Model | 14.0(8) P=0.05 | 11.6(8) P=0.11 | 0.95 | 0.10 | 0.89 | 0.95 | 0.95 | 0.96 | 1.75 |

χ^2 , Chi-square; S-B χ^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index; χ^2/df , Normed Chi-square. ($N=100$)

Testing of the hypothesis and analysis of the structural model

The review of the hypothesised model revealed that the t -value of the completely standardised coefficient of IKT→SK regression path is insignificant, where t -value = 1.5.

(a) Findings of the direct insignificant relationships:

SK f (IKT): an insignificant relationship ($beta = 0.14$) was found between IKT and the SK creation activities. This indicates that infrastructure of knowledge transfer has no autonomous effects on the time spent on sympathised knowledge transfer activities. The findings of this model revealed that hypothesis H2a, which predicts a direct positive relationship between IKT and SK creation activities, was not supported. The statistics on the hypothesised relationship are presented in table 6.21.

H2b: IKT and CK: CK f (IKT) → CK = α IKT + ε

The results of the SEM

The structural model was estimated with one latent variable (IKT) and one path. Two cases of multivariate outlier were identified and, hence, they were deleted. As shown in table 6.18 Chi-square value is not significant at 0.05 significance level, ($\chi^2 (4) = 8.4, P =$

0.08), the scaled Chi-square value is also not significant at 0.05 significance level ($S-B X^2(4) = 8.8, P = 0.06$) and all other fit indices indicate that the hypothesised model is acceptable as $GFI = 0.97, RMSEA = 0.10, TLI = 0.92, IFI = 0.97, CFI = 0.97, R^2CFI = 0.96$ and $X^2/df = 2.1$. Therefore, the hypothesised model was accepted and adopted to test the hypothesis H2b of this study. The result of the structural model is displayed in table 6.18. Figure 6.7 shows the SEM diagram for the accepted hypothesised model.

Figure 6.7 Hypothesised model of IKT supporting CK activities

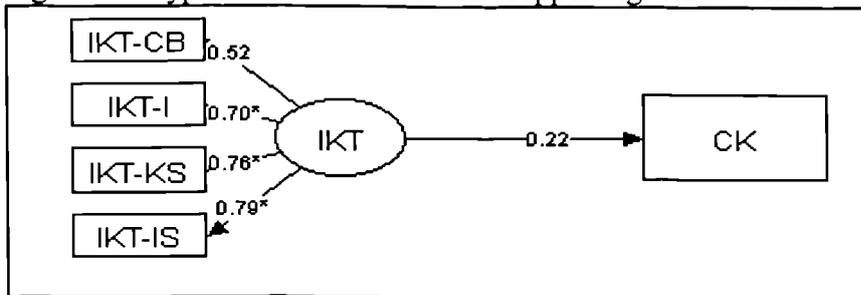


Table 6.18 Goodness of fit for the structural equation model of IKT supporting CK

| | AFM | | | | IFM | | | | PFM |
|--------------------|------------------|------------------|------|-------|------|------|------|----------|----------|
| | X^2 | $S-B X^2$ | GFI | RMSEA | TLI | IFI | CFI | R^2CFI | X^2/df |
| Hypothesised Model | 8.4(4) P=0.08 | 8.8(4) P=0.06 | 0.97 | 0.10 | 0.92 | 0.97 | 0.97 | 0.96 | 2.1 |

X^2 , Chi-square; $S-B X^2$, Scaled $S-B X^2$; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; R^2CFI , Robust comparative fit index; X^2/df , Normed Chi-square. ($N=100$)

Testing of the hypothesis and analysis of the structural model

The review of the hypothesised model revealed that the t -value ($t=1.7$) of the completely standardised coefficient of $IKT \rightarrow CK$ regression path is insignificant.

Findings of the direct insignificant relationships

CK f (IKT): an insignificant relationship ($\beta = 0.22$) was found between IKT and the CK creation activities. This indicates that the elements of IKT have no autonomous effects on the time spent on conceptual knowledge activities. The finding of this model revealed that hypothesis H2a, which predicts a direct positive relationship between IKT and CK creation activities was not supported. The statistics on the hypothesised relationship are presented in table 6.21.

H2c: IKT and SyK: SyK f (IKT) \rightarrow SyK = α IKT + ϵ

The result of the SEM

One case was identified as a multivariate outlier and, hence, it was deleted. The structural model fit accepted as Chi-square value is not significant at 0.05 significance level, ($\chi^2 (13) = 20.9, P = 0.07$), the scaled Chi-square value is also not significant at 0.05 significance level ($S-B \chi^2 (13) = 17.4, P = 0.09$) and all other fit indices indicated that the hypothesised model was accepted as GFI = 0.94, RMSEA = 0.08, TLI = 0.92, IFI = 0.95, CFI = 0.95, $R^2CFI = 0.95$ and $\chi^2/df = 1.61$. Therefore, the hypothesised model is accepted as the best model and adopted for testing hypothesis H2c of this study. The result of the structural model is displayed in table 6.19. Figure 6.8 shows the SEM diagram for the accepted hypothesised model.

Figure 6.8 Hypothesised model of IKT supporting SyK activities

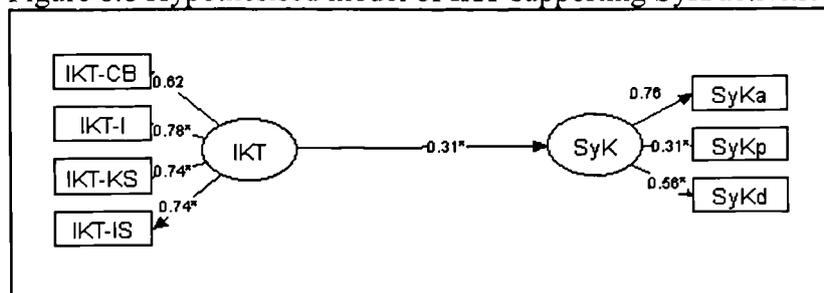


Table 6.19 Goodness of fit for the structural equation model of IKT supporting SyK

| | AFM | | | | IFM | | | | PFM |
|--------------------|--------------------|--------------------|------|-------|------|------|------|------------------|-------------|
| | χ^2 | S-B χ^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI | χ^2/df |
| Hypothesised Model | 20.9(13) P=0.07 | 20.0(13) P=0.09 | 0.94 | 0.08 | 0.92 | 0.95 | 0.95 | 0.95 | 1.61 |

χ^2 , Chi-square; S-B χ^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index; χ^2/df , Normed Chi-square. ($N=101$)

Testing the hypothesis and the analysis of the structural model

The review of the hypothesised model revealed that the t -value of the completely standardised coefficient of IKT \rightarrow SyK regression path is significant, where t -value = 2.17. The structural equation fit of the endogenous construct is as follows.

- The coefficient of determination R^2 of the SyK (regression path: IKT \rightarrow SyK) = 0.10 shows that 10% of the total variance in SyK creation activities was accounted for by IKT.

(a) The results of the direct significant relationships

- Direct regression path SyK f (IKT): a positive relationship ($\beta = 0.31$) was found between IKT and the SyK creation activities. This indicates that IKT will promote

the time spent on systemic knowledge creation and transfers activities. This relationship is significant at 0.05 significance level.

(b) The result of the indirect significant relationships

➤ Indirect regression path SyKA f (IKT): a positive relationship ($beta = 0.24$) was found between the IKT and the systemic knowledge accumulation activities (SyKA). This implies that IKT will lead to more time being spent on SKA activities. This indirect relationship is significant at 0.05 significance level.

➤ Indirect regression path SyKP f (IKT): an insignificant relationship ($beta = 0.10$) was found between the IKT and the systemic knowledge processing activities (SyKP). This indicates that IKT has no effect on the time to be spent on SyKP activities. This indirect relationship is insignificant at 0.05 significance level.

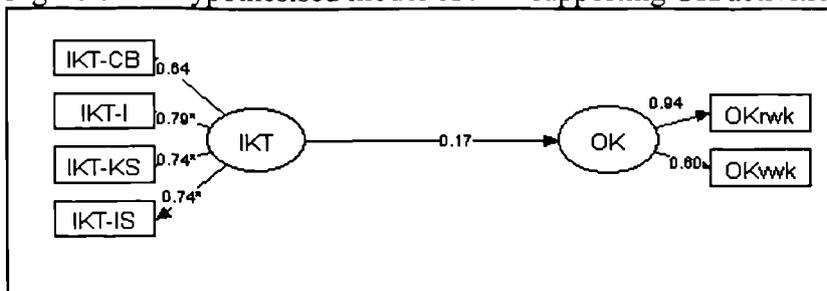
Indirect regression path: SyKD f (IKT): an insignificant relationship ($beta = 0.18$) was found between the IKT and the systemic knowledge dissemination activities (SyKD). This denotes that IKT has no effect on the time to be spent on SyKD activities. This indirect relationship is insignificant at 0.05 significance level. The findings of the direct relationship of this model revealed that hypothesis H2c, which predicts a direct positive relationship between IKT and SyK creation activities, is supported. The statistics on the hypothesised relationship are presented in table 6.21.

H2d: IKT and OK: $OK \sim f(IKT) \rightarrow OK = \alpha IKT + \varepsilon$

The results of the SEM

The review of the hypothesised model (see figure 6.9A) revealed that the t -value of the completely standardised coefficient of IKT→OK regression path is insignificant, where t -value = 1.65. However, the structural model indicates a good fit, as Chi-square value of the hypothesised model is insignificant at 0.05 significance level and all other indices reflect a sound fit (see table 6.20). Utilising the LaGrange Multiplier (LM) as a part of EQS program to identify any possible modification for the hypothesised model revealed that one direct path can be used for modification which was not previously hypothesised. This path is from IKT-KS to OK creation. The new path has the theoretical support (see chapter three); accordingly, this new path was added to the revised model and the insignificant path of IKT to OK was removed.

Figure 6.9A Hypothesised model of IKT supporting OK activities



The revised model was estimated with two latent variables (IKT and OK) and one regression path (IKT-KS→OK). Two cases were identified as multivariate outliers, so they were deleted. As shown in table 6.19, Chi-square value is not significant at 0.05 significance level, ($X^2(7) = 7.6, P = 0.37$) and the same results were found for the scaled

Chi-square. All other fit indices indicated that the revised model is acceptable as GFI = 0.98, RMSEA = 0.03, TLI = 1.00, IFI = 1.00, CFI = 1.00, ^RCFI = 1.00 and $X^2/df = 1.1$. Therefore, the revised model was accepted. The result of the structural model is displayed in table 6.20. Figure 6.9B shows the SEM diagram for the accepted hypothesised model.

Figure 6.9B Revised model of IKT supporting OK activities

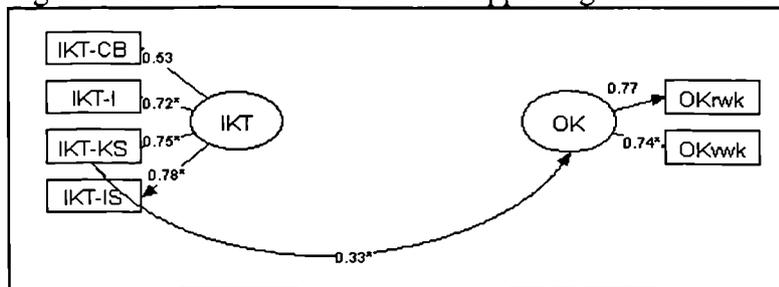


Table 6.20 Goodness of fit for the structural equation model of IKT supporting OK

| | AFM | | | | IFM | | | | PFM |
|--------------------|-------------------|-------------------|------|-------|------|------|------|------------------|-------------|
| | χ^2 | S-B χ^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI | χ^2/df |
| Hypothesised Model | 12.4(7) P=0.09 | 12.8(7) P=0.08 | 0.96 | 0.09 | 0.93 | 0.97 | 0.97 | 0.96 | 1.77 |
| Revised Model | 7.6(7) P=0.37 | 7.6(7) P=0.37 | 0.98 | 0.03 | 1.00 | 1.00 | 1.00 | 1.00 | 1.08 |

χ^2 , Chi-square; S-B χ^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index; χ^2/df , Normed Chi-square. ($N=100$)

Testing the hypothesis and the analysis of the structural model

The review of the revised model (see figure 6.9B) revealed that the t -value of the completely standardised coefficient of IKT→OK regression path is significant, where t -value = 2.7. This relationship is significant at 0.01 significance level. The analysis of the

new direct relationship and the structural equation fit of the endogenous construct are as follows.

- The coefficient of determination R^2 of OK (regression path: IKT-KS \rightarrow OK) = 0.11 shows that 11% of the total variance in OK creation activities was accounted for by IKT-KS.

The results of the direct significant relationships

Direct regression path OK f (IKT-KS): a positive relationship ($beta = 0.33$) was found between IKT and OK-KS creation activities. This indicates that IKT-KS will promote the time spent on systemic knowledge creation and transfers activities. The findings indicated that hypothesis H2d was not completely supported in its original form, yet a new relationship had been identified which indicates that only one element of IKT has a positive effect on OK activities. This relationship is accepted, as it is significant at 0.01 significance level. A summary of the overall statistics on the hypothesised relationships is presented in table 6.21.

Table 6.21 Summary of SCs (*beta*), *t*-value and R² of IKT and OKC

| Regression Path | Standardised coefficient (<i>beta</i>) | <i>t</i> -value | R ² |
|------------------------|--|-----------------|----------------|
| Direct effect | | | |
| SK = <i>f</i> (IKT) | 0.14 ⁺ | <u>1.5</u> | N/A |
| K&S = <i>f</i> (SK) | 0.25* | 2.15 | 0.06 |
| CK = <i>f</i> (IKT) | 0.22 ⁺ | <u>1.69</u> | N/A |
| SyK = <i>f</i> (IKT) | 0.31* | 2.17 | 0.10 |
| OK = <i>f</i> (IKT) | 0.17 ⁺ | <u>1.76</u> | N/A |
| OK = <i>f</i> (K&S) | 0.33* | 2.7 | 0.11 |
| Indirect effect | | | |
| SKA = <i>f</i> (K&S) | 0.08* | 2.04 | N/A |
| SKT = <i>f</i> (K&S) | 0.25* | 2.50 | N/A |
| SyKA = <i>f</i> (IKT) | 0.24* | 2.17 | N/A |
| SyKP = <i>f</i> (IKT) | 0.10 ⁺ | <u>1.64</u> | N/A |
| SyKD = <i>f</i> (IKT) | 0.18 ⁺ | <u>1.86</u> | N/A |
| OKrkw = <i>f</i> (K&S) | 0.26** | 2.6 | N/A |
| OKvkw = <i>f</i> (K&S) | 0.25* | 2.5 | N/A |

** Significant at 0.01 probability level, * Significant at 0.05 probability level, + Insignificant relationship

6.3.3.3 Independent construct CKT and OKC constructs, where these relationships are design to test hypotheses H3a to H3d

H3a: CKT and SK: $SK = f(CKT) \rightarrow SK = \alpha CKT + \varepsilon$

The results of the SEM

The structural model was estimated with two latent variables (CKT, SK) and one path. Two cases were deleted as they are multivariate outliers. As shown in table 6.22 Chi-square value is insignificant at 0.05 significance level, ($X^2(3) = 2.2, P = 0.53$), the scaled Chi-square value is also not significant at 0.05 significance level ($S-B X^2(3) = 2.3, P =$

0.52) and all other fit indices indicate that the revised model is acceptable: GFI = 0.99, RMSEA = 0.03, TLI = 1.00, IFI = 1.00, CFI = 1.00, R^2 CFI = 1.00 and $X^2/df = 0.73$. As a result, the hypothesised model was accepted as the best model. The findings of the structural model are displayed in table 6.22. Figure 6.10 shows the SEM diagram for the accepted hypothesised model.

Figure 6.10 Hypothesised model of CKT supporting SK activities

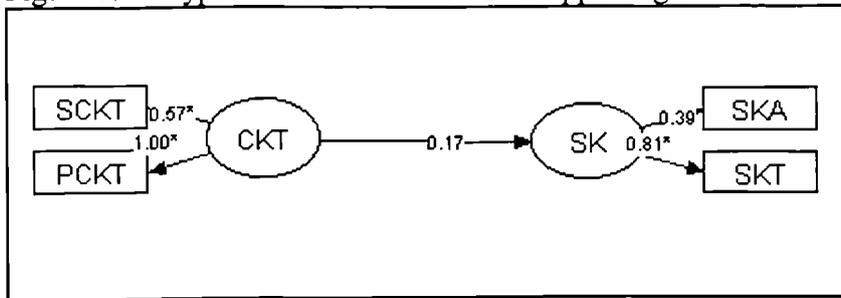


Table 6.22 Goodness of fit for the structural equation model of CKT supporting SK

| | AFM | | | | IFM | | | | PFM |
|--------------------|------------------|------------------|------|-------|------|------|------|-----------|----------|
| | X^2 | S-B X^2 | GFI | RMSEA | TLI | IFI | CFI | R^2 CFI | X^2/df |
| Hypothesised Model | 2.2(2) P=0.53 | 2.3(2) P=0.52 | 0.99 | 0.03 | 1.00 | 1.00 | 1.00 | 1.00 | 0.73 |

X^2 , Chi-square; S-B X^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; R^2 CFI, Robust comparative fit index; X^2/df , Normed Chi-square. ($N=100$)

Testing the hypothesis and the analysis of the structural model

Reviewing the hypothesised model (see figure 6.10) revealed that the t -value of the completely standardised coefficient of CKT→SK regression path is insignificant, where t -value = 1.3.

The results of the direct insignificant relationships:

SK f (CKT): an insignificant relationship ($\beta = 0.17$) was found between CKT and SK creation activities. This indicates that culture of knowledge transfer which is centred around socialisation and conducive management's policy towards encouraging knowledge transfer and, thus, promoting creation activities has no independent effects on the time spent on sympathised knowledge transfer activities. The findings of this model revealed that hypothesis H3a, which predicts a direct positive relationship between CKT and SK creation activities, was not supported. The statistics on the hypothesised relationship are presented in table 6.26.

H3b: CKT and CK: CK f (CKT) \rightarrow CK = α ITISKCFs + ϵ

The results of the SEM

Two cases were identified as multivariate outliers, so they were deleted. The structural model fit was accepted as Chi-square value is not significant at 0.05 significance level, ($\chi^2 (1) = 0.16, P = 0.70$), the scaled Chi-square value is also not significant at 0.05 significance level ($S-B \chi^2 (1) = 0.13, P = 0.72$) and all other fit indices indicated that the hypothesised model is a perfect fit as: GFI = 1.00, RMSEA = 0.00, TLI = 1.00, IFI = 1.00, CFI = 1.00, R^2 CFI = 1.00 and $\chi^2/df = 0.16$. Therefore, the hypothesised model is accepted as the best model and adopted for testing hypothesis H3b of this study. The result of the structural model is displayed in table 6.23. Figure 6.11 shows the SEM diagram for the accepted hypothesised model.

Figure 6.11 Hypothesised model of CKT supporting CK activities

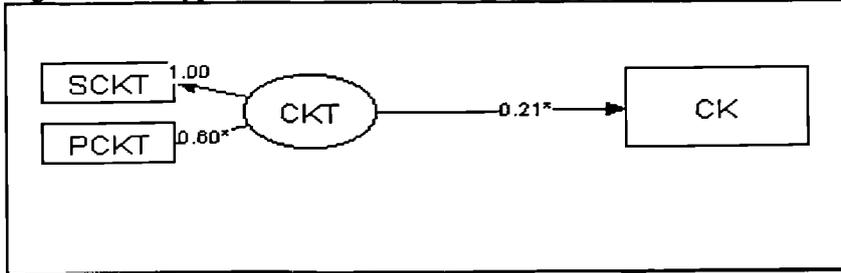


Table 6.23 Goodness of fit for the structural equation model of CKT supporting CK

| | AFM | | | | IFM | | | | PFM |
|--------------------|-------------------|-------------------|------|-------|------|------|------|------------------|-------------|
| | χ^2 | S-B χ^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI | χ^2/df |
| Hypothesised Model | 0.16(1) P=0.70 | 0.13(1) P=0.72 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.16 |

χ^2 , Chi-square; S-B χ^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index; χ^2/df , Normed Chi-square. ($N=100$)

Testing the hypothesis and the analysis of the structural model

The review of the hypothesised model revealed that the t -value ($t=2.2$) of the completely standardised coefficient of CKT→CK regression path is significant. This relationship is significant at 0.05 significance level. The structural equation fit of the endogenous construct is as follows.

- The coefficient of determination R^2 of CK (regression path: CKT→CK) = 0.06 shows that 6% of the total variance in CK creation activities was accounted for by CKT.

Findings of the results of the direct relationship

Direct regression path CK f (CKT): a positive relationship ($beta = 0.21$) was found between CKT and CK creation activities. The findings of this model reveal that hypothesis H3b was supported in its original form. Although the R^2 revealed that the relationship is weak, this relationship is accepted, as it is statistically significant at 0.05 significance level.

H3c: CKT and SyK: SyK f (CKT) \rightarrow SyK = α CKT + ϵ

The results of SEM

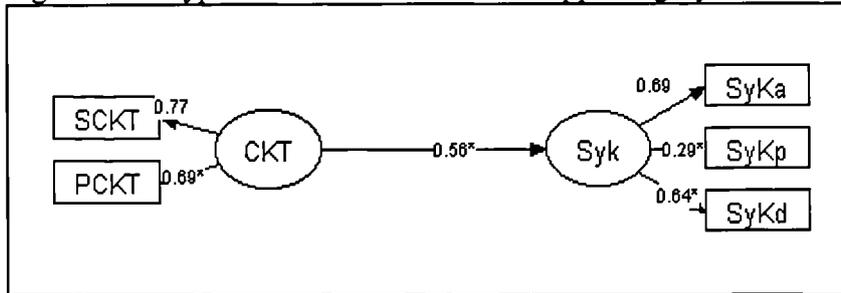
Two cases were identified as multivariate outliers and, hence, they were deleted. The structural model fit was accepted as Chi-square value is not significant at 0.05 significance level, ($\chi^2 (4) = 6.9, P = 0.14$), the scaled Chi-square value is also not significant at 0.05 significance level ($S-B \chi^2 (4) = 6.6, P = 0.16$) and all other fit indices indicated that the hypothesised model is acceptable as GFI = 0.97, RMSEA = 0.08, TLI = 0.90, IFI = 0.96, CFI = 0.96, R^2 CFI = 0.96 and $\chi^2/df = 1.73$. Therefore, the hypothesised model is accepted as the best model and adopted for testing hypothesis H3c of this study. The result of the structural model is displayed in table 6.24. Figure 6.12 shows the SEM diagram for the accepted hypothesised model.

Table 6.24 Goodness of fit for the structural equation model of CKT supporting SyK

| | AFM | | | | IFM | | | | PFM |
|--------------------|------------------|------------------|------|-------|------|------|------|-----------|-------------|
| | χ^2 | $S-B \chi^2$ | GFI | RMSEA | TLI | IFI | CFI | R^2 CFI | χ^2/df |
| Hypothesised Model | 6.9(4) P=0.14 | 6.6(4) P=0.16 | 0.97 | 0.08 | 0.90 | 0.96 | 0.96 | 0.96 | 1.73 |

χ^2 , Chi-square; S-B χ^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; R^2 CFI, Robust comparative fit index; χ^2/df , Normed Chi-square. ($N=100$)

Figure 6.12 Hypothesised model of CKT supporting SyK activities



Testing of the hypothesis and analysis of the structural model

The review of the hypothesised model revealed that the t -value ($t=2.9$) of the completely standardised coefficient of CKT \rightarrow SyK regression path is significant. This relationship is significant at 0.01 significance level. The structural equation fit of the endogenous construct is as follows.

- The coefficient of determination R^2 of the SyK (regression path: CKT \rightarrow SyK) = 0.32 shows that 32% of the total variance in SK creation activities was accounted for by CKT.

(a) Findings of the direct significant relationships

- Direct regression path SyK f (CKT): a positive relationship ($\beta = 0.56$) was found between CKT and SyK creation activities. This indicates that those CKT elements, socialisation and management policy on knowledge creation, will support the time spent on systemic knowledge creation activities.

(b) Findings of the indirect significant relationships

- Indirect regression path SyKA f (CKT): a positive relationship ($\beta = 0.39$) was found between CKT and systemic knowledge accumulation activities (SyKA). This implies that CKT will cause more time to be spent on SyKA activities. This indirect relationship is significant at 0.01 significance level.

- Indirect regression path SyKP f (CKT): an insignificant relationship ($\beta = 0.17$) was found between the CKT and systemic knowledge processing activities (SyKP). This indicates that CKT has no effect on the time spent on SyKP activities. This indirect relationship is insignificant at 0.05 significance level.

- Indirect regression path SyKD f (CKT): a significant relationship ($\beta = 0.36$) was found between the CKT and systemic knowledge dissemination activities (SyKD). This denotes that CKT will cause more time to be spent on SyKD activities. This indirect relationship is significant at 0.01 significance level.

The findings of this model revealed that hypothesis H3c, which predicts a direct positive relationship between CKT and SyK creation activities, is supported; the statistics on the hypothesised relationship are presented in table 6.26.

H3d: CKT and OK: $OK f(CKT) \rightarrow OK = \alpha ITISKCFs + \varepsilon$

The results of SEM

The hypothesised model was estimated with two latent variables (CKT and OK) and one regression path (CKT→OK). One case was identified as a multivariate outlier, so it was deleted. As shown in table 6.15, Chi-square value is not significant at 0.05 significance level, ($X^2(1) = 0.77, P = 0.38$) and the same result were found for the scaled Chi-square. All other fit indices indicated that the revised model is accepted as GFI = 0.99, RMSEA = 0.00, TLI = 1.00, IFI = 1.00, CFI = 1.00, ^RCFI = 1.00 and $X^2/df = 0.77$. Therefore, the hypothesised model was accepted. Figure 6.13 shows the SEM diagram for the accepted hypothesised model.

Figure 6.13 Hypothesised model of CKT supporting OK activities

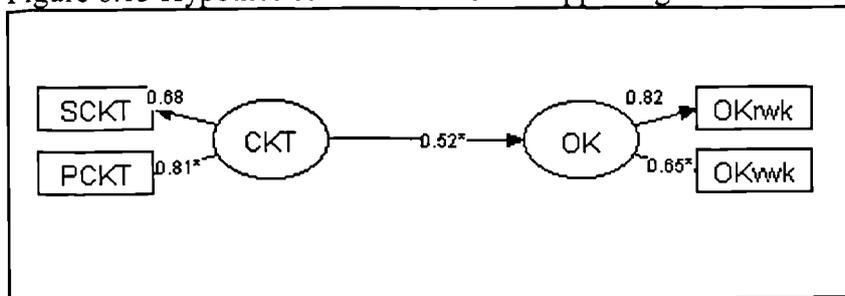


Table 6.25 Goodness of fit for the structural equation model of CKT supporting OK

| | AFM | | | | IFM | | | | PFM |
|--------------------|-------------------|-------------------|------|-------|------|------|------|------------------|----------|
| | X^2 | S-B X^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI | X^2/df |
| Hypothesised Model | 0.77(1) P=0.38 | 0.77(1) P=0.38 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.77 |

X^2 , Chi-square; S-B X^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index; X^2/df , Normed Chi-square. (N=101)

Testing of the hypothesis and analysis of the structural model

The review of the hypothesised model revealed that the t -value ($t=3.4$) of the completely standardised coefficient of CKT→OK regression path is significant. This relationship is significant at 0.01 significance level. The structural equation fit of the endogenous construct is as follows.

- The coefficient of determination R^2 of OK (regression path: CKT→OK) = 0.27 shows that 27% of the total variance in OK creation activities was accounted for by the CKT.

(a) Findings of the direct significant relationships

- OK f (CKT): a positive significant relationship ($beta = 0.52$) was found between CKT and OK creation activities. This indicates that those CKT elements, socialisation and management policy, will promote the time spent on operational knowledge creation activities. This relationship is accepted at 0.01 significance level.

(b) Findings of the indirect significant relationships

- Indirect regression path OK-RWK f (CKT): a positive significant relationship ($beta = 0.42$) is found between CKT and operational knowledge (real world knowledge). This implies that CKT will lead to more time being spent on RWK activities. This indirect relationship is significant at 0.01 significance level.

➤ Indirect regression path OK-VWK $f(\text{CKT})$: a positive relationship ($\beta = 0.33$) was found between CKT and the operational knowledge (virtual world knowledge). This implies that CKT will lead to more time being spent on VWK activities. This indirect relationship is significant at 0.01 significance level.

The findings of this model revealed that hypothesis H3d, which predicts a direct positive relationship between CKT and OK creation activities, is completely supported.

Table 6.26 Summary of SCs (β), t -value and R^2 of CKT and OKC

| Regression Path | Standardised coefficient (β) | t -value | R^2 |
|-------------------------------------|--------------------------------------|-------------|-------|
| Direct effect | | | |
| SK = $f(\text{CKT})$ | 0.17 ⁺ | <u>1.3</u> | N/A |
| CK = $f(\text{CKT})$ | 0.21* | 2.2 | 0.05 |
| SyK = $f(\text{CKT})$ | 0.56** | 2.9 | 0.32 |
| OK = $f(\text{CKT})$ | 0.52** | 3.4 | 0.27 |
| Indirect effect | | | |
| SyKA = $f(\text{CKT})$ | 0.39** | 2.9 | N/A |
| SyKP = $f(\text{CKT})$ | 0.17 ⁺ | <u>1.95</u> | N/A |
| SyKD = $f(\text{CKT})$ | 0.36** | 2.8 | N/A |
| OK _{rwk} = $f(\text{CKT})$ | 0.42** | 3.4 | N/A |
| OK _{vwk} = $f(\text{CKT})$ | 0.33** | 2.8 | N/A |

**Significant at 0.01 probability level, *Significant at 0.05 probability level, + Insignificant relationship

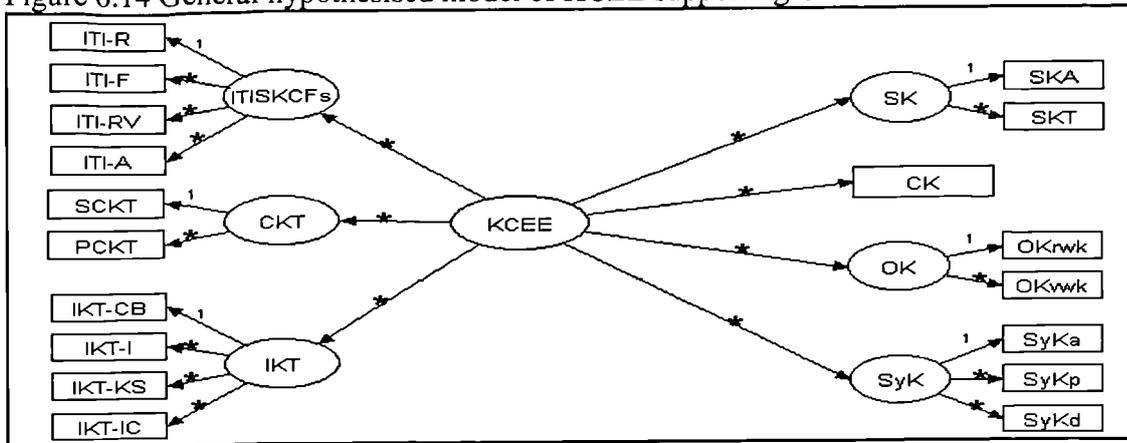
6.4 Structural equation models: macro-analysis (the shared effect)

6.4.1 Hypothesised model of KCEE supporting time spent on OKC activities

Based on the theoretical development of the proposed model as discussed in chapter three, a general hypothetical model (figure 6.14) was designed for a better understanding of the shared effect of role of ITISKCFs, IKT and CKT as integrated elements that represent a knowledge creation enabling environment (KCEE) on the time spent on organisational knowledge creation activities (OKC) activities. As indicated, the proposed KCEE consists of three major constructs: information technology infrastructure supporting knowledge creation factors (ITISKCFs), culture of knowledge transfer (CKT) and infrastructure for knowledge transfer (IKT).

Due to the limitation of the sample size and the model complexity, the summated scale technique (Hair et. al., 1998) was used to reduce the number of variables. The new variables of this model in each of the seven constructs were products of the summated scale technique (see previous chapter). The general hypothesised model consists of eighteen summated variables and seven latent variables (the square represents a summated variable, and the circle represents the latent variable). The strategies for operationalisation and measurement of the model variables were thoroughly discussed in chapter five.

Figure 6.14 General hypothesised model of KCEE supporting OKC



Due to the model complexity and the limitations of the sample size, and as recommended by Hair et al., (1998), the model size required at least a minimum of five observations for each estimated parameter. Thus, the general hypothesised model shown in figure 6.14 was divided into four sub-models, where every type of organisational knowledge creation (the dependent variable; SK, CK, SyK, and OK) is placed separately, each in a single sub-model, maintaining the independent variables in all of the four sub-models (see figures 6.15 to 6.20)

6.4.1.1 Analysis and results of the first model of KCEE supporting SK

Hypothesis (H4): KCEE and SK: $SK f(KCEE) \rightarrow SK = \alpha KCEE + \varepsilon$

The measurement model

Before examining the relation of the selected KCEE traits to OKC, the researcher tested a variety of measurement models of KCEE traits. The researcher specifically compared (a) one-factor model, in which the indicators of all the enablers traits all loaded on one factor, (b) a group factor model, in which indicators for the enablers traits loaded on specific traits factors, where the latter were correlated with each other and, (c) a higher-order factor

model, in which indicators for the enablers traits loaded on specific trait factors and the latter all loaded on a single higher-order factor. Overall fit was evaluated and the higher-order factor model had the best fit, so it was chosen to represent KCEE (comparison of the three measurement models and the overall fit evaluation is presented in Appendix D).

A CFA of the best-fit measurement model was carried out to make sure that the indicators were reliable. Two cases were identified as multivariate outliers, so they were deleted. The Chi-square statistic was 41.01 with 33 degree of freedom and ($P=0.16$), the scaled Chi-square statistic was 36.87 with 33 degree of freedom and ($P=0.29$). All indexes exceeded the recommended acceptance level (see Hair, 1998, p. 654-661), as the goodness of fit measures were 0.93 and 0.05 for GFI and RMSEA, respectively, CFI = 0.98, CFI^R = 0.99, TLI = 0.97, IFI = 0.98 and the normed $\chi^2 = 1.24$. All standardised coefficients (SCs) of the first-order and the higher-order were significant at 0.05 significance level. The overall model fit measures showed that the model is a good fit. Other findings of the measurement model revealed that KCEE explains 96% the total variance in CKT (the latent variable), 0.58% of the total variance of IKT (the latent variable) and explains 12% of the total variance of ITISKCFs (the latent variable).

The composite reliability was used to assess the internal consistency for the latent variables: ITISKCFs, CKT and IKT, and for the exogenous construct KCEE. The composite reliability was 0.79, 0.73, 0.81 and 0.77, respectively, adding these measures to the measures of the goodness of fit indices suggests the existence of an indicative

convergent validity. Figure 6.15 shows the CFA path diagram of the measurement model and table 6.27 show the results of the measurement model.

Figure 6.15 Higher order CFA path diagram of the measurement model

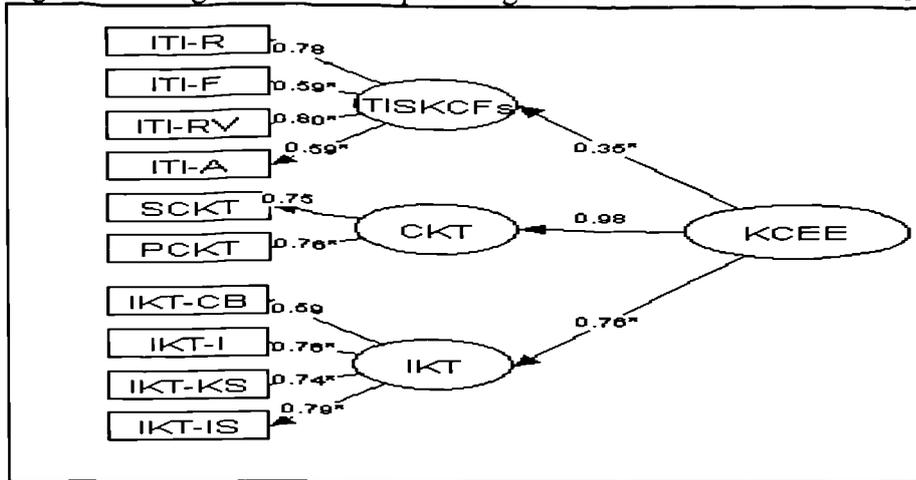


Table 6.27 Standardised loadings, t -value and R^2 results of the measurement model

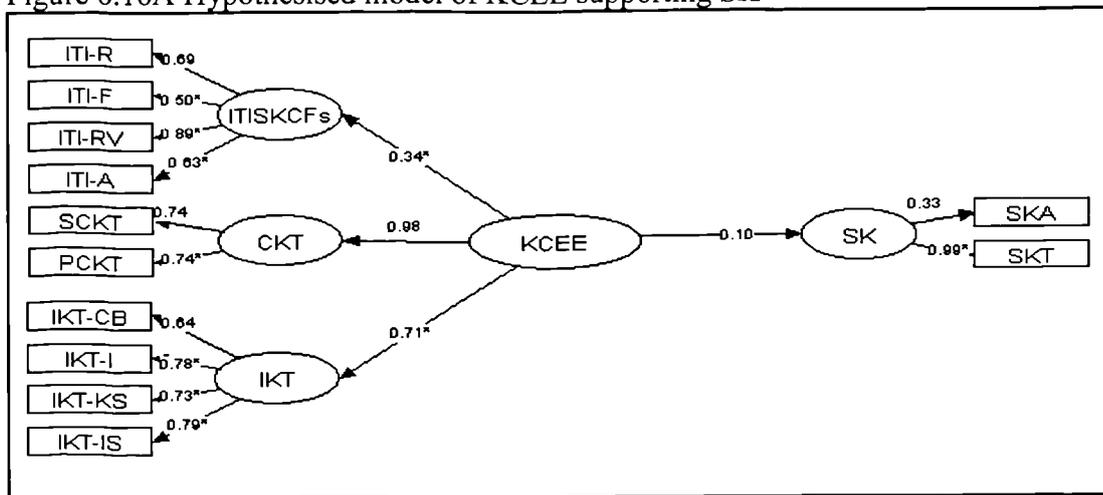
| Indicator | SCs (α) | T-value | R^2 |
|--------------------------|------------------|---------|-------|
| $ITISKCFs = f(KCEE)^H$ | 0.35** | N/A | 0.12 |
| $CKT = f(KCEE)^H$ | 0.98** | 2.0 | 0.96 |
| $IKT = f(KCEE)^H$ | 0.76* | 3.69 | 0.58 |
| $ITI-R = f(ITISKCFs)^F$ | 0.78* | N/A | 0.61 |
| $ITI-F = f(ITISKCFs)^F$ | 0.59* | 5.7 | 0.35 |
| $ITI-RV = f(ITISKCFs)^F$ | 0.80* | 7.0 | 0.64 |
| $ITI-A = f(ITISKCFs)^F$ | 0.66* | 5.0 | 0.34 |
| $IKT-CB = f(I)^F$ | 0.59* | N/A | 0.35 |
| $IKT-I = f(I)^F$ | 0.72* | 5.23 | 0.58 |
| $IKT-KS = f(I)^F$ | 0.74* | 4.49 | 0.55 |
| $IKT-IS = f(I)^F$ | 0.79* | 4.93 | 0.62 |
| $PCKT = f(CKT)^F$ | 0.76* | 5.76 | 0.58 |
| $SCKT = f(CKT)^F$ | 0.75* | N/A | 0.56 |

* Significant at 0.01 level, ** Significant at 0.05 level, ^F: first-order CFA, ^H: Higher-order CFA

The results of the structural equation model

The review of the hypothesised model (see figure 6.16A) revealed that the t -value of the completely standardised coefficient of KCEE→SK regression path is insignificant, where t -value = 0.77. However, the Chi-square value of the hypothesised model is significant at 0.05 significance level (see table 6.28), which indicated that the hypothesised model could be improved. Utilising the LaGrange Multiplier (LM) as a part of EQS 5.7 program to identify modification indices reveals two direct paths for modification (see appendix E) previously hypothesised: the first path was from ITISKCFs to SK creation and the second path was from SK to IKT-KS. The two new paths have the theoretical support (see chapter three); accordingly, the two new paths were added to the revised model and the insignificant path of KCEE to SK was removed.

Figure 6.16A Hypothesised model of KCEE supporting SK



Finally, the revised model was estimated with five latent variables and five paths. The addition of the new two paths has improved the model fit. As shown in table 6.28, Chi-square value is not significant at 0.05 significance level, ($\chi^2(50) = 53.6, P = 0.34$), the

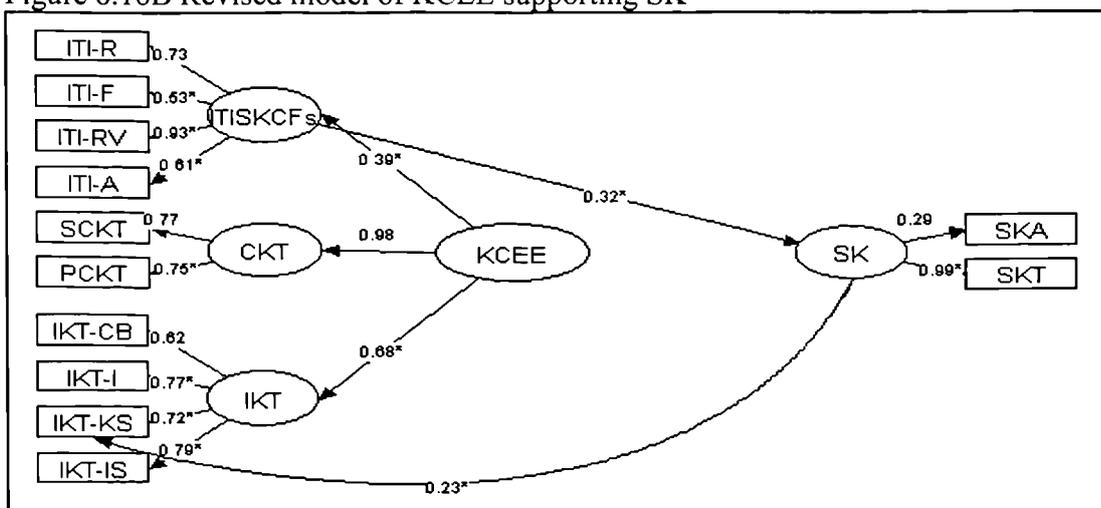
scaled Chi-square value is also not significant at 0.05 significance level ($S-B \chi^2(50) = 51.1, P = 0.43$) and all other fit indices indicated that the revised model is acceptable as $GFI = 0.92, RMSEA = 0.03, TLI = 0.99, IFI = 0.99, CFI = 0.99, RCFI = 1.00$ and $\chi^2/df = 1.1$. Therefore, the revised model is accepted as the best model and adopted to test the hypotheses for this study. Figure 6.16B shows the accepted model with the two added new paths. The result of the structural model is displayed in tables 6.28 and 6.29. Figure 6.16B shows the SEM diagram for the accepted revised model.

Table 6.28 Goodness of fit for the structural equation model of KCEE supporting SK

| | AFM | | | | IFM | | | | PFM |
|--------------------|--------------------|--------------------|------|-------|------|------|------|----------|-------------|
| | χ^2 | $S-B \chi^2$ | GFI | RMSEA | TLI | IFI | CFI | R^2CFI | χ^2/df |
| Hypothesised Model | 77.4(52) P=0.01 | 73.6(52) P=0.03 | 0.89 | 0.07 | 0.91 | 0.93 | 0.93 | 0.93 | 1.49 |
| Revised Model | 53.6(50) P=0.34 | 51.1(50) P=0.43 | 0.92 | 0.03 | 0.99 | 0.99 | 0.99 | 1.00 | 1.1 |

χ^2 , Chi-square; $S-B \chi^2$, Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; R^2CFI , Robust comparative fit index; χ^2/df , Normed Chi-square. ($N=100$)

Figure 6.16B Revised model of KCEE supporting SK



Testing the hypothesis and analysis of the structural model

The review of the revised model (see figure 6.16B) revealed that the t -value of the completely standardised coefficient of ITISKCFs \rightarrow SK regression path is significant, where t -value = 2.1. The t -value of the completely standardised coefficient of SK \rightarrow IKT-KS regression path is also significant where t -value = 2.4. The structural equation fit of the endogenous construct is as follows.

- The coefficient of determination R^2 of SK (regression path: ITISKCFs \rightarrow SK) = 0.09 shows that 9% of the total variance in SK creation activities was accounted for by ITISKCFs.

(a) Findings of the direct significant relationships

- ITISKCFs construct SK f (ITISKCFs): a positive relationship ($beta = 0.32$) was found between ITISKCFs and SK creation activities. This relationship will not be discussed as it has been explained in H1a. The interesting findings from this model are that the magnitude of impact of ITISKCFs on SK has been reduced in this model of shared effects as compared to the dependent effect of ITISKCFs on SK alone (see H1a). However, this relationship is significant on 0.05 significance level and, hence, it was accepted.
- IKT-KS f (SK) a positive relationship ($beta = 0.23$) was found between the time spent on SK creation activities and the individual knowledge and skills. This

unhypothesised relationship, which predicts the direct relationship between SK and IKT-KS, is accepted at 0.05 significance level.

Table 6.29 Standardised coefficients, *t*-value and R² of the KCEE-SK model

| Regression Path | Standardised coefficient | <i>t</i> -value | R ² |
|--------------------------|--------------------------|-----------------|----------------|
| Direct effect | | | |
| SK = <i>f</i> (ITISKCFs) | 0.32* | 2.1 | 0.09 |
| IKT-KS = <i>f</i> (SK) | 0.23* | 2.40 | N/A |

*Significant at 0.05 probability level

6.4.1.2 Analysis and results of the second model of KCEE supporting CK

Hypothesis (H5): KCEE and CK: $CK = f(KCEE) \rightarrow CK = \alpha KCEE + \varepsilon$

Discussion of the measurement model will not be included in this section or the following ones since it has been thoroughly explained in the previous section. The only difference between the remaining three models and the previous one is that only the dependent variable is altered with a new construct representing the remaining three types of organisational knowledge creation. The analysis for the remaining models will start with structural model findings.

The results of the structural equation model

The structural model fit was accepted, as Chi-square value is not significant at 0.05 significance level, ($\chi^2(41) = 47.8, P = 0.22$), the scaled Chi-square value is also not

significant at 0.05 significance level ($S-B X^2(41) = 44.0, P = 0.33$) and all other fit indices indicated that the revised model is acceptable: GFI = 0.92, RMSEA = 0.04, TLI = 0.97, IFI = 0.98, CFI = 0.98, $R^2CFI = 0.99$ and $X^2/df = 1.17$. Therefore, the hypothesised model is accepted as the best model and adapted for testing hypothesis H4 of this study. The result of the structural model is displayed in table 6.30A and 6.30B. Figure 6.17 shows the SEM diagram for the accepted model.

Figure 6.17 Accepted hypothesised model of KCEE supporting CK

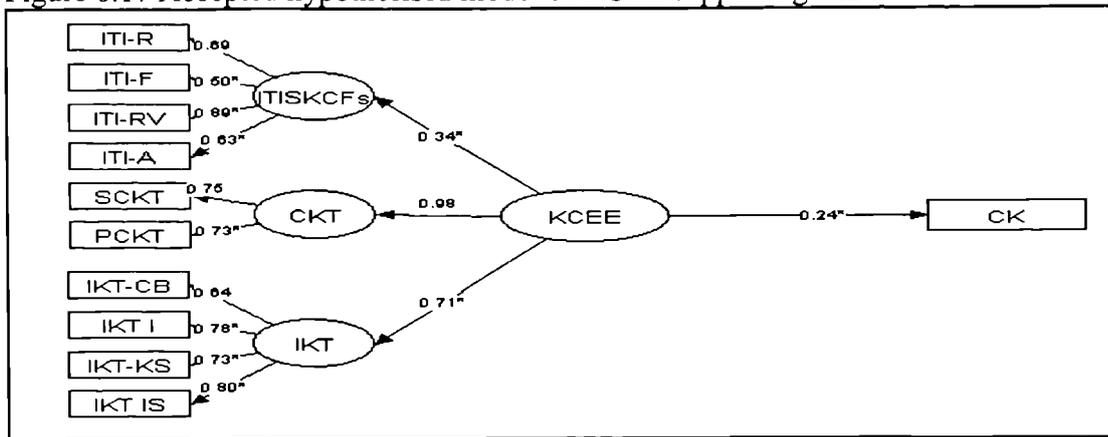


Table 6.30A Goodness of fit for the structural equation model of KCEE supporting CK

| | AFM | | | | IFM | | | | PFM |
|--------------------|---------------------|---------------------|------|-------|------|------|------|----------|----------|
| | X^2 | $S-B X^2$ | GFI | RMSEA | TLI | IFI | CFI | R^2CFI | X^2/df |
| Hypothesised Model | 47.8 (41) P=0.22 | 44.0 (41) P=0.33 | 0.92 | 0.04 | 0.97 | 0.98 | 0.98 | 0.99 | 1.17 |

X^2 , Chi-square; $S-B X^2$, Scaled $S-B$ Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; R^2CFI , Robust comparative fit index; X^2/df , Normed Chi-square. ($N=100$)

Testing the hypothesis and analysis of the structural model

The review of the hypothesised model (see figure 6.17) revealed that the t -value of the completely standardised coefficient of KCEE \rightarrow CK regression path is significant, where t -value = 2.0. The structural equation fit of the endogenous construct is as follow.

- The coefficient of determination R^2 of CK (regression path: KCEE \rightarrow CK) = 0.06 shows that only 6% of the total variance in CK creation activities was accounted for by KCEE.

Findings of the direct significant relationships

- CK f (KCEE): a positive relationship ($beta = 0.24$) was found between KCEE and CK creation activities. This implies that the knowledge-enabled environment supported by the three-knowledge creation enabling constructs, ITISKCFs, CKT and IKT, will promote the time spent on conceptual knowledge creation and transfer activities. The findings of the accepted hypothesised model (see figure 6.17) revealed that KCEE \rightarrow CK regression path is significant and, hence, H5 which predicts a direct relationship between KCEE and the time spend on CK creation activities is accepted at 0.05 significance level.

Table 6.30B Standardised coefficients, t -value and R^2 of the KCEE-CK model

| Regression Path | Standardised coefficient | t -value | R^2 |
|----------------------|--------------------------|------------|-------|
| Direct effect | | | |
| CK = f (KCEE) | 0.24* | 2.00 | 0.06 |

* Significant at 0.05 probability level

6.4.1.3 Analysis and results of the third model of KCEE supporting SyK

Hypothesis (H6): KCEE and SyK: $SyK f(KCEE) \rightarrow SyK = \alpha KCEE + \varepsilon$

The results of the structural equation model

The structural model fit was accepted, as Chi-square value is not significant at 0.05 significance level, ($X^2 (60) = 71.9, P = 0.16$), the scaled Chi-square value is also not significant at 0.05 significance level ($S-B X^2 (60) = 67.6, P = 0.26$) and all other fit indices indicated that the revised model is acceptable: GFI = 0.90, RMSEA = 0.04, TLI = 0.96, IFI = 0.97, CFI = 0.97, $R^2CFI = 0.98$ and $X^2/df = 1.20$. Therefore, the hypothesised model is accepted as the best model and adopted for testing hypothesis H6 of this study. The result of the structural model is displayed in tables 6.31A and 6.31B. Figure 6.18 shows the SEM diagram for the accepted hypothesised model.

Figure 6.18 Accepted hypothesised model of KCEE supporting SyK

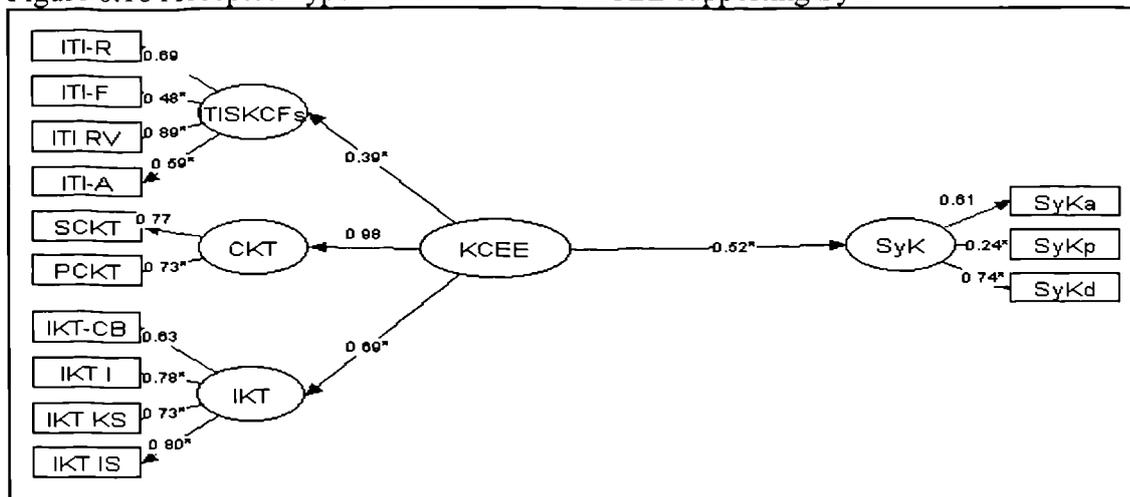


Table 6.31A Goodness of fit for the structural equation model of KCEE supporting SyK

| | AFM | | | | IFM | | | | PFM |
|--------------------|---------------------|---------------------|----------|-------|------|------|------|------------------|-------------|
| | χ^2 | S-B χ^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI | χ^2/df |
| Hypothesised Model | 71.9 (60) P=0.16 | 67.6 (60) P=0.26 | 0.9 0 | 0.04 | 0.96 | 0.96 | 0.97 | 0.98 | 1.20 |

χ^2 , Chi-square; S-B χ^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index; χ^2/df , Normed Chi-square. ($N=100$)

Testing the hypothesis and analysis of the structural model

The review of the hypothesised model (see figure 6.18) revealed that the t -value of the completely standardised coefficient of KCEE \rightarrow SyK regression path is significant, where t -value = 2.9. The structural equation fit of the endogenous construct is as follows.

- The coefficient of determination R^2 of SyK (regression path: KCEE \rightarrow SyK) = 0.27 shows that 27% of the total variance in SyK creation activities was accounted for by KCEE.

Findings of the direct significant relationships

- Direct regression path SyK f (KCEE): a positive relationship ($beta = 0.52$) was found between KCEE and SyK creation activities. This indicates that knowledge enabling environment will promote the time spent on systemic knowledge creation and transfer activities. The findings of the accepted hypothesised model revealed that the KCEE \rightarrow SyK regression path is significant and, hence, H6 which predicts a direct relationship between KCEE and the time spend on SyK creation activities, is accepted at 0.05 significance level.

Table 6.31B Standardised coefficients, *t*-value and R² of the KCEE-SyK model

| Regression Path | Standardised coefficient | <i>t</i> -value | R ² |
|-----------------------|--------------------------|-----------------|----------------|
| Direct effect | | | |
| SyK = <i>f</i> (KCEE) | 0.52* | 2.29 | 0.27 |

*Significant at 0.05 probability level

6.4.1.4 Analysis and results of the fourth model of KCEE supporting OK

Hypothesis (H7): KCEE and OK: $OK = f(KCEE) \rightarrow OK = \alpha KCEE + \varepsilon$

The results of the structural equation model

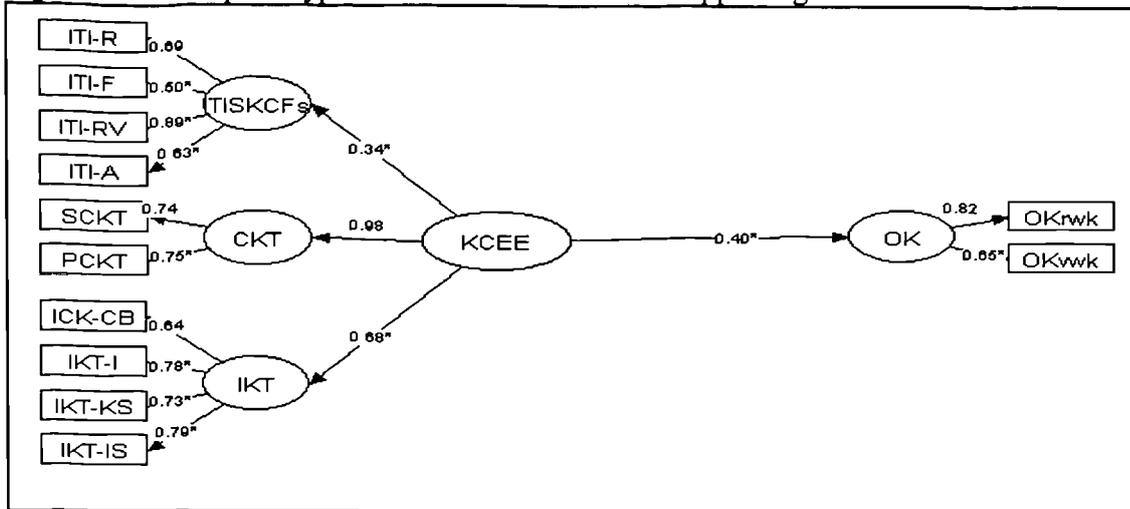
The structural model fit was accepted, as Chi-square value is not significant at 0.05 significance level, ($\chi^2 (50) = 61.3, P = 0.13$), the scaled Chi-square value is also not significant at 0.05 significance level (*S-B* $\chi^2 (50) = 56.6, P = 0.24$) and all other fit indices indicated that the revised model is acceptable as GFI = 0.91, RMSEA = 0.05, TLI = 0.96, IFI = 0.97, CFI = 0.97, ^RCFI = 0.98 and $\chi^2/df = 1.20$. Therefore, the hypothesised model is accepted as the best model and adopted for testing hypothesis H7 of this study. The result of the structural model is displayed in tables 6.32A and 6.32B. Figure 6.19 shows the SEM diagram for the accepted hypothesised model.

Table 6.32A Goodness of fit for the structural equation model of KCEE supporting OK

| | AFM | | | | IFM | | | | PFM |
|--------------------|---------------------|---------------------|------|-------|------|------|------|------------------|-------------|
| | χ^2 | <i>S-B</i> χ^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI | χ^2/df |
| Hypothesised Model | 61.3 (50) P=0.13 | 56.6 (50) P=0.24 | 0.91 | 0.05 | 0.96 | 0.97 | 0.97 | 0.98 | 1.23 |

χ^2 , Chi-square; *S-B* χ^2 , Scaled *S-B* Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index; χ^2/df , Normed Chi-square. (*N*=100)

Figure 6.19 Accepted hypothesised model of KCEE supporting OK



Testing the hypothesis and analysis of the structural model

The review of the hypothesised model (see figure 6.19) revealed that the t -value of the completely standardised coefficient of KCEE \rightarrow OK regression path is significant, where t -value = 2.44. The structural equation fit of the endogenous construct is as follows.

- The coefficient of determination R^2 of the OK (regression path: KCEE \rightarrow OK) = 0.16 shows that 16% of the total variance in OK creation activities was accounted for by KCEE.

Findings of the direct significant relationships

- Direct regression path OK f (KCEE): a positive relationship ($\beta = 0.40$) was found between KCEE and OK creation activities. This indicates that knowledge creation enabling environment, ITISKCFs, CKT and IKT, will encourage the time spent on

operational knowledge creation and transfer activities. The findings of the accepted hypothesised model revealed that the KCEE →OK regression path is significant thus, H7, which predicts a direct relationship between KCEE and the time spend on OK creation activities, is accepted at 0.05 significance level.

Table 6.32B Standardised coefficients, *t*-value and R² of the KCEE-OK model

| Regression Path | Standardised coefficient | <i>t</i> -value | R ² |
|----------------------|--------------------------|-----------------|----------------|
| Direct effect | | | |
| OK = <i>f</i> (KCEE) | 0.40* | 2.44 | 0.16 |

* Significant at 0.05 probability level

6.5 Summary

Frequency and descriptive statistics were used to examine the characteristics of the research sample. The mean statistics revealed that, on average, the respondents agreed on the role of information technology supporting the knowledge creation factors. The respondents agreed on the existence of infrastructure for knowledge transfer in their organisation. The respondents also revealed that both the culture of knowledge transfer and the knowledge creation activities are practised moderately.

The *t*-test and the Mann Whitney U test were used to investigate if there is a difference between the two groups (banks and building societies) of the research sample. The two tests revealed no difference for most the research constructs except for ITISKCFs construct (ITI-R, ITI-F, ITI-RV, ITI-A) and IKT-KS of the IKT construct and SCKT of

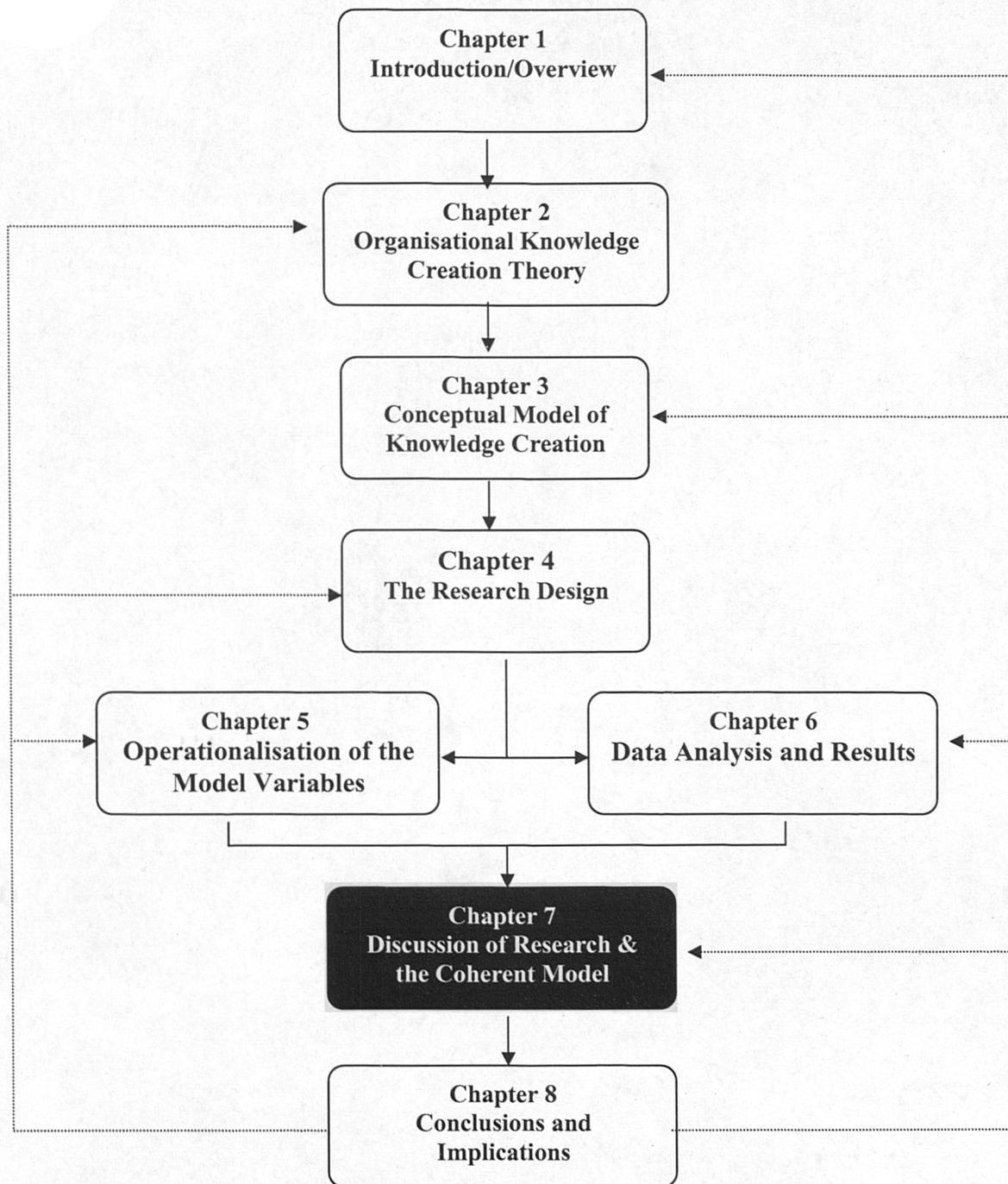
the CKT construct, where these variables are affected by the type of the group they belong to.

A micro and macro analysis strategy was adopted to test for the research hypotheses. CFA indicated that the measurement model fitted the sample data adequately; the goodness of fit indices for the measurement model were adequate, thus, the proposed measurement model is accepted. Evidence of the internal consistency was provided by composite reliability. Through utilising SEM and the *t*-test of beta significance support for most of the research, hypotheses exhibited statistical significance, thus, most hypotheses of this study were accepted. Hypotheses H1b, H2a, H3a, H3b were not supported as the *t*-test exhibited statistical insignificance. The structural model fit indices for the hypothesised model of the macro analysis of KCEE and SK indicated ill fit, thus, the model was revised. The structural model fit indices for the revised model for KCEE and SK indicated a good fit. Thus, hypothesis H4 was not completely accepted in its original form; two new unhypothesised relationships were introduced to the revised model and both exhibited statistical significance. All remaining hypotheses H5, H6, and H7 exhibited statistical significance and, hence, were accepted. The structural model fit indices for the hypothesised models in the micro and macro analysis for most models and sub-models indicated a good fit, thus the hypothesised models were accepted with no modification. All significant direct and direct relationships revealed by the all models were examined and statistically interpreted.

Chapter Seven

Discussion of Research and the Coherent Model

Figure 7.1 Chapter seven in the context of the thesis



Chapter Seven

Discussion of research and the coherent model

7.0 Introduction

In the process of analysing data, structural equation modelling was performed and significant relationships were identified in this research. The statistical results presented in the previous chapter suggested that information technology which supports the knowledge enabling factors (ITISKCFs), was a significant enabler of three (sympathised, systemic and, operational knowledge) of the four types of organisational knowledge creation identified by Nonaka (1994) Nonaka et. al., (1994), Nonaka and Takeuchi (1995) and Nonaka et. al., (2000a). The evidence of the statistical results showed that the culture of knowledge transfer was related to only three types of organisational knowledge, which are conceptual, systemic and, operational knowledge. The direct effect of innovative work environment (termed as the infrastructure for knowledge transfer) was limited only to one type of organisational knowledge which is the systemic knowledge and has an indirect effect on operational knowledge through one of its elements (previous knowledge and individual skills). The findings of the research are analysed and discussed in this chapter and the significant results were integrated into a coherent model of organisational knowledge creation. Tables 7.1 to 7.8 summarised the results of the hypothesised testing.

7.1 Microanalysis: discussion of the results (the autonomous effect)

Microanalysis is designed to test the relationship between the enablers of knowledge creation and their autonomous impacts on the organisational knowledge creation modes. Based on the theoretical development in chapter three, information technology infrastructure that support the knowledge creation factors, the culture of knowledge transfer and the innovative work environment were identified as possible enablers of knowledge creation. The following sections will discuss the results of the finding revealed in the previous chapter.

7.1.1 Results of ITISKCFs and OKC constructs

H1a: Sympathised knowledge and information technology

The evidence of the survey results showed that a positive significant relationship was found between ITISKCFs and SK creation activities. The structural model result reveals that *beta* is equal to 0.45 and the *t*-value ($t=2.2$) of the hypothesised model *SK f* (*ITISKCFs*) is significant. This indicates that knowledge enabling factors supported by information technology infrastructure (ITISKCFs) will promote the time spent on sympathised knowledge creation and transfer activities, where the activities of this phase of knowledge creation are concentrated around sharing tacit knowledge through shared problem solving activity. Information technology infrastructure has a wide support in the literature for its role in supporting the creation of knowledge. Quinn (1992) noted that organisational wisdom and managerial knowledge could be captured and stored by information technology in databases so that information technology leverages the

accumulated intellect. Cohen and Levinthal (1990) indicated that accumulated prior knowledge facilitates an organisation's capability to create new knowledge. Thus, the use of information technology infrastructure that supports the knowledge creation enabling factors can help in storing, retrieving and accessing prior knowledge and, hence, helping organisations to create new knowledge. In particular, sharing redundant information promotes the sharing of sympathised knowledge, because individuals can sense what others are trying to articulate (Nonaka and Takeuchi, 1995). According to McCulloch¹ (1965) "principle of redundancy of potential command" redundancy of information is a prerequisite to "realization". Sharing redundant information facilitated by information technology can help an organisation's members to understand their role in the organisation and, thus, control the direction of their thinking and action towards future knowledge creation activities. Information technology can enhance the requisite variety processed by an organisation's members by assuring a fast access to the broadest variety of relevant and necessary information going through fewest steps, enabling individuals to combine information differently and flexibly, and by identifying who owns the information, and where the information is located (Scott, 1998). Thus, the information technology enhanced requisite variety can help to advancement sympathised knowledge creation activities, while information technology supports autonomy by assuring that the necessary information required by the individual is stored on his/her networking PC and, thus, can act when facing an enquiry or a decision. Information technology ability that supports the ease of making changes to match the frequent fluctuating of information can trigger a break down of routine and, thus, enable individuals to react quickly to new developments (Scott, 1998). This discussion implies that enabling factors of knowledge

¹ as cited in Nonaka and Takeuchi, (1995, p. 81)

creation supported by information technology will have a reflective impact on the time spent on shared problem solving activities leading to the creation sympathised knowledge. From the findings of the direct relationship between information technology and creation sympathised knowledge creation activities, and the indirect relationship between information technology and both sympathised knowledge acquisition and transfer (see table 7.2), it can be concluded that information technology infrastructure that support the knowledge creation factors have to some extent more impact on the transfer than the acquisition activities of sympathised knowledge creation activities. To conclude, this model revealed that hypothesis H1a, which predicts a direct positive relationship between information technology and sympathised knowledge creation activities, was completely supported.

H1b: Conceptual knowledge and information technology

There was no significant evidence that information technology infrastructure that support the knowledge creation factors have a positive relationship with conceptual knowledge creation activities. The structural model result revealed that *beta* is equal to 0.15 and the *t*-value ($t=1.38$) of the hypothesised model *CK f (ITISKCFs)* is insignificant. The findings of this model revealed that hypothesis H1b, which predicts a direct positive relationship between information technology infrastructure and conceptual knowledge creation activities, was not supported. This indicates that knowledge enabling factors supported by information technology infrastructure have no impact on the time spent on conceptual knowledge creation and transfers activities, where activities are focused on

creating a concept from a new idea. This result contradicts with the views of Nonaka and Takeuchi (1995) where they believe that enabling factors of knowledge creation can facilitate the conceptual knowledge creation. As such autonomy can help individuals to expand their thinking horizon, requisite variety helps individuals to acclimatise to new perspectives when looking at a problem and redundancy of information helps individuals to understand figurative language better and to develop their mental models. Johnson (2000) found that individual and project autonomy, creative chaos (fluctuation) and redundancy was not significant to knowledge creation, which partly confirms the results of this research, but it should be noted that Johnson (2000) results was generalised to knowledge creation as a whole, rather than to conceptual knowledge, as in the results of this research.

H1c: Systemic knowledge and information technology

The evidence of the structural model result shows that a positive significant relationship is found between information technology infrastructure that supports the knowledge creation factors and systemic knowledge creation activities. The structural model result revealed that *beta* is equal to 0.49 and the *t*-value ($t=4.0$) of the hypothesised model *SKf* (*ITISKCFs*) is significant. This denotes that information technology infrastructure will promote the time spent on systemic knowledge creation and transfers activities. Information technology infrastructure was also found to have a positive indirect relationship with the systemic knowledge accumulation activities, systemic knowledge processing activities and the systemic knowledge dissemination activities. This implies

that information technology infrastructure will lead to more time being spent on all of SyK activities. Based on the findings of the indirect relationship between information technology infrastructure and the activities of systemic knowledge, which can be seen in table 7.2, it can be concluded that information technology infrastructure have a stronger impact on the accumulation than the dissemination and the processing activities of systemic knowledge creation. As noted by Huber (1991), previous knowledge should be linked to new information to create new knowledge. Systemic knowledge creation is about linking newly created information with previous knowledge. Information technology support of prior knowledge can contribute to understanding previous issues and current issues (Zoonky, 1999; El Sawy, 1986) and, hence, accelerates the organisation's ability to create new knowledge. Nonaka (1994) considered this stage of knowledge creation (the systemic knowledge creation activities, where activities are centred around building a prototype and cross levelling knowledge) is a complex one and requires a dynamic co-operation of various functions within the organisation. Nonaka and Takeuchi (1995) pointed out that the knowledge enabling factors, especially requisite variety and redundancy of information, are important in facilitating this phase of knowledge creation activities.

H1d: Operational knowledge and information technology

There was significant evidence that information technology infrastructure that supports the knowledge creation factors have a positive relationship with operational knowledge creation activities. The structural model result revealed that *beta* is equal to 0.34 and the

t -value ($t=2.7$) of the hypothesised model $OK f (ITISKCFs)$ is significant. The findings of this model revealed that the hypothesis H1d, which predicts a direct positive relationship between information technology infrastructure that supports the knowledge creation factors and operational knowledge creation activities was supported. Information technology infrastructure was also found to have a positive indirect relationship with operational knowledge activities (real world knowledge and virtual world knowledge). This indicates that knowledge enabling factors (redundancy, fluctuation, requisite variety and task-oriented autonomy) supported by information technology infrastructure will promote the time spent on operational knowledge creation and transfer activities where the activities of this phase of knowledge creation is concentrated around justifying the newly created concept. Scott (1998) partly supports this result by emphasising the role of information technology infrastructure in support of knowledge enabling factors. It should be noted here that Scott (1998) did not link information technology infrastructure to a specified type of knowledge, such as operational knowledge creation as in this result but rather, to knowledge creation as a whole. The justification process, according to Nonaka et al., (2000a), involves the process of determining if the newly created concept is worthwhile for the organisation and society, and they asserted that redundancy of information would facilitate this phase of knowledge creation. Based on the findings of the indirect relationship (see table 7.2) between information technology infrastructure and the activities of operational knowledge, it can be concluded that information technology infrastructure have to some extent more impact of the virtual world knowledge than the real world knowledge activities of operational knowledge creation. The overall finding of this model revealed

that hypothesis H1d, which predicts that there is a direct positive relationship between information technology infrastructure and operational creation activities, is supported.

Table 7.1 Summary of the research hypotheses (H2a-d) and their results

| Hypotheses | Description | Beta | t-value | Comment |
|------------|---|-------------------|---------|-----------------|
| H1a | There is a positive relationship between ITISKCFs and SK | 0.45* | 2.2 | Accepted |
| H1b | There is a positive relationship between ITISKCFs and CK | 0.15 ⁺ | 1.38 | <u>Rejected</u> |
| H1c | There is a positive relationship between ITISKCFs and SyK | 0.49* | 4.0 | Accepted |
| H1d | There is a positive relationship between ITISKCFs and OK | 0.34** | 2.7 | Accepted |

**Significant at 0.01, *Significant at 0.05, ⁺ Insignificant

Table 7.2 Standardised coefficient (*beta*) and *t*-value of the ITISKCFs and OKC

| Regression Path | Standardised coefficient (<i>beta</i>) | <i>t</i> -value |
|------------------------|--|-----------------|
| SKA = f (ITISKCFs) | 0.24* | 2.2 |
| SKT = f (ITISKCFs) | 0.28* | 2.5 |
| SyKA = f (ITISKCFs) | 0.43** | 3.9 |
| SyKP = f (ITISKCFs) | 0.16* | 2.1 |
| SyKD = f (ITISKCFs) | 0.26** | 2.6 |
| OKrwk = f (ITISKCFs) | 0.20** | 2.8 |
| OKvkw = f (ITISKCFs) | 0.34** | 3.1 |

**Significant at 0.01 probability level, * Significant at 0.05 probability level, + Insignificant relationship

7.1.2 Results of IKT and OKC constructs

H2a: Sympathised knowledge and infrastructure of knowledge transfer

There was no significant evidence that infrastructure of knowledge transfer has a positive relationship with sympathised knowledge creation activities. The structural model result revealed that *beta* is equal to 0.14 and the *t*-value ($t=1.5$) of the hypothesised model *SK f* (*IKT*) is insignificant. The findings of this model revealed that hypothesis H2a, which predicts a direct positive relationship between infrastructure of knowledge transfer and sympathised creation activities, was not supported. This indicates that the infrastructure of knowledge transfer, which is centred around creative behaviour, integration and team working, knowledge base and individual's skill, and the support of information systems that is designed to manage and disseminate information easily, have no autonomous effects on the time spent on sympathised knowledge transfer activities. Previous research (Tang, 1999; Leonard-Barton, 1995; Robinson and Stern, 1997) indicated that the availability of information, skills and knowledge, together with creative behaviour and the integration of people, will determine the ability and the inclination of an organisation's member to find an innovative solution and, hence, the creation of new knowledge. It should be noted here that this view was not supported when dealing with sympathised knowledge (tacit – tacit), but this view was supported, as will be seen latter in hypothesis H2c. This result could be accepted, as the tacit to tacit knowledge transfer (sympathised knowledge) through shared problem solving is a complex and difficult phase. Von Krogh et. al., (2000) described tacit knowledge as a “mystery”. The findings of this model indicate that infrastructure of knowledge transfer alone cannot contribute to the process of unlocking this “mystery” of tacit knowledge. To conclude, the findings of

this model revealed that hypothesis H2a, which predicts a direct positive relationship between infrastructure of knowledge transfer and sympathised creation activities, was not supported. The statistics on the hypothesised relationship are presented in table 7.2.

H2b: Conceptual knowledge and infrastructure of knowledge transfer

The evidence of the structural equation modelling showed that infrastructure of knowledge transfer has no effect on conceptual knowledge creation activities. The structural model result revealed that *beta* is equal to 0.22 and the *t*-value ($t=1.69$) of the hypothesised model $CK f(IKT)$ is insignificant. The findings of this model revealed that hypothesis H2b, which predicts a direct positive relationship between infrastructure of knowledge transfer and conceptual knowledge creation activities, was not supported. This indicates that the elements of infrastructure of knowledge transfer have no autonomous effects on the time spent on conceptual knowledge activities. Takeuchi (2001), in his descriptions of the kind of knowledge (conceptual knowledge), more specifically on the conversion of knowledge, indicated that conversion from explicit to tacit, explicit to explicit and tacit to tacit are possible, “ *However, the biggest ‘bang’ in organisational knowledge creation comes from converting tacit to explicit*” (Takeuchi, 2001, p.328). Combining this view with that of Von Krogh et. al., (2000) on the mystery of tacit knowledge as a starting point of knowledge conversion, indicates that this type of knowledge conversion requires more efforts and, more possibly, a different enabler, as will be seen in the later section on the analysis of the culture of knowledge transfer as an enabler of knowledge creation. The finding of this model rejected the

views of Tang (1999), Leonard-Barton (1995) and Robinson and Stern (1997), as mentioned in H2a, and confirms that infrastructure of knowledge transfer alone cannot contribute to the process of unlocking this “mystery” and, hence, releases new explicit knowledge.

H2c: Systemic knowledge and infrastructure of knowledge transfer

The evidence of the structural equation modelling results showed that a positive significant relationship was found between infrastructure of knowledge transfer and systemic knowledge creation activities. The structural model result revealed that *beta* is equal to 0.31 and the *t*-value ($t=2.17$) of the hypothesised model $SyK f (IKT)$ is significant. This indicates that infrastructure of knowledge transfer will promote the time spent on systemic knowledge creation and transfer activities. Infrastructure of knowledge transfer was also found to have a positive indirect relationship with the systemic knowledge accumulation activities and has no effect on both systemic knowledge processing and systemic knowledge dissemination (see table 7.4). According to Tang (1998), creative behaviour, integration and team working, knowledge base and skilful individuals and the support of information systems that is designed to manage and disseminate information easily will determine the ability and tendency of an organisation’s members to raise projects and find innovative solutions. The findings of this hypothesis confirm the views of Tang (1999), Leonard-Barton (1995) and Robinson and Stern (1997) where they asserted that individuals are more likely to be creative when they are empowered to take initiatives for problem sensing and solving. In the light of

these findings of H2a, H2b and H2c, it can be inferred that these views are only applicable when knowledge creation activities are centred on the creation and conversion of explicit to explicit knowledge. Thus, organisational support for infrastructure of knowledge transfer will encourage individuals to spend more time on building prototypes and levelling knowledge. Based on the findings of the direct relationship indirect relationship of infrastructure of knowledge transfer on systemic knowledge creation activities, we can conclude that infrastructure of knowledge transfer generally affects the systemic knowledge creation activities, more precisely, effect the part of systemic knowledge that is concerned with the accumulation of systemic knowledge. The findings of this model revealed that hypothesis H2c, which predicts a direct positive relationship between infrastructure of knowledge transfer and systemic knowledge creation activities, is supported.

H2d: Operational knowledge and infrastructure of knowledge transfer

There was no significant evidence that infrastructure of knowledge transfer has a positive relationship with operational knowledge creation activities. The structural model result revealed that *beta* is equal to 0.17 and the *t*-value ($t=1.76$) of the hypothesised model $OK \rightarrow IKT$ is insignificant. The findings of this model revealed that hypothesis H2d, which predicts a direct positive relationship between infrastructure of knowledge transfer and operational knowledge creation activities, was not supported, in its original form. The use of SEM revealed a new significant path (IKT-KS) which had been adopted in the revised model (see chapter 6, p.192), where *t*-value = 2.7. This indicates that only

knowledge and individual skills (IKT-KS) of infrastructure of knowledge transfer elements will effect the time spent on operational knowledge creation and transfer activities. This result indicates that individual skills and the organisational knowledge-based are positively related to the time spent on operational knowledge. Support for this new result is found in Cohen and Levinthal (1990) where they indicated that accumulated prior knowledge facilitates an organisation's capability to create new knowledge. Previous knowledge should be linked to new information to create new knowledge (Huber, 1991). In other words, individual creativity, insights and resourcefulness, combined with good learning and training, will facilitate the process of conversion explicit knowledge into tacit knowledge and, hence, disseminate new knowledge across the organisation. Summary of the overall results of H2a-d can be seen in tables 7.3 and 7.4.

Table 7.3 Summary of the research hypotheses (H2a-d) and their results

| Hypotheses | Description | <i>Beta</i> | <i>t</i> -value | Comment |
|------------|--|-------------------|-----------------|---------------------------|
| H2a | There is a positive relationship between IKT and SK | 0.14 ⁺ | 1.5 | <u>Rejected</u> |
| H2b | There is a positive relationship between IKT and CK | 0.22 ⁺ | 1.69 | <u>Rejected</u> |
| H2c | There is a positive relationship between IKT and SyK | 0.31* | 2.17 | Accepted |
| H2d | There is a positive relationship between IKT and OK | 0.17 ⁺ | 1.76 | <u>Partially Accepted</u> |

**Significant at 0.01, *Significant at 0.05, ⁺ Insignificant relationship

Table 7.4 Standardised coefficient (*beta*) and *t*-value of IKT and OKC

| Regression Path | Standardised coefficient (<i>beta</i>) | <i>t</i> -value |
|---|--|-----------------|
| Unhypothesised paths (Direct effect) | | |
| OK = $f(K\&S)$ | 0.33* | 2.7 |
| Indirect effect | | |
| SKA = $f(K\&S)$ | 0.08* | 2.04 |
| SKT = $f(K\&S)$ | 0.25* | 2.50 |
| SyKA = $f(IKT)$ | 0.24* | 2.17 |
| SyKP = $f(IKT)$ | 0.10 ⁺ | <u>1.64</u> |
| SyKD = $f(IKT)$ | 0.18 ⁺ | <u>1.86</u> |
| OK-rwk = $f(K\&S)$ | 0.26** | 2.6 |
| OK-vkw = $f(K\&S)$ | 0.25* | 2.5 |

** Significant at 0.01 probability level, * Significant at 0.05 probability level, ⁺ Insignificant relationship

7.1.3 Results of CKT and OKC constructs

H3a: Sympathised knowledge and culture of knowledge transfer

There was significant evidence that culture of knowledge transfer have a no relationship with sympathised knowledge creation activities. The structural model result revealed that *beta* is equal to 0.17 and the *t*-value ($t=1.3$) of the hypothesised model $SK f(CKT)$ is significant. The findings of this model revealed that hypothesis H3a, which predicts a direct positive relationship between culture of knowledge transfer and sympathised knowledge creation activities, was not supported. This indicates that culture of knowledge transfer that is centred around socialisation and conducive management's policy towards encouraging knowledge transfer and, thus, promoting creation activities, have no significant and independent effects on the time spent on sympathised knowledge

transfer activities. The result of this hypothesis can be seen as an unexpected result. Many researchers did emphasise on role of socialisation (McNabb and Sepic, 1995; Von Krogh, 1998) and conducive policy for knowledge creation (Davenport and Prusak, 1998; Harris and Hartman, 1992; Dastmalchian et al., 1991) in the creation of knowledge. Nonaka (1994) asserted that tacit to tacit transfer is a complex and difficult phase in knowledge conversion. Von Krogh, (1998) stated that, for sympathised (tacit) knowledge to be created, a special type of culture where love and care is the imperative necessity. The findings of these results indicate that culture of knowledge transfer alone cannot advance to the process of unlocking this “mystery” of sympathised knowledge.

H3b: Conceptual knowledge and culture of knowledge transfer

The evidence of the structural equation modelling results showed that a positive significant relationship was found between culture of knowledge transfer and conceptual knowledge creation activities. The structural model result reveals that *beta* is equal to 0.21 and the *t*-value ($t=2.2$) of the hypothesised model $CK f (CKT)$ is significant. This indicates that culture of knowledge transfer will promote the time spent on conceptual knowledge creation and transfer activities. This finding is truly significant in that it is the only enabler of this type of organisational knowledge. This indicates that culture of knowledge transfer will encourage the time spent on conceptual knowledge creation and transfer activities. This result indicates that socialisation activities and the management policy adopted to encourage individuals to create knowledge are positively related to the

time spent on conceptual knowledge. Common ground, through teaming and job rotation, time and space, appreciation of knowledge no matter the level of the source and acceptance of creative errors, all of which will facilitate knowledge transfer, will facilitate the process of conversion tacit knowledge into explicit knowledge and, hence, disseminate new knowledge across the organisation. Unlike sympathised knowledge, the view of McNabb and Sepic (1995) and Von Krogh (1998) and views of Davenport and Prusak (1998), and Harris and Hartman (1992) in the creation of knowledge were supported. This is an indication that culture of socialisation and the existence of a conducive management policy are both applicable to the creation of conceptual knowledge.

H3c: Systemic knowledge and culture of knowledge transfer

The evidence of the structural equation modelling results shows that culture of knowledge transfer has a positive relationship with systemic knowledge creation activities. The structural model result revealed that *beta* is equal to 0.56 and the *t*-value ($t=2.9$) of the hypothesised model *SyKf(CKT)* is significant. The findings of this model revealed that hypothesis H3c, which predicts a direct positive relationship between culture of knowledge transfer and systemic knowledge creation activities was supported. Culture of knowledge transfer was also found to have an indirect significant relationship with two of the systemic knowledge activities (systemic knowledge accumulation and dissemination) and has no effect on systemic knowledge processing. The finding of the

direct relationship indicates that the culture of knowledge transfer elements, socialisation and management policy on knowledge creation will support the time spent on systemic knowledge creation and transfer activities. According to Von Krogh (1998) and Davenport and Prusak (1998), knowledge “friendly” culture plays a significant role in promoting knowledge creation activities. It should be noted here that the views of Davenport and Prusak (1998) were not specific to types of organisational knowledge creation and conversion modes, rather than their support to the role the culture of knowledge transfer in enabling knowledge creation as a whole. Culture of knowledge transfer that is conducive to knowledge creation activities will encourage individuals to spend more time on systemic knowledge creation activities, such as building prototypes and levelling of knowledge. Based on the results of the direct and the indirect relationship between the culture of knowledge transfer and systemic knowledge creation activities, it can be concluded that culture of knowledge transfer generally affects the systemic knowledge creation activities or, more precisely, affects the parts of systemic knowledge that is concerned with the process of accumulation and dissemination of knowledge creation activities.

H3d: Operational knowledge and culture of knowledge transfer

The evidence of the survey results showed that a positive significant relationship was found between culture of knowledge transfer and operational knowledge creation activities. The structural model result revealed that *beta* is equal to 0.52 and the *t*-value

($t=3.4$) of the hypothesised model $OK f (CKT)$ is significant. The findings of this relationship revealed that hypothesis H3d, which predicts a direct positive relationship between culture of knowledge transfer and operational knowledge creation activities, was supported. The culture of knowledge transfer was also found to have an indirect significant relationship with all operational activities. CKT that is conducive to knowledge creation activities will encourage individuals to spend more time on operational knowledge creation activities, such as sharing or trying to understanding management vision and values through communication with fellow members. This can be realised when middle managers are engaged in “enactive liaisoning” activities with the functional department, and work on overlapping product development through cross-functional teams. The culture of knowledge transfer will facilitate forming teams and encourage an organisation’s members to conduct experiments and share results. Based on the findings of the direct and the indirect relationship, one can conclude that the culture of knowledge transfer has more impact on real-world knowledge creation activities than virtual-world knowledge creation activities. To conclude, the results of hypothesis testing of H3b, H3c and H3d did support the views (McNabb and Sepic, 1995; Von Krogh, 1998) on the role of socialisation and the conducive policy (Davenport and Prusak, 1998; Harris and Hartman, 1992) in the creation of knowledge. A summary of the overall results of H3a-d can be seen in tables 7.5 and 7.6.

Table 7.5 Summary of the research hypotheses (H3a-d) and their results

| Hypotheses | Description | <i>Beta</i> | <i>t</i> -value | Comment |
|------------|--|-------------------|-----------------|-----------------|
| H3a | There is a positive relationship between CKT and SK | 0.17 ⁺ | 1.3 | <u>Rejected</u> |
| H3b | There is a positive relationship between CKT and CK | 0.21* | 2.2 | Accepted |
| H3c | There is a positive relationship between CKT and SyK | 0.56** | 2.9 | Accepted |
| H3d | There is a positive relationship between CKT and OK | 0.52** | 3.4 | Accepted |

**Significant at 0.01, *Significant at 0.05, ⁺ insignificant relationship

Table 7.6 Standardised coefficient (*beta*) and *t*-value of CKT and OKC

| Regression Path | Standardised coefficient (<i>beta</i>) | <i>t</i> -value |
|------------------------|--|-----------------|
| Indirect effect | | |
| SyKA = <i>f</i> (CKT) | 0.39** | 2.9 |
| SyKP = <i>f</i> (CKT) | 0.17 ⁺ | <u>1.95</u> |
| SyKD = <i>f</i> (CKT) | 0.36** | 2.8 |
| OKrwk = <i>f</i> (CKT) | 0.42** | 3.4 |
| OKvkw = <i>f</i> (CKT) | 0.33** | 2.8 |

**Significant at 0.01 probability level, *Significant at 0.05 probability level, + Insignificant relationship

7.2 Macro-analysis: discussion of results (the shared effect)

H4: Sympathised knowledge and the knowledge creation-enabling environment

There was no significant evidence that the knowledge creation enabling environment has a positive relationship with sympathised knowledge creation activities. The structural model result revealed that *beta* is equal to 0.10 and the *t*-value (*t*=0.77) of the

hypothesised relationship $SK \rightarrow KCEE$ is insignificant. The findings of this model revealed that hypothesis H4, which predicts a direct positive relationship between knowledge creation enabling environment and sympathised knowledge creation activities was not supported in its original form. The use of structural equation modelling revealed two new significant paths ($SK \rightarrow ITISKCFs$) and $IKT-KS \rightarrow SK$) which had been adopted in the revised model (see chapter 6, p.209). The first unhypothesised relationship $SK \rightarrow ITISKCFs$ in this model will not be discussed here as it has been in the previous section, 7.1.1. The other interesting finding is the relationship between $IKT-KS$ and SK . The finding of this new relationship indicates that engaging in tacit knowledge creation activities will increase the level of knowledge and skill that the individual had previously. As indicated earlier, theoretical support for this finding can be found in Cohen and Levinthal (1990) and Huber (1991). This finding implies that sympathised knowledge created by sharing problem-solving activities will lead to accumulating more knowledge for an organisation's members and improving their knowledge creation skills. The overall findings from these new relationships is that the magnitude of impact of $ITISKCFs$ on SK has been reduced in this model of shared effects as compared to the autonomous effect of $ITISKCFs$ on SK alone (see H1a). This indicates that the current practices of the culture and the infrastructure of knowledge transfer is affecting the effect that $ITISKCFs$ have on SK .

Table 7.7 Standardised coefficients and *t*-value of the KCEE-SK model

| Regression Path | Standardised coefficient | <i>t</i> -value |
|-------------------------------------|--------------------------|-----------------|
| Unhypothesised Direct effect | | |
| SK = f (ITISKCFs) | 0.32* | 2.1 |
| IKT-KS = f (SK) | 0.23* | 2.40 |

* Significant at 0.05 probability level

H5: Conceptual knowledge and the knowledge creation-enabling environment

The evidence of the structural equation modelling results showed that a positive significant relationship was found between the knowledge creation enabling environment and conceptual knowledge creation activities. The structural model result revealed that *beta* is equal to 0.24 and the *t*-value ($t=2.0$) is significant. This indicates that the knowledge creation enabling environment will promote the time spent on conceptual knowledge creation and transfers activities. This implies that the knowledge enabled environment supported by the three-knowledge creation enabling constructs, ITISKCFs, CKT and IKT, will promote the time spent on conceptual knowledge creation and transfers activities. Information technology infrastructure can facilitate the conceptual knowledge creation factors by supporting autonomy that helps individual to diverge their thinking freely, by supporting requisite variety that helps individual to adapt new viewpoint for looking at a problem and by supporting redundancy of information helping individuals to comprehend figurative language better and to shape up their mental models. These views have tremendous support from the founders of the organisational knowledge creation theory (Nonaka and Takeuchi, 1995; Nonaka et al., 1994, 2000b).

Culture of knowledge transfers support socialisation by encouraging face-to-face meetings, establishing a common ground, through education and discussion and by establishing a space and time for knowledge transfer through fairs and talk rooms. The culture of knowledge transfer adopts knowledge creation supportive policies such as accepting and rewarding creative errors, hire employees for their openness of ideas and appreciates knowledge regardless of the hierarchical level of the source. These views are supported by Davenport and Prusak (1998) and O'Dell and Garyson (1998) among others. The infrastructure for knowledge transfer that is shaped around creative behaviour, integration and team working, knowledge base and skilful individuals, both culture and infrastructure will have its profound impact on knowledge transfer. These views are supported by O'Dell and Garyson (1998) and Tang (1998). An integration of the mentioned elements leads to strengthening the knowledge creation enabling environment and, thus, promoting individuals to spend more time on conceptual knowledge transfer activities. The findings of this relationship revealed that the *t*-value of the completely standardised coefficient of KCEE→CK regression path is significant. Thus, H5, which predicts a direct relationship between the knowledge creation enabling environment and the time spend on conceptual knowledge creation activities, is accepted at 0.05 significance level.

H6: Systemic knowledge and the knowledge creation-enabling environment

There was significant evidence that the knowledge creation enabling environment has a positive relationship with systemic knowledge creation activities. The structural model

result revealed that *beta* is equal to 0.52 and the *t*-value ($t=0.29$) of the hypothesised relationship $SyK f (KCEE)$ is significant. The findings of this model revealed that hypothesis H6, which predicts a direct positive relationship between KCEE and SK creation activities, was supported. This indicates that a knowledge-enabling environment will promote the time spent on systemic knowledge creation and transfer activities. Consequently, ITISKCFs will enhance the knowledge enabling factors, CKT through encouraging socialisation and adopting conducive knowledge creation policies (Davenport and Prusak, 1998) and IKT through enforcing creative behaviour, integration, knowledge and individual skills, information and communication (Tang, 1998 and Leonard-Barton, 1995). All of which will lead to empowering the knowledge enabling environment and, thus, facilitating the creation of systemic knowledge by promoting more time to be spent on its creation activities.

H7: Operational knowledge and the knowledge creation-enabling environment

The evidence of the survey results showed that a positive significant relationship was found between the knowledge creation enabling environment and the operational knowledge creation activities. The structural model result revealed that *beta* is equal to 0.40 and the *t*-value ($t=2.44$) is significant. The findings of this relationship revealed that hypothesis H7, which predicts a direct positive relationship between the knowledge creation enabling environment and operational knowledge creation activities, was supported. This indicates that knowledge creation enabling environment (ITISKCFs, CKT and IKT) will encourage the time spent on operational knowledge creation and

transfers activities. Accordingly, ITISKCFs will boost the knowledge enabling factors. Top managers should encourage socialisation and positive knowledge creation policies through adopting a knowledge friendly culture (Davenport and Prusak, 1998) and investing in knowledge transfer infrastructure by supporting creative behaviour, integration, knowledge base and individual skills, and information and communication systems (Tang, 1998). An integration of the capabilities of these enablers will give more strength to the knowledge enabling environment and, thus, facilitate the creation of operational knowledge by promoting more time to be spent on these activities.

Table 7.8 Summary of the research hypotheses (H4-7) and their results

| Hypotheses | Description | <i>Beta</i> | <i>t</i> -value | Comment |
|------------|--|-------------------|-----------------|--|
| H4 | There is a positive relationship between KCEE and the time spent on sympathised knowledge creation activities. | 0.10 ⁺ | 0.77 | <u>Partially accepted</u> ² |
| H5 | There is a positive relationship between KCEE and the time spent on conceptual knowledge creation activities. | 0.24* | 2.00 | Accepted |
| H6 | There is a positive relationship between KCEE and the time spent on systemic knowledge creation activities. | 0.52* | 2.29 | Accepted |
| H7 | There is a positive relationship between KCEE and the time spent on operational knowledge creation activities. | 0.40* | 2.44 | Accepted |

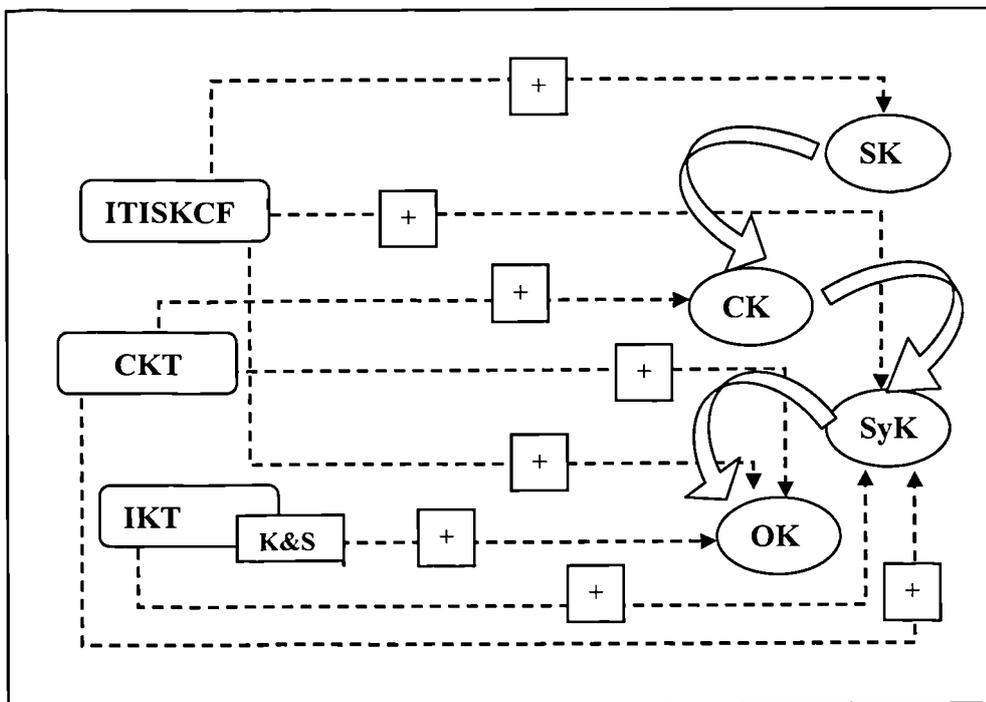
**Significant at 0.01, *Significant at 0.05, ⁺Significant at 0.01

² See unhypothesised direct relationships table 7.7

7.3 Coherent model of organisational knowledge creation

The findings of this research confirmed the underlying process of knowledge creation, which was similar to those proposed in the organisational knowledge creation theory identified by Nonaka (1994). This theory was confirmed by Nonaka et. al., (1994, 2000b), Raghuram (1996), Scott (1998) and Kidd (1998). The significant relationships identified by this research are integrated to form a coherent model of organisational knowledge creation (see figure 7.2). This model represents the knowledge creation and conversion modes hypothesised by Nonaka and Takeuchi (1995) which were confirmed by this research. The model also includes the enablers of organisational knowledge creation (OKC) that are found to have a significant relationship with the activities of OKC.

Figure 7.2 Coherent model of organisational knowledge creation activities



The model represents the four types of organisational knowledge creation: sympathised knowledge creation (SK), conceptual knowledge (CK), systemic knowledge creation (SyK) and, operational knowledge creation activities. The enablers of knowledge creation are represented by information technology that support knowledge enabling factors (ITISKCFs), the culture of knowledge transfer (CKT) and the infrastructure for knowledge transfer (IKT) along with one of its elements, seen as the individual knowledge and skills (IKT-K&S). The dotted arrows representing direct relationships and the positive sign represent the direction of this relationship (see table 8.2). The bold arrows represent the spiral of knowledge that moves from one mode into another mode of knowledge creation in a continuous manner. The process of OKC works as described by Nonaka and Takeuchi (1995) moving from tacit to explicit then to tacit again, over and over. The model links each enabler of OKC with each mode of organisational knowledge creation where the likelihood of positive relation exists. This model is seen to modify the previous theory of OKC by redefining the enabler factors described by Nonaka and Takeuchi's model of organisational knowledge creation and further expanding the theory by integrating more enablers. The coherent model adopted and confirmed the organisational knowledge creation (OKC) process with some modification (for more details the operationalisation of the organisational knowledge creation variables in chapter five, p. 120). The knowledge enabling factors identified by Nonaka and Takeuchi's (1995) model were adopted and then refined with information technology infrastructure, then introduced as a new enabler of organisational knowledge creation. The coherent model of this research also integrated the culture of knowledge transfer identified by Davenport and Prusak (1998) and the innovative work environment (termed

in this study as the infrastructure for knowledge transfer (IKT)) as a new enabler of organisational knowledge creation. Only the enabling factors that have significant relationship with OKC are included in the coherent model. A summary of the role of the enabling factor supporting organisational knowledge creation can be seen in table 7.9.

Table 7.9 Summary of the enabling factor and the OKC modes

| | Enablers of organisational knowledge creation modes |
|----------------------------|---|
| Sympathised Knowledge (SK) | ITISKCFs (positive support) |
| Conceptual Knowledge (CK) | CKT positive (positive support) |
| Systemic Knowledge (SyK) | CKT, ITISKCFs, IKT (all positive support) |
| Operational Knowledge (OK) | CKT, ITISKCFs, IKT-KS (all positive support) |

7.3.1 The coherent model in the context of the study

Nonaka and Takeuchi's (1995) model (described in chapter three) shows that the process of knowledge creation is via conversion from tacit to explicit knowledge. This conversion is based on the interaction and conversion between the two types of knowledge, tacit and explicit, in a spiral manner. It is important to indicate that the conversion does not occur within individuals but between individuals and within an organisation. This interaction is called knowledge conversion which is developed on the critical presupposition that individual knowledge is created and enlarged by means of a social interaction between tacit and explicit knowledge. According to Nonaka and Takeuchi (1995) the interaction between the main two types of knowledge allow the

positing of four different modes of knowledge conversion. They asserted that the knowledge creation process takes place through four modes of knowledge conversion.

1. Socialisation: (from tacit knowledge to tacit knowledge) is the process of converting tacit knowledge through shared experience which, typically, occurs in a traditional apprenticeship. According to Nonaka et. al., (2000b) apprentices acquire tacit knowledge needed for their job as being exposed to hand on experience rather than from written material, such as books and manuals. They further expand the process of acquiring tacit knowledge beyond the boundaries of the organisation though interacting with its customers and suppliers and, hence, taking advantage of their embedded tacit knowledge. The output of this interaction and conversion lead to the creation of sympathised knowledge referred to as experimental knowledge assets. The findings of this research have confirmed this type of knowledge with minor adjustment. Nonaka et. al., (1994) hypothesised that the factors that constitute this type of knowledge are: (a) tacit knowledge accumulation, (b) extra firm collection, (c) intra firm collection and (d) transfer of tacit knowledge. This research confirms the last factor, integrates the second and third factors (referred to in this study as tacit knowledge acquisition) and rejected the first factor. More details can be seen in chapter five on the operationalisation of tacit knowledge. As a result of this research information technology that supports the knowledge creation factors (ITISKCFs) has been found to be the only enabler of this type of knowledge. General support³ for this

³ General support means here is the ITI support for knowledge creation as a whole without specifying the exact type of knowledge such as sympathised, conceptual, systemic and, operational knowledge.

result can be found in Cohen and Levinthal (1990), Huber (1991), Khalil (1996), Davenport and Prusak (1998), Scott (1998) and Pemberton and Stonehouse (2002) (see hypotheses testing H1a to H1d).

2. Externalisation: (from tacit knowledge to explicit knowledge) is the process of articulating tacit knowledge as explicit; in other words, making tacit knowledge explicit. An example of this conversion process is the creation of a concept in new product development. The output of this interaction and conversion leads to the creation of conceptual knowledge (Nonaka and Takeuchi, 1995). The finding of this research has confirmed this mode as described by and Takeuchi (1995). As a result of this research the culture of knowledge transfer has been found to be the only enabler of this type of knowledge. General support⁴ for this result can be found in Nonaka and Takeuchi (1995), Davenport and Prusak (1998) and O'Dell and Garyson (1998).

3. Combination: (from explicit knowledge to explicit knowledge) is the process of converting explicit knowledge into more convoluted and systematic sets of explicit knowledge. The output of this interaction and conversion lead to the creation of systemic knowledge. According to Nonaka et. al., (1994), the factors that constitute the systemic knowledge creation are: (a) acquisition of explicit knowledge, (b)

⁴ General support means here is the support for knowledge creation as a whole without specifying the exact type of knowledge such as sympathised, conceptual, systemic and, operational knowledge.

processing of explicit knowledge and (c) dissemination of explicit knowledge, all of which has been confirmed by this research (for more detail, see chapter five on the operationalisation of systemic knowledge). As a result of this research the culture of knowledge transfer (CKT), information technology infrastructure that supports the knowledge enabling factors (ITISKCFs) and the innovative work environment (referred to in this research as (IKT)) have been found to support this type of knowledge. CKT has the largest enabler role of the time spent on the creation of this type of organisational knowledge, followed by ITISKCFs and IKT which were found to have the least enabler role. General support⁵ for this result can be found in Cohen and Levinthal (1990), Huber (1991), Nonaka and Takeuchi (1995), Khalil (1996), Tang (1998), O'Dell and Garyson (1998), Davenport and Prusak (1998) and Scott (1998).

4. Internalisation: (from explicit knowledge to tacit knowledge) is the process of converting and embodying explicit knowledge as tacit knowledge in which the created explicit knowledge is shared throughout the organisation and then converted to tacit knowledge by individuals. It is closely related to 'learning by doing'. The output of this interaction and conversion lead to the creation of operational knowledge. According to Nonaka et. al., (1994), the factors that constitute the operational knowledge creation are: (a) real-world knowledge (personal experience)

⁵ General support means here is the support for knowledge creation as a whole without specifying the exact type of knowledge such as sympathised, conceptual, systemic and, operational knowledge.

and (b) virtual-world knowledge (simulation and experimentation). The finding of this research has confirmed the existence of these two factors (see chapter five for more details on the operationalisation of operational knowledge). The findings of this research suggested that CKT and ITISKCFs are the main enabler of this type of organisational knowledge. The results also revealed that knowledge and skills (an element of IKT) is also an enabler of operational knowledge. CKT is found to have the largest enabler role followed by both ITISKCFs and IKT-KS where the last two enablers were found to have to some extent, the same level of impact of the time spent of the operational knowledge creation activities. General support⁶ for this result can be found in Cohen and Levinthal (1990), Huber (1991), Nonaka and Takeuchi (1995), Khalil (1996), Tang (1998, 1999), O'Dell and Garyson (1998), Davenport and Prusak (1998), Scott (1998) and Pemberton and Stonehouse (2002).

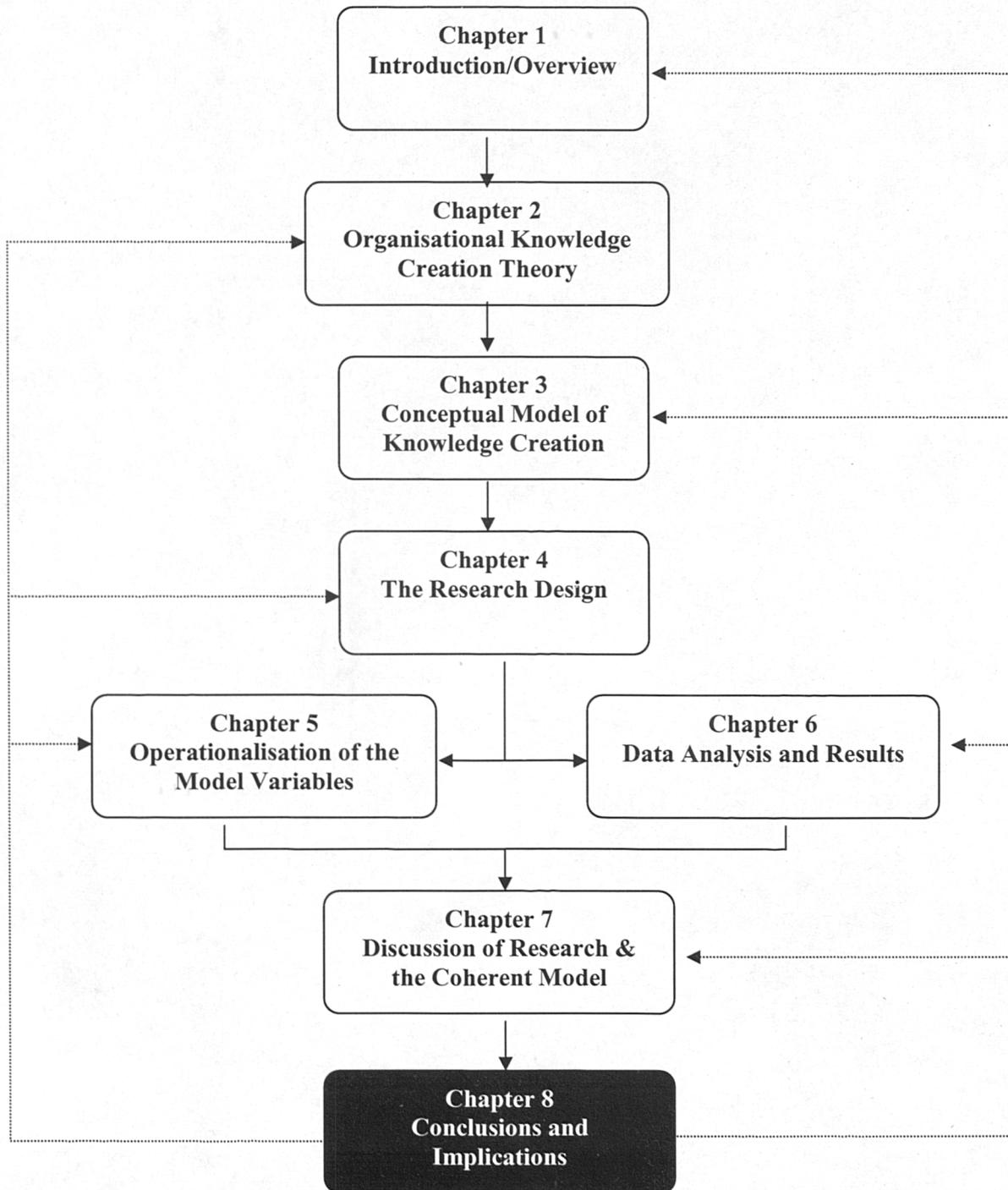
To conclude, information technology the support the knowledge enabling factors was the only enabler that support the sympathised knowledge creation activities. The culture of knowledge transfer was the only enabler of conceptual knowledge creation activities. All three factor (culture of knowledge transfer, information technology and, the innovative work environment were found to support the two remaining organisational knowledge creation activities (systemic and operational knowledge) where culture has relatively the highest impact on these two activities of knowledge creation, followed by information technology, where the innovative work environment has the least impact.

⁶ General support means here is the support for knowledge creation as a whole without specifying the exact type of knowledge such as sympathised, conceptual, systemic, and operational knowledge.

The next chapter starts with a review of the main findings of the research and then presents the contribution of this research to the theory and the implication of management and suggestions for further research.

Chapter Eight Conclusions and Implications

Figure 8.1 Chapter eight in the context of the thesis



Chapter Eight

Conclusions and Implications

8.0 Introduction

This study began with the observation that changing economic and business environments call for a new understanding of the value of knowledge as a source of competitiveness, an agent of change and a major asset of the organisation. This study has investigated three major questions. ‘What are the characteristics of an information technology infrastructure that enhance the knowledge enabling factors capability for the support of organisational knowledge creation activities?’ ‘Does the information technology infrastructure capability affect the time spent on organisational knowledge creation activities?’ ‘How does the culture of knowledge transfer and infrastructure for knowledge transfer play a role when combined with the information technology infrastructure capabilities has on the time spent on organisational knowledge creation activities?’ To answer these questions, the study utilised, redefines and then expands Nonaka and Takeuchi’s (1995) model for organisational knowledge creation. A questionnaire survey was performed to increase the understanding of the process of knowledge creation, to quantify the factors of interest and to test for their autonomous and shared effect and relationship to organisational knowledge creation. The research utilised advanced multivariate statistical techniques (CFA and SEM enabled by EQS 5.7 software). This led to a number of compelling findings. A summary of the major findings is presented and the major contributions of this research to both theory and practise are outlined. Then, various managerial implications are presented. The major limitations of the research are outlined followed by suggested future research directions.

8.1 Summary of the main findings

The overall results of the empirical investigation did support the general framework, presented in the research model in chapter three. Using confirmatory factor analysis the knowledge creation and conversion modes hypothesised by Nonaka and Takeuchi's (1995) model were also confirmed, with one minor adjustment of the socialisation mode. IT infrastructures that support the knowledge enabling factors (ITISKCFs) were positively related to the sympathised, systemic and operational knowledge creation activities, while ITISKCFs did not support the conceptual knowledge creation activities. The culture of knowledge transfer (CKT) was positively related to systemic, and operational knowledge creation activities; CKT was also found to have a significant but weak relationship with the conceptual knowledge creation activities. CKT did not support the activities aimed at the creation of sympathised knowledge. The infrastructure of knowledge transfer (IKT) was positively related to systemic knowledge and only one element of this factor (IKT-KS) was found to have a significant relationship with the operational knowledge creation activity. IKT did not support the activities aimed at the creation of both sympathised and conceptual knowledge. Summary of the research hypotheses and their results is presented in table 8.1

Table 8.1 Summary of the research hypotheses and their results

| Hypotheses | Description | Comment |
|------------|--|---------------------------|
| H1a | There is a positive relationship between ITISKCFs and SK | Accepted |
| H1b | There is a positive relationship between ITISKCFs and CK | <u>Rejected</u> |
| H1c | There is a positive relationship between ITISKCFs and SyK | Accepted |
| H1d | There is a positive relationship between ITISKCFs and OK | Accepted |
| H2a | There is a positive relationship between IKT and SK | <u>Rejected</u> |
| H2b | There is a positive relationship between IKT and CK | <u>Rejected</u> |
| H2c | There is a positive relationship between IKT and SyK | Accepted |
| H2d | There is a positive relationship between IKT and OK | <u>Partially Accepted</u> |
| H3a | There is a positive relationship between CKT and SK | <u>Rejected</u> |
| H3b | There is a positive relationship between CKT and CK | Accepted |
| H3c | There is a positive relationship between CKT and SyK | Accepted |
| H3d | There is a positive relationship between CKT and OK | Accepted |
| H4 | There is a positive relationship between KCEE and the time spent on sympathised knowledge creation activities. | <u>Partially accepted</u> |
| H5 | There is a positive relationship between KCEE and the time spent on concept knowledge creation activities. | Accepted |
| H6 | There is a positive relationship between KCEE and the time spent on systemic knowledge creation activities. | Accepted |
| H7 | There is a positive relationship between KCEE and the time spent on operational knowledge creation activities. | Accepted |

More specifically, the results indicated that the phases of organisational knowledge creation and conversion modes; socialisation activities that lead to the creation of sympathised knowledge were all loaded significantly and this was first tested using explanatory factor analysis (EFA) and then was confirmed by the confirmatory factor

analysis (CFA). All items representing the activity that concern with the transfer of tacit knowledge 'sympathised' and the acquisition activities were found to be loading significantly on these factors. Items that represent the accumulation activities of tacit knowledge were not confirmed by CFA. The externalisation mode of knowledge conversion was tested first using EFA and then it was confirmed by CFA; all items representing this model of knowledge creation and conversion were found to have a significant loading and, hence, this mode of the activities that leads to the creation of conceptual knowledge was confirmed. The third mode of knowledge conversion was confirmed. All items representing this activity, which is concerned with the accumulation, processing and dissemination were confirmed by CFA and they were found to have significant loadings and, thus, the overall systemic knowledge creation activities were confirmed. Internalisation is the last model of organisational knowledge conversion; all items representing this mode were confirmed by CFA. Two main activities representing these activities emerged as results of EFA and these main activities, representing the real world knowledge and virtual world knowledge, were found to have significant loadings and, hence, the activities of operational knowledge were confirmed.

The result indicated that the information technology infrastructure supporting the knowledge enabling factors (redundancy, fluctuation, autonomy, and requisite variety) is positively related to the overall activities that lead to the creation of sympathised knowledge. This means that, with the existence of ITISKCFs, managers are more likely to spend more time on the acquisition and transfer of tacit-to-tacit knowledge activities and actively search for new opportunities to create knowledge

rather than to collect information. ITISKCFs are also positively related to both systemic and operational knowledge (explicit-to-explicit and explicit-to-tacit), respectively. This means that, with the existence of ITISKCFs, managers are likely to spend more time in experimenting and prototyping activities, justifying and leveraging new knowledge. ITISKCFs were found to have no relationship with the activities aimed at the conversion of tacit-to-explicit and, hence, ITISKCFs did not support the creation of conceptual knowledge. This finding revealed that conversion of tacit-to-explicit is a difficult task and requires more than ITISKCFs to be enabled. As indicated by many researchers such as Nonaka and Takeuchi (1995), this mode of knowledge creation is probably the most difficult one. This research acknowledged this finding and calls for more investigation into the concept of this mode and suggested for further research to include the concept of CARE as an enabler, which has been induced by Von Krogh (1998) and Von Krogh et. al., (2000).

The culture of knowledge transfer (CKT) was positively related to systemic and operational knowledge, and was found to have a significant but weak relationship with conceptual knowledge. The existence of this type of culture supports socialisation by encouraging face-to-face meetings, supporting common grounds through discussion and teaming, educating employees on the importance of flexibility, appreciating knowledge regardless of the source and rewarding creative errors and collaboration. With the support of this culture, managers are likely to spend more time on experimenting, prototyping and encouraging employees to participate in the knowledge creation activities and managers are more likely to spend more time acting as communicators between different functional departments leading to more

collaborative work. CKT did not support the activity aimed at tacit-to-tacit conversion. The research acknowledges this finding and calls for further research on this concept with relation to CKT; again, the concept of CARE could be a good start to explore the concept of sympathised knowledge with concern to CKT.

Infrastructure for knowledge transfer (IKT) was positively related to systemic knowledge (explicit-to-explicit) knowledge conversion and was partially related to operational knowledge (explicit-to-tacit) through one of its elements (the individual skills and knowledge). This means that managers are likely to spend more time on the process of explicit-to-explicit/tacit conversion provided that integration, teams, and creative behaviour are supported. Skills and knowledge are enhanced and the existence of supportive information systems where information and databases are well managed and where the system provides great assistance in finding ideas and opportunities. IKT has failed to support the creation of both sympathised (tacit-to-tacit) and conceptual knowledge (tacit-to-explicit). This finding is probably due the complexity of these two types of knowledge.

The integration of the three enablers of organisational knowledge creation (OKC) into an overall environment that enables knowledge creating termed as KCEE, which is hypothesised by this research, revealed the following findings: KECC has a significant relationship with systemic, operational knowledge and a significant but weak relationship with conceptual knowledge creation activities. KECC has failed to support sympathised knowledge creation activities. These results of the shared effect

of the three enablers through KCEE did not contradict the previous finding of the autonomous effect that the three enablers have on organisational knowledge creation. Two interesting findings were revealed: first, the magnitude of effect that ITISKCFs on sympathised knowledge was reduced (as *Beta* was decreased from 0.45 to a 0.32) as a result of this integration; second, the significant but weak relationship that CKT had with CK was improved to some extent (as *Beta* was increased from 0.21 to a 0.24).

To conclude this summary of findings, the enablers of organisational knowledge creation activities are more supportive when the conversion of knowledge starts from explicit moving toward explicit and/or tacit, and have little or no support when the conversion of knowledge creation starts from tacit moving toward tacit and/or explicit. This general finding confirms the complexity of tacit knowledge as Von Krogh, Ichijo, and Nonaka (2000) call it the ‘mystery’ of tacit knowledge.

8.2 Contributions to knowledge

The research has provided a number of contributions to the literature on organisational knowledge creation from the intra-organisational perspective.

The first contribution is a better understanding of knowledge creation in the services industry viewpoint. The research provided substantial evidence on the applications of organisational knowledge creation in the services industry. This has not been adequately examined in the past by other researchers. Most of the previous work on the organisational knowledge creation has focused on the knowledge creation process

in an organisation with orientation toward tangible product innovation, while this research has focused on the knowledge creation process in organisations with orientation toward intangible ‘soft’ innovation, such as financial products. The fundamental process of knowledge creation in the services industry context has not been studied. This research provides the first glance of how knowledge is created in this industry.

The second contribution came as a result of modifying Nonaka and Takeuchi’s (1995) model by redefining the enabling factors through inducing information technology infrastructure as a new enabler of knowledge creation. Previous studies on information technology (IT) have focused on the role of IT in knowledge creation by imposing IT as an enabler of the knowledge creation process, making little or no consideration to the fact that knowledge creation is mainly a human act. Valuing the role of IT in knowledge management and in knowledge creation in particular, this research proposes a different way of dealing with IT. The research introduced IT infrastructure capability to enhance the role enabling factors rather than imposing IT on the activity of the knowledge creation process itself. By adopting this view, this research has contributed to a better understanding of IT role in knowledge creation. This methodology adopted by the research has meditated between the two extreme views on the role of IT in knowledge management and, more precisely, on the role of IT in knowledge creation.

The third and the fourth contributions are related to the previous one. This research has extended Nonaka and Takeuchi's (1995) model by adding two new enablers; the first, is a specific type of culture termed in this research as the culture of knowledge transfer and the second is the innovative work environment termed in this research as the infrastructure of knowledge transfer. Previous research did not make the distinctions when relating these enablers to organisational knowledge creation modes. The view was to generalise the findings of the relationships between these enablers to the overall knowledge creation with little or no consideration of the modes of knowledge creation; for example, relating a positive effect of organisational culture to organisational knowledge creation as a whole and making no distinctions on the specific effect that these enablers has on the type of knowledge created as a result of the conversion process, such as (tacit-to-tacit, tacit-to explicit, etc...). The research has contributed to understanding better the enablers' role by identifying the specific effect of these enablers on each of the knowledge conversion processes and on the type of knowledge creation that emerges as a result of it.

The fourth contribution is provided from the evaluation of the robustness of Nonaka and Takeuchi's (1995) organisational knowledge creation model, especially the knowledge creating process and the knowledge conversion. This research has confirmed all the knowledge creation phases and conversion process, with one minor adjustment on the socialisation mode (tacit-to-tacit). Nonaka et al., (1994, 2000b) hypothesised and then confirmed the existence of four phases to this mode. These phases are tacit knowledge accumulation, intra-firm collection, extra-firm collection and tacit knowledge transfer. Findings of this research confirmed the last phase,

integrated the second and the third phase, which is referred to in this study as tacit knowledge acquisition, and rejected the first one.

8.3 Implications for managers

The findings of the research have identified a number of implications that can be useful to managers.

1. Recommendations for the design of information technology infrastructure that support knowledge creation activities
 - a. Managers are advised to make sure that the design of an information technology infrastructure should support redundancy of information, which means the availability of information that goes beyond the immediate operational requirements, as redundancy can offer an overlapping knowledge within the organisation, which helps the organisation's members to sense what others are trying to articulate, and promote cross-functional collaboration.
 - b. Managers are encouraged, when designing information technology infrastructure, to make sure that information can be easily transferred among and between employees. Sharing information within the organisation will encourage individuals to share their own tacit knowledge.
 - c. Information technology infrastructure can play a significant role in promoting and supporting autonomy. Information technology increases the level of

independence of an individual by creating an extra horizon to experiment and try to solve a problem, as autonomy increases the possibilities of individuals to motivate him or herself and, hence, works as a driver for the organisation's members to generate new and original ideas. Managers are advised to make sure that the required level of autonomy is made possible.

d. Organisations should adopt an open posture towards any environmental change in order to improve its ability to create and capture new knowledge. The speed, flexibility and ease of making changes given to the organisation by information technology such as the web technology will help organisations to react quickly and update its information.

e. Managers should make sure that the design of an information technology infrastructure will allow accessibility to be granted to all employees. For example, using databases and friendly graphical user interface should make it possible for people to access easily various type of information. Accessibility leads to facilitating the augmentation of new knowledge and should help to spread that knowledge across the organisation.

f. Managers should consider the concept of memory reminding mechanisms which information technology infrastructure can offer.

2. The culture and infrastructure for knowledge transfer

- a. Managers are encouraged to infuse the sense of co-operation.
- b. Managers should appreciate and encourage knowledge sharing. One way of doing that is by creating an award for knowledge sharing and where only employees can nominate a candidate.
- c. Managers are encouraged to provide their employees with the time and space for knowledge creation; for example, fair, talk room, etc...
- d. Managers should expand their horizon of intolerance by accepting and rewarding the creative errors and collaboration.
- e. Managers are encouraged to improve their employees' skills through continuous training, teaming and job rotation and by infusing a sense of crisis and demand that employees should find a solution/s.

8. 4 Limitations of the study

The research was carried out with the intention of being as accurate as possible but it is acknowledged that limitations to the findings presented in previous chapters do exist.

1. The choice of population was limited to a single industry, which has a tendency to limit the generalisability of the findings in the context of other industries.

However, restricting the research to one industry may affect the concept of the generalisability of the result. A number of researchers have asserted that the rationale for conducting single industry studies is to lessen the problem of industry confusion (Ibrahim, 2000; Colgate 1996; Boyd and Elliott, 1998).

2. The choice of methodology was limited to one method of data collection (the questionnaire survey). It is acknowledged that, because of using postal surveys the researcher is not able to get the respondents to explain their responses, or for a particular response to ask the question 'why'. It is clearly indicated in the methodology chapter that it was beyond the research power, due to a number of constraints mentioned in chapter four, to choose multiple methods of data collection.

8.5 Areas for further research

The findings of this research have answered all the questions asked by the researcher; the objectives are all satisfied and achieved. In undertaking such research where gaps may exist, many questions are raised as a consequence. The following directions are suggested for further research.

1. The research findings indicated that ITISKCFs and IKT have an insignificant relationship with conceptual knowledge. Further research should attempt to delve deeper into the process of conceptual knowledge creation to improve the overall elements of these two enablers and, hence, the likelihood of enhancing

their enabling role of tacit-to-explicit conversion. Such research should complement the research in this thesis.

2. Further research should integrate more than one type of service industry of similar characteristics of business environment such as a knowledge and information intensive industries, where continuous innovation, high competitiveness, speed of products to market and customer focus (for more details see chapter one section 1.1.1) is part of its main characteristic. The researcher suggests that further research might consider the telecommunication service industry, such as telephone and mobiles and its related services, since it has to some extent similar business characteristics.
3. Further research is encouraged to transfer the research model of this study from the intra-organisational to inter-organisational setting (suggestions: R&D collaborative project and joint venture).

8.6 Conclusion

Organisational knowledge creation activities were investigated throughout this research and a number of compelling results were identified. The subject of knowledge creation is relatively new and interesting area; however, it is still largely undeveloped. It represents a wide and open venue for researchers who are eager for new knowledge. This research has managed to close some of the gaps that exist, many are still there be understood and investigated. Some of these were highlighted for further research.

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Appendix A: a sample of the cover letter

University of
HUDDERSFIELD

Barclays Bank
Product Development
Longwood Close,
West Wood Business Park
Coventry, CV4 8JN

F. Alkhalidi
Research Staff
Huddersfield University Business School
University of Huddersfield
Queensgate, Huddersfield
HD1 3DH
Tell: 01484 473197

Dear Mr.

Re: Research project on the role of information and communication technologies supporting knowledge and innovation management in the UK financial service industry.

In response to a telephone conversation I had with you, I am enclosing some additional information about my research.

I am currently undertaking a research project at Huddersfield University Business School. The main focus of the research is on the use of information technology (IT) to supporting organisational knowledge creation and sharing activities intended for developing new financial products and services. The research also examine the level of organisational "knowledge friendly culture" and it role on promoting maximum time spend on the knowledge creation activities.

The first stage of the empirical research "the pilot study" has been recently concluded. The Second, and most principal part of the research, is the primary data collection. For this stage we kindly request you assistant us to identify 12 to 15 line managers within you organisation that could participate in this survey and thereby provide support for our investigation.

I would be pleased to send you a competitive industry analysis as a token of appreciation for your participation in this study. These findings should prove of great value to your department and your organisation as a whole.

I can assure you of complete confidentiality. No individual or company name will be revealed to any source under any circumstance. Research findings will be written in summary and one institution could not be able to identified from other. I hope the above proposal will interest you and that you fell that the research will also be of a benefit to your organisation.

Thanks gain for your time in considering this research. I will give you a call next week to hear your reply. A copy of the survey instrument is included for your review.

Yours Sincerely

F. Alkhalidi
Email: f.alkhalidi@hud.ac.uk

Appendix B: the survey instrument



University of
HUDDERSFIELD

**HUDDERSFIELD UNIVERSITY BUSINESS SCHOOL
DEPARTMENT OF ECONOMICS AND BUSINESS STUDIES**

SURVEY INSTRUMENT

**THE CONTENTS OF THIS SURVEY ARE ABSOLUTELY CONFIDENTIAL.
INFORMATION IDENTIFYING THE RESPONDENT WILL NOT BE
DISCLOSED UNDER ANY CIRCUMSTANCES.**

- **It is very imperative that you fill out this survey.**

1. Bank Name: _____
2. Your Division: _____
3. Your current position: _____
4. Name: _____

PLEASE READ THE FOLLOWING EXPLANATORY NOTE CAREFULLY BEFORE YOU PROCEED ANSWERING THE QUESTIONNAIRE.

1. **Computer:** means a personal computer with various configurations supported by network technology facilitating two way communications.
2. **Innovating** means putting new ideas to gainful use.
3. **"My organisation"** refers to the organisation one normally works for and excludes any associated organisation.
4. **Projects** refers to all those projects and tasks that deal with quality and productivity improvement, system integration, design, research and development, starting a new product or business processes etc.
5. **"Abductive Thinking":** means to carry off or lead away the promoting of rational thoughts and reasoning in order to extract new concepts or ideas.
6. **"Enactive liaisoning":** Is to have power to act as a connection, or a means of communication between different groups or units of an organisation by working closely with more than one group in order to communicate information between them.

Section 1. The following questions are about the your usage of computer (whether it is direct or indirect)

Please indicate to what extent you agree with the following assertions.

1=Strongly disagree 2=Disagree 3=Uncertain 4=Agree 5=Strongly agree

| | | | | | |
|---|---|---|---|---|---|
| 1. Computer supports the availability of variety of information, such as information about business activities, management responsibilities, and the organisation as a whole. | 1 | 2 | 3 | 4 | 5 |
| 2. Overlapping information enabled by computer allows me to sense what my colleagues are trying to articulate. | 1 | 2 | 3 | 4 | 5 |
| 3. Overlapping information facilitated by computer enables me to surpass functional boundaries to offer advice or provide information from a different perspective to other organisational members. | 1 | 2 | 3 | 4 | 5 |
| 4. Overlapping information facilitated by computer helps me to understand my role in the organisation. | 1 | 2 | 3 | 4 | 5 |
| 5. Overlapping information enabled by computer promotes the sharing of information across functions. | 1 | 2 | 3 | 4 | 5 |
| 6. Constantly changing information facilitated by the computer enables me to relate old information to new ones to form new concepts or ideas. | 1 | 2 | 3 | 4 | 5 |
| 7. Frequent changes in information facilitated by the computer triggers a breakdown of routines. | 1 | 2 | 3 | 4 | 5 |
| 8. Information changes frequently, enabled by the ease of making changes with the computer. | 1 | 2 | 3 | 4 | 5 |
| 9. Computer enables the making of changes in the way information is processed to react to new developments. | 1 | 2 | 3 | 4 | 5 |
| 10. Computer helps me to identify the subject matter expert. | 1 | 2 | 3 | 4 | 5 |
| 11. Computer insures me a fast access to the broadest variety of necessary and relevant information, going through the fewest steps. | 1 | 2 | 3 | 4 | 5 |
| 12. Computer enabled the construction of information processing channels that match the information loads imposed by the environment. | 1 | 2 | 3 | 4 | 5 |
| 13. Computer enables me to combine information differently, flexibly, and quickly. | 1 | 2 | 3 | 4 | 5 |
| 14. Computer enables me to identify where information is located and accumulated. | 1 | 2 | 3 | 4 | 5 |
| 15. A great deal of necessary information to accomplish my tasks is coming from the computer. | 1 | 2 | 3 | 4 | 5 |
| 16. Information needed to perform my task is stored in the computer enabling me to act independently when facing a problem or an inquiry. | 1 | 2 | 3 | 4 | 5 |
| 17. With the use of computers my level of freedom for undertaking tasks has been expanded. | 1 | 2 | 3 | 4 | 5 |
| 18. Computer facilitation of testing, experimenting, and forecasting has encouraged risk taking behaviour in exploring new ideas. | 1 | 2 | 3 | 4 | 5 |
| 19. My cognitive style in relation to problem solving has been weakened through the use of computer. | 1 | 2 | 3 | 4 | 5 |

**Section 2. The following questions are about the dynamics of your Work.
How often do you perform the following activities? And how critical are these activities for successfully performing your job.**

1=Never 2=Occasionally 3=Some of the time 4=Most of the time 5=All the time

| | | | | | |
|---|---|---|---|---|---|
| 1. Gathering information from sales and customer service site | 1 | 2 | 3 | 4 | 5 |
| 2. Sharing experience with suppliers and customers. | 1 | 2 | 3 | 4 | 5 |
| 3. Engaging in dialogue with competitors. | 1 | 2 | 3 | 4 | 5 |
| 4. Engaging in body language through management by wandering about. | 1 | 2 | 3 | 4 | 5 |
| 5. Getting ideas for corporate strategy from daily social life. | 1 | 2 | 3 | 4 | 5 |
| 6. Interacting with external expert and informal meetings with competitors. | 1 | 2 | 3 | 4 | 5 |
| 7. Finding new strategies by wandering about inside the firm. | 1 | 2 | 3 | 4 | 5 |
| 8. Finding new market opportunities by wandering about inside the firm. | 1 | 2 | 3 | 4 | 5 |
| 9. Creating a work environment that allows peers to gain expertise through practice (on job training). | 1 | 2 | 3 | 4 | 5 |
| 10. Creating a work environment that allows peers to gain expertise through apprenticeship. | 1 | 2 | 3 | 4 | 5 |
| 11. Facilitating creative and essential dialogue. | 1 | 2 | 3 | 4 | 5 |
| 12. Using "abductive thinking" to acquire new thoughts and ideas | 1 | 2 | 3 | 4 | 5 |
| 13. Using analogy, metaphor, and model in dialogue for concept creation. | 1 | 2 | 3 | 4 | 5 |
| 14. Employing figurative language to creatively brainstorm ideas and concept creation. | 1 | 2 | 3 | 4 | 5 |
| 15. Executing and trying out tentative designs on a small scale. | 1 | 2 | 3 | 4 | 5 |
| 16. Engaging in planning strategies and operations | 1 | 2 | 3 | 4 | 5 |
| 17. Assembling internal and external data using published literature. | 1 | 2 | 3 | 4 | 5 |
| 18. Utilising computer simulation and forecasting for possible future products or services. | 1 | 2 | 3 | 4 | 5 |
| 19. Building or creating manuals or users guide for products or services | 1 | 2 | 3 | 4 | 5 |
| 20. Documentation and databases on products or services. | 1 | 2 | 3 | 4 | 5 |
| 21. Building up materials by gathering management figures and technical information from all over the organisation. | 1 | 2 | 3 | 4 | 5 |
| 22. Engaging in planning of presentations to transmit newly created concepts. | 1 | 2 | 3 | 4 | 5 |
| 23. Engaging in implementation of presentations to transmit newly created concepts. | 1 | 2 | 3 | 4 | 5 |
| 24. Engaging in "enactive liaison" activities with functional departments through cross-functional development teams. | 1 | 2 | 3 | 4 | 5 |
| 25. Searching and sharing new values and thoughts. | 1 | 2 | 3 | 4 | 5 |
| 26. Engaging in overlapping products and services development. | 1 | 2 | 3 | 4 | 5 |
| 27. Sharing and trying to understand management visions and values through communication with fellow members in the organisation. | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|--|---|---|---|---|---|
| 28. Engaging in facilitating prototyping for new products and services. | 1 | 2 | 3 | 4 | 5 |
| 29. Engaging in benchmarking and test markets for new products and services. | 1 | 2 | 3 | 4 | 5 |
| 30. Facilitating the challenging spirit within the organisation. | 1 | 2 | 3 | 4 | 5 |
| 31. Forming teams and conducting research on ideas for future products and services, and sharing results with the entire department. | 1 | 2 | 3 | 4 | 5 |

Section 3. The following questions are about your organisation

Section 3A: Please indicate to what extent you agree with the following assertions.

1=Strongly disagree 2=Disagree 3= Uncertain 4=Agree 5=Strongly agree

| | | | | | |
|---|---|---|---|---|---|
| 1. I find my colleagues very helpful in sharing knowledge and information. | 1 | 2 | 3 | 4 | 5 |
| 2. I find my colleagues very helpful when I encountered difficulties with my work. | 1 | 2 | 3 | 4 | 5 |
| 3. In my organisation people show little interest in each other's work. | 1 | 2 | 3 | 4 | 5 |
| 4. In my organisation very few people take the initiative to raise new projects. | 1 | 2 | 3 | 4 | 5 |
| 5. I have colleagues who help others to turn ideas into action and reality. | 1 | 2 | 3 | 4 | 5 |
| 6. I have colleagues who impress me with their innovative ideas, energy, and resourcefulness. | 1 | 2 | 3 | 4 | 5 |
| 7. My colleagues and I are able to come up with creative ideas when we face tough problems. | 1 | 2 | 3 | 4 | 5 |
| 8. My organisation creates its own intellectual assets, e.g. special techniques, patents. | 1 | 2 | 3 | 4 | 5 |
| 9. In my organisation different departments work together harmoniously. | 1 | 2 | 3 | 4 | 5 |
| 10. In my organisation there is a strong sense of mutual trust. | 1 | 2 | 3 | 4 | 5 |
| 11. My organisation captures information diligently from external sources, e.g. customers. | 1 | 2 | 3 | 4 | 5 |
| 12. Teamwork is poor in my organisation. | 1 | 2 | 3 | 4 | 5 |
| 13. Documentation, information, and databases are well managed in my organisation | 1 | 2 | 3 | 4 | 5 |
| 14. In my organisation the dissemination of information relevant to work is excellent. | 1 | 2 | 3 | 4 | 5 |
| 15. My organisation is unable to accumulate knowledge or learn and benefit from experience. | 1 | 2 | 3 | 4 | 5 |
| 16. My organisation information system is a great aid to finding ideas and opportunities. | 1 | 2 | 3 | 4 | 5 |

Section 3B. For the following questions, please indicate to what extent these activities are practised in your organisation.

| | | | | |
|----------------------|-----------------|-------------------|----------------|---------------------|
| 1=Very little extent | 2=little extent | 3=Moderate extent | 4=Great extent | 5=Very great extent |
|----------------------|-----------------|-------------------|----------------|---------------------|

| | | | | | |
|---|---|---|---|---|---|
| 1. My organisation encourages building relationships and trust through face-to-face meetings. | 1 | 2 | 3 | 4 | 5 |
| 2. My organisation supports establishing common ground through education, discussion, publication, teaming, and job rotation. | 1 | 2 | 3 | 4 | 5 |
| 3. My organisation supports establishing time and space for knowledge transfer through fairs, talk room, and conference reports. | 1 | 2 | 3 | 4 | 5 |
| 4. In my organisation management evaluate individual's performance and provide incentives based on sharing knowledge. | 1 | 2 | 3 | 4 | 5 |
| 5. My organisation educates employees for flexibility. | 1 | 2 | 3 | 4 | 5 |
| 6. My organisation encourages a non-hierarchical approach to knowledge. i.e. knowledge is appreciated no matter the hierarchical-level of the source. | 1 | 2 | 3 | 4 | 5 |
| 7. Leadership and top management conveys their vision regarding what kind of knowledge should be developed. | 1 | 2 | 3 | 4 | 5 |
| 8. My organisation hires for openness of ideas | 1 | 2 | 3 | 4 | 5 |
| 9. My organisation provides time for learning | 1 | 2 | 3 | 4 | 5 |
| 10. In my organisation management accepts and rewards creative error and collaboration. | 1 | 2 | 3 | 4 | 5 |

Section 4. To help us classify your answers, please answer the following questions about your bank and your self.

1. Age: ()
2. What is your level of education? (mark one)
 1. HND () 2. Bachelor's Degree () 3. Postgraduate degree or equivalent ()
3. Please indicate the number of innovating projects (see explanatory note, item 2 & 4) you have been involved in. e.g. developing either a product or a process.

None () 1-5 () 6-10 () 11-15 () More than 15 ()
4. How long have you been in your current position? _____ Years _____ Months.
5. Please indicate the number of approval levels from your position to the Division Executive Officer.

0 level () 1-2 levels () 3-4 levels () 5-6 levels. ()

Section 5. Please include any comments.

Thank you for your valuable time

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 Tel: 01484 473197, Email: f.alkhalidi@hud.ac.uk

Appendix C: List of retail banks and building societies in the actual sample.

Retail banks in the actual sample.

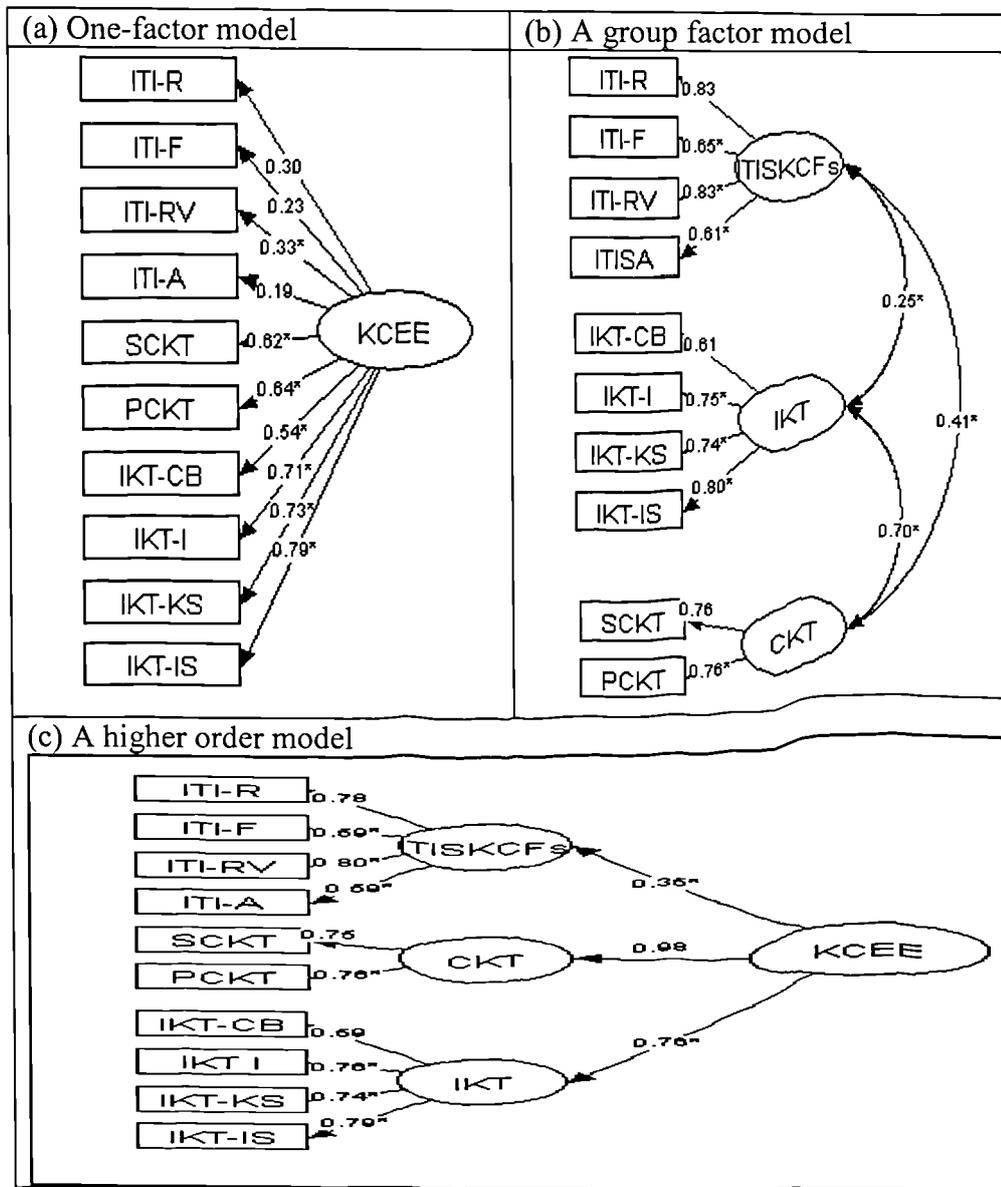
| |
|--------------------------|
| Abbey National PLC |
| Alliance & Leicester PLC |
| Bank of Scotland |
| Barclays Bank PLC |
| Clydesdale Bank PLC |
| First Direct |
| Halifax Bank PLC |
| HSBC |
| Lloyds TSB |
| Nat West Bank |
| Royal Bank of Scotland |
| Sainsburys Bank |
| The Cooperative Bank |
| Yorkshire Bank PLC |

Building Societies in the actual sample.

| |
|-------------------------------------|
| Barnsley Building Society |
| Bath Investment & Building Society |
| Beverley Building Society |
| Britannia Building Society |
| Buckinghamshire Building Society |
| Cambridge Building Society |
| Catholic Building Society |
| Chelsea Building Society |
| Cheshire Building Society |
| Chorley & District Building Society |
| Coventry Building Society |
| Cumberland Building Society |
| Derbyshire Building Society |
| Dudley Building Society |
| Dunfermline Building Society |
| Furness Building Society |
| Gainsborough Building Society |
| Hanley Economic Building Society |
| Harpenden Building Society |
| Hinckley and Rugby Building Society |
| Ipswich Building Society |
| Kent Reliance Building Society |
| Lambeth Building Society |

| |
|---|
| Leeds & Holbeck Building Society |
| Leek United Building Society |
| Loughborough Building Society |
| Manchester Building Society |
| Mansfield Building Society |
| Market Harborough Building Society |
| Marsden Building Society |
| Melton Mowbray Building Society |
| Mercantile Building Society |
| Monmouthshire Building Society |
| National Counties Building Society |
| Nationwide Building Society |
| Newbury Building Society |
| Newcastle Building Society |
| Norwich & Peterborough Building Society |
| Nottingham Building Society |
| Portman Building Society |
| Principality Building Society |
| Progressive Building Society |
| Saffron Walden Herts & Essex Building Society |
| Scarborough Building Society |
| Scottish Building Society |
| Shepshed Building Society |
| Skipton Building Society |
| Staffordshire Building Society |
| Stroud & Swindon Building Society |
| Teachers' Building Society |
| Tipton & Coseley Building Society |
| Universal Building Society |
| West Bromwich Building Society |
| Yorkshire Building Society |

Appendix D: Comparison between measurement models of KCEE traits



Goodness of fit for the three proposed measurement models of KCEE traits

| | AFM | | | | IFM | | | |
|--------------------|----------------------|----------------------|------|-------|------|------|------|------------------|
| | χ^2 | S-B χ^2 | GFI | RMSEA | TLI | IFI | CFI | ^R CFI |
| One-factor model | 159.0(35) P=0.000 | 149.1(35) P=0.000 | 0.74 | 0.19 | 0.53 | 0.65 | 0.60 | 0.65 |
| Group factor model | 55.0(32) P=0.007 | 47.3(32) P=0.04 | 0.91 | 0.09 | 0.91 | 0.94 | 0.94 | 0.94 |
| Higher order Model | 41.0(33) P=0.16 | 36.8(33) P=0.29 | 0.97 | 0.05 | 0.97 | 0.98 | 0.98 | 0.99 |

χ^2 , Chi-square; S-B χ^2 , Scaled S-B Chi-square; GFI, Goodness-of-fit index; RMSEA, Root-mean-square error of approximation; TLI, Tucker-Lewis fit index; IFI, Incremental fit index; CFI, Comparative fit index; ^RCFI, Robust comparative fit index.

Appendix E Sample of the SEM output (Model KECC-SK)

EQS, A STRUCTURAL EQUATION PROGRAM
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MULTIVARIATE SOFTWARE, INC.
VERSION 5.7b (C) 1985 - 1998.

PROGRAM CONTROL INFORMATION

```

1  /TITLE
2  Model created by EQS 5.7b -- KCEE-SK3.EDS
3  /SPECIFICATIONS
4  DATA='C:\FIRAS\DATA\ALHAMD\FRAG.ESS';
5  VARIABLES= 18; CASES= 102; del=13, 36;
6  METHODS=ML,ROBUST;
7  MATRIX=RAW;
8  /LABELS
9  V1=ITISR; V2=ITISF; V3=ITISRV; V4=ITISA; V5=SKA;
10 V6=SKT; V7=CK; V8=SyKa; V9=SyKp; V10=SyKd;
11 V11=OKrwk; V12=OKvwk; V13=SCKT; V14=PCKT; V15=IKT-CB;
12 V16=IKT-I; V17=IKT-KS; V18=IKT-IS;
13 /EQUATIONS
14 V1 = + 1F1 + 1E1;
15 V2 = + *F1 + 1E2;
16 V3 = + *F1 + 1E3;
17 V4 = + *F1 + 1E4;
18 V5 = + 1F5 + 1E5;
19 V6 = + *F5 + 1E6;
20 V13 = + 1F2 + 1E13;
21 V14 = + *F2 + 1E14;
22 V15 = + 1F3 + 1E15;
23 V16 = + *F3 + 1E16;
24 V17 = + *F3 + *F5 + 1E17;
25 V18 = + *F3 + 1E18;
26 F1 = + *F4 + 1D1;
27 F2 = + 1F4 + 1D2;
28 F3 = + *F4 + 1D3;
29 F5 = + *F1 + 1D5;
30 /VARIANCES
31 F4 = *;
32 E1 = *;
33 E2 = *;
34 E3 = *;
35 E4 = *;
36 E5 = *;
37 E6 = 0.01;
38 E13 = *;
39 E14 = *;
40 E15 = *;
41 E16 = *;
42 E17 = *;
43 E18 = *;
44 D1 = *;
45 D2 = 0.01;
46 D3 = *;
47 D5 = *;
48 /COVARIANCES
49 E2 , E1 = *;
50 /LMTEST
51 PROCESS=SIMULTANEOUS;
52 SET=PVV, PFV, PFF, PEE, PDD, GVV, GVF, GFV, GFF, BVF, BFF;

```

```
TITLE:   Model created by EQS 5.7b -- KCEE-SK3.EDS
EQS/EM386 Licensee: Firas Alkhalidi
 53  /PRINT
 54  effect=yes; covariance=yes; correlation=yes;
 55  digit=3;
 56  linesize =80;
 57  fit=all;
 58  /OUTPUT
 59  parameters;
 60  standard errors;
 61  listing;
 62  data='EQSOUT&.ETS';
 63  /END
```

63 RECORDS OF INPUT MODEL FILE WERE READ

CASE NUMBERS DELETED FROM RAW DATA ARE: 13 36

DATA IS READ FROM C:\FIRAS\DATA\ALHAMD\FRAG.ESS
THERE ARE 18 VARIABLES AND 102 CASES
IT IS A RAW DATA ESS FILE

TITLE: Model created by EQS 5.7b -- KCEE-SK3.EDS
 EQS/EM386 Licensee: Firas Alkhalidi

SAMPLE STATISTICS BASED ON COMPLETE CASES

UNIVARIATE STATISTICS

| VARIABLE | ITISR | ITISF | ITISRV | ITISA | SKA |
|---------------|---------|---------|---------|---------|--------|
| MEAN | 3.4680 | 3.4400 | 3.6600 | 3.8167 | 2.3920 |
| SKEWNESS (G1) | -0.4455 | -0.6582 | 0.0000 | -0.4292 | 0.4890 |
| KURTOSIS (G2) | 0.0978 | 0.4528 | -0.1074 | -0.4878 | 0.1895 |
| STANDARD DEV. | 0.5477 | 0.5343 | 0.5073 | 0.7049 | 0.7380 |

| VARIABLE | SKT | SCKT | PCKT | IKT-CB | IKT-I |
|---------------|---------|---------|---------|---------|---------|
| MEAN | 3.1250 | 3.2999 | 3.2743 | 3.8813 | 3.5015 |
| SKEWNESS (G1) | -0.0892 | -0.0314 | -0.0259 | -0.9200 | -0.7517 |
| KURTOSIS (G2) | -0.4200 | -0.2874 | 0.2445 | 1.8704 | 0.5954 |
| STANDARD DEV. | 0.9384 | 0.6981 | 0.6281 | 0.6108 | 0.7420 |

| VARIABLE | IKT-KS | IKT-IS |
|---------------|---------|---------|
| MEAN | 3.6550 | 3.2145 |
| SKEWNESS (G1) | -0.4412 | -0.0949 |
| KURTOSIS (G2) | 0.0986 | -0.5505 |
| STANDARD DEV. | 0.5110 | 0.6283 |

MULTIVARIATE KURTOSIS

MARDIA'S COEFFICIENT (G2, P) = 5.4236
 NORMALIZED ESTIMATE = 1.4794

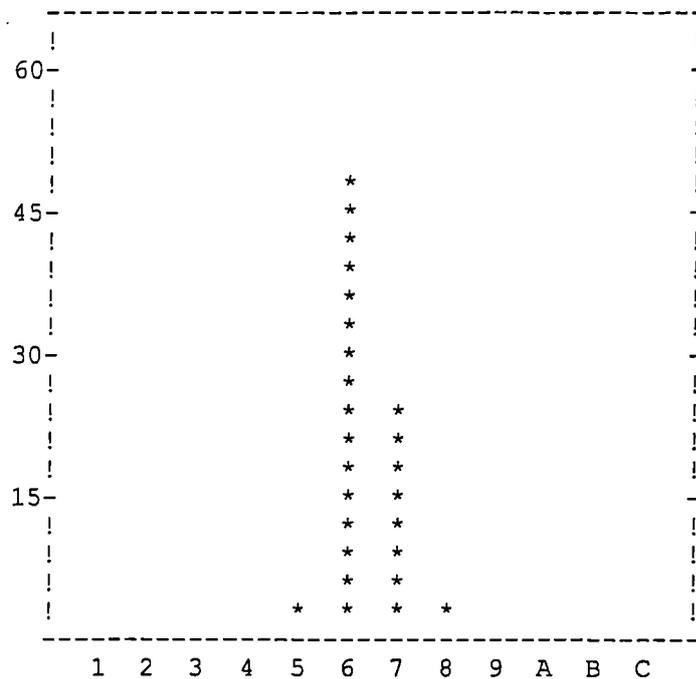
ELLIPTICAL THEORY KURTOSIS ESTIMATES

MARDIA-BASED KAPPA = 0.0323 MEAN SCALED UNIVARIATE KURTOSIS = 0.0471
 MARDIA-BASED KAPPA IS USED IN COMPUTATION. KAPPA= 0.0323

CASE NUMBERS WITH LARGEST CONTRIBUTION TO NORMALIZED MULTIVARIATE KURTOSIS:

| CASE NUMBER | 8 | 15 | 27 | 28 | 80 |
|-------------|----------|---------|---------|---------|----------|
| ESTIMATE | 133.9654 | 93.4687 | 97.1938 | 89.9039 | 157.4855 |

DISTRIBUTION OF STANDARDIZED RESIDUALS



| | RANGE | | FREQ | PERCENT |
|-------|-------|--------|------|---------|
| 1 | -0.5 | - -- | 0 | 0.00% |
| 2 | -0.4 | - -0.5 | 0 | 0.00% |
| 3 | -0.3 | - -0.4 | 0 | 0.00% |
| 4 | -0.2 | - -0.3 | 0 | 0.00% |
| 5 | -0.1 | - -0.2 | 4 | 5.13% |
| 6 | 0.0 | - -0.1 | 47 | 60.26% |
| 7 | 0.1 | - 0.0 | 24 | 30.77% |
| 8 | 0.2 | - 0.1 | 3 | 3.85% |
| 9 | 0.3 | - 0.2 | 0 | 0.00% |
| A | 0.4 | - 0.3 | 0 | 0.00% |
| B | 0.5 | - 0.4 | 0 | 0.00% |
| C | ++ | - 0.5 | 0 | 0.00% |
| TOTAL | | | 78 | 100.00% |

EACH "*" REPRESENTS 3 RESIDUALS

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 MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

MODEL COVARIANCE MATRIX FOR MEASURED AND LATENT VARIABLES

| | | | ITISR | ITISF | ITISRV | ITISA | SKA |
|--------|---|----|-------|-------|--------|-------|-------|
| | | | V 1 | V 2 | V 3 | V 4 | V 5 |
| ITISR | V | 1 | 0.300 | | | | |
| ITISF | V | 2 | 0.159 | 0.286 | | | |
| ITISRV | V | 3 | 0.170 | 0.119 | 0.257 | | |
| ITISA | V | 4 | 0.160 | 0.112 | 0.201 | 0.497 | |
| SKA | V | 5 | 0.027 | 0.019 | 0.034 | 0.031 | 0.545 |
| SKT | V | 6 | 0.102 | 0.071 | 0.128 | 0.120 | 0.228 |
| SCKT | V | 13 | 0.060 | 0.042 | 0.075 | 0.070 | 0.012 |
| PCKT | V | 14 | 0.052 | 0.036 | 0.065 | 0.061 | 0.010 |
| IKT-CB | V | 15 | 0.032 | 0.022 | 0.040 | 0.038 | 0.006 |
| IKT-I | V | 16 | 0.047 | 0.033 | 0.059 | 0.056 | 0.009 |
| IKT-KS | V | 17 | 0.043 | 0.030 | 0.054 | 0.050 | 0.035 |
| IKT-IS | V | 18 | 0.039 | 0.027 | 0.049 | 0.046 | 0.008 |
| F1 | F | 1 | 0.135 | 0.094 | 0.170 | 0.160 | 0.027 |
| F2 | F | 2 | 0.060 | 0.042 | 0.075 | 0.070 | 0.012 |
| F3 | F | 3 | 0.032 | 0.022 | 0.040 | 0.038 | 0.006 |
| F4 | F | 4 | 0.060 | 0.042 | 0.075 | 0.070 | 0.012 |
| F5 | F | 5 | 0.027 | 0.019 | 0.034 | 0.031 | 0.059 |

| | | | SKT | SCKT | PCKT | IKT-CB | IKT-I |
|--------|---|----|-------|-------|-------|--------|-------|
| | | | V 6 | V 13 | V 14 | V 15 | V 16 |
| SKT | V | 6 | 0.881 | | | | |
| SCKT | V | 13 | 0.045 | 0.488 | | | |
| PCKT | V | 14 | 0.039 | 0.240 | 0.395 | | |
| IKT-CB | V | 15 | 0.024 | 0.143 | 0.124 | 0.373 | |
| IKT-I | V | 16 | 0.035 | 0.211 | 0.183 | 0.235 | 0.551 |
| IKT-KS | V | 17 | 0.135 | 0.138 | 0.120 | 0.150 | 0.222 |
| IKT-IS | V | 18 | 0.030 | 0.176 | 0.152 | 0.196 | 0.290 |
| F1 | F | 1 | 0.102 | 0.060 | 0.052 | 0.032 | 0.047 |
| F2 | F | 2 | 0.045 | 0.277 | 0.240 | 0.143 | 0.211 |
| F3 | F | 3 | 0.024 | 0.143 | 0.124 | 0.158 | 0.235 |
| F4 | F | 4 | 0.045 | 0.267 | 0.232 | 0.143 | 0.211 |
| F5 | F | 5 | 0.228 | 0.012 | 0.010 | 0.006 | 0.009 |

| | | | IKT-KS | IKT-IS | F1 | F2 | F3 |
|--------|---|----|--------|--------|-------|-------|-------|
| | | | V 17 | V 18 | F 1 | F 2 | F 3 |
| IKT-KS | V | 17 | 0.267 | | | | |
| IKT-IS | V | 18 | 0.185 | 0.395 | | | |
| F1 | F | 1 | 0.043 | 0.039 | 0.135 | | |
| F2 | F | 2 | 0.138 | 0.176 | 0.060 | 0.277 | |
| F3 | F | 3 | 0.150 | 0.196 | 0.032 | 0.143 | 0.158 |
| F4 | F | 4 | 0.138 | 0.176 | 0.060 | 0.267 | 0.143 |
| F5 | F | 5 | 0.035 | 0.008 | 0.027 | 0.012 | 0.006 |

| | | | F4 | F5 |
|----|---|---|-------|-------|
| | | | F 4 | F 5 |
| F4 | F | 4 | 0.267 | |
| F5 | F | 5 | 0.012 | 0.059 |

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 MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

GOODNESS OF FIT SUMMARY

INDEPENDENCE MODEL CHI-SQUARE = 419.635 ON 66 DEGREES OF FREEDOM

INDEPENDENCE AIC = 287.63469 INDEPENDENCE CAIC = 49.69346
 MODEL AIC = -46.37173 MODEL CAIC = -226.63024

CHI-SQUARE = 53.628 BASED ON 50 DEGREES OF FREEDOM
 PROBABILITY VALUE FOR THE CHI-SQUARE STATISTIC IS 0.33697
 THE NORMAL THEORY RLS CHI-SQUARE FOR THIS ML SOLUTION IS 49.543.

SATORRA-BENTLER SCALED CHI-SQUARE = 51.0489
 PROBABILITY VALUE FOR THE CHI-SQUARE STATISTIC IS 0.43220

BENTLER-BONETT NORMED FIT INDEX= 0.872
 BENTLER-BONETT NONNORMED FIT INDEX= 0.986
 COMPARATIVE FIT INDEX (CFI) = 0.990
 ROBUST COMPARATIVE FIT INDEX = 0.997
 BOLLEN (IFI) FIT INDEX= 0.990
 McDonald (MFI) FIT INDEX= 0.982
 LISREL GFI FIT INDEX= 0.923
 LISREL AGFI FIT INDEX= 0.880
 ROOT MEAN SQUARED RESIDUAL (RMR) = 0.026
 STANDARDIZED RMR = 0.059
 ROOT MEAN SQ. ERROR OF APP. (RMSEA)= 0.029
 90% CONFIDENCE INTERVAL OF RMSEA (0.000, 0.071)

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 MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

MEASUREMENT EQUATIONS WITH STANDARD ERRORS AND TEST STATISTICS
 (ROBUST STATISTICS IN PARENTHESES)

ITISR =V1 = 1.000 F1 +1.000 E1

ITISF =V2 = .698*F1 +1.000 E2
 .135
 5.154
 (.132)
 (5.274)

ITISRV =V3 = 1.258*F1 +1.000 E3
 .219
 5.747
 (.199)
 (6.320)

ITISA =V4 = 1.180*F1 +1.000 E4
 .219
 5.396
 (.209)
 (5.637)

SKA =V5 = 1.000 F5 +1.000 E5

SKT =V6 = 3.826*F5 +1.000 E6
 1.105
 3.461
 (1.173)
 (3.261)

SCKT =V13 = 1.000 F2 +1.000 E13

PCKT =V14 = .866*F2 +1.000 E14
 .173
 5.013
 (.175)
 (4.943)

IKT-CB =V15 = 1.000 F3 +1.000 E15

IKT-I =V16 = 1.481*F3 +1.000 E16
 .235
 6.300
 (.252)
 (5.868)

IKT-KS =V17 = .927*F3 + .496*F5 +1.000 E17

| | | |
|---------------|----------|------------|
| | .154 | .210 |
| | 6.014 | 2.369 |
| | (.214) | (.204) |
| | (4.339) | (2.433) |
| IKT-IS =V18 = | 1.234*F3 | +1.000 E18 |
| | .198 | |
| | 6.239 | |
| | (.236) | |
| | (5.228) | |

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 MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

CONSTRUCT EQUATIONS WITH STANDARD ERRORS AND TEST STATISTICS
 (ROBUST STATISTICS IN PARENTHESES)

| | | |
|----------|---------|-----------|
| F1 =F1 = | .223*F4 | +1.000 D1 |
| | .097 | |
| | 2.307 | |

| | | |
|----------|----------|-----------|
| F2 =F2 = | 1.000 F4 | +1.000 D2 |
|----------|----------|-----------|

| | | |
|----------|---------|-----------|
| F3 =F3 = | .533*F4 | +1.000 D3 |
| | .130 | |
| | 4.088 | |

| | | |
|----------|---------|-----------|
| F5 =F5 = | .197*F1 | +1.000 D5 |
| | .092 | |
| | 2.132 | |

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DECOMPOSITION OF EFFECTS WITH STANDARDIZED VALUES

| PARAMETER | | TOTAL EFFECTS | | | | | | |
|-----------|--------|--------------------|------------------------|------------------------|-----------|------------|--|--|
| ----- | | ----- | | | | | | |
| ITISR | =V1 = | .672 F1 | + .210 F4 | + .741 E1 | + .638 D1 | | | |
| ITISF | =V2 = | .481*F1 | + .151 F4 | + .877 E2 | + .456 D1 | | | |
| ITISRV | =V3 = | .913*F1 | + .286 F4 | + .409 E3 | + .867 D1 | | | |
| ITISA | =V4 = | .616*F1 | + .193 F4 | + .788 E4 | + .585 D1 | | | |
| SKA | =V5 = | .098 F1 .316 D5 | + .330 F5 | + .031 F4 | + .944 E5 | + .093 D1 | | |
| SKT | =V6 = | .296 F1 .949 D5 | + .994*F5 | + .093 F4 | + .107 E6 | + .281 D1 | | |
| SCKT | =V13 = | .754 F2 | + .741 F4 | + .656 E13 | + .143 D2 | | | |
| PCKT | =V14 = | .726*F2 | + .713 F4 | + .687 E14 | + .138 D2 | | | |
| IKT-CB | =V15 = | .652 F3 | + .452 F4 | + .758 E15 | + .470 D3 | | | |
| IKT-I | =V16 = | .794*F3 | + .550 F4 | + .607 E16 | + .573 D3 | | | |
| IKT-KS | =V17 = | .070 F1 .066 D1 | + .714*F3 + .515 D3 | + .234*F5 + .224 D5 | + .517 F4 | + .643 E17 | | |
| IKT-IS | =V18 = | .782*F3 | + .542 F4 | + .623 E18 | + .564 D3 | | | |
| F1 | =F1 = | .313*F4 | + .950 D1 | | | | | |
| F2 | =F2 = | .982 F4 | + .190 D2 | | | | | |
| F3 | =F3 = | .693*F4 | + .721 D3 | | | | | |
| F5 | =F5 = | .297*F1 | + .093 F4 | + .282 D1 | + .955 D5 | | | |

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CORRELATIONS AMONG INDEPENDENT VARIABLES

| | E | | D | |
|-----------|---|--------|---|---|
| E2 -ITISF | | .340*I | | I |
| E1 -ITISR | | I | | I |
| | | I | | I |

 E N D O F M E T H O D

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MULTIVARIATE LAGRANGE MULTIPLIER TEST BY SIMULTANEOUS PROCESS IN STAGE 1
 PARAMETER SETS (SUBMATRICES) ACTIVE AT THIS STAGE ARE:

PVV PFV PFF PEE PDD GVV GVF GFV GFF BVF BFF

CUMULATIVE MULTIVARIATE STATISTICS

UNIVARIATE INCREMENT

| STEP | PARAMETER | CHI-SQUARE | D.F. | PROBABILITY | CHI-SQUARE | PROBABILITY |
|------|-----------|------------|------|-------------|------------|-------------|
| 1 | E16,E15 | 12.219 | 1 | 0.000 | 12.219 | 0.000 |

Execution begins at 00:52:37.88
 Execution ends at 00:52:38.21
 Elapsed time = 0.33 seconds